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Abstract

A hand-off is the process during which a node is handed off between two mobility agents. Mobile IP hand-offs occur as a consequence of lower layer (i.e., link-layer) hand-offs that signify a location switch between two IP networks. For the duration of a Mobile IP hand-off, a mobile node is unable to send or receive traffic. The length of this disruption is considered critical because it can affect the performance of communications. An additional factor that is closely bound with that of Mobile IP hand-offs is that of agent selection. That involves the selection of the most suitable mobility agent from which a mobile node should receive service. With the help of link-layer information such as signal strength, signal quality and throughput it is possible to accelerate Mobile IP hand-offs on one side and on the other to lead to the selection of the best possible mobility agent. This draft describes a policy based Mobile IP handoff decision method (POLIMAND) that allows for enhanced Mobile IP handoffs and optimal agent selection based on link layer information.

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1. Introduction

For the duration of Mobile IP hand-offs a mobile node is unable to send or receive traffic and is therefore said to suffer network service disruption. In order to reduce the duration of Mobile IP hand-offs and choose the optimal mobility agent for the provision of Mobile IP services, Mobile IP can benefit from link layer information available in all bearer technologies (wireless or wirelined).
In specific, in cellular and wireless LAN networks, Mobile IP hand-off decision making can benefit from link layer information such as signal strength, signal quality and throughput for the support of seamless roaming and low packet loss during handoffs. This draft describes a policy based Mobile IP hand-off method (POLIMAND) that considers the aforementioned link layer information that are indicative of the status of any underlying bearer technology to determine the terms of each hand-off.

Due to existence of a wide range of wireless bearer technologies with different characteristics, POLIMAND introduces an intermediate layer between Mobile IP and any bearer technologies. This layer gathers and evaluates information from the various link-layers generating hints towards Mobile IP. POLIMAND can monitor changes in various link-layer parameters, determining tendencing or forecasting upcoming changes in link state. By means of introducing thresholds POLIMAND can provide link quality control for each of the underlying bearer technologies separately. This combined with filtering of mobility agent advertisements can lead to effective Mobile IP hand-off decision making without the need for major changes in the Mobile IP protocol.

The advantages of POLIMAND are:

It provides a uniform interface for a range of heterogeneous bearer technologies for the interaction with Mobile IP.
It may interact with Mobile IP with the help of hints that indicate when and how a Mobile IP hand-off should occur.
If interaction with Mobile IP is not supported, it may through filtering of mobility agent advertisements lead Mobile IP to perform a hand-off.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC-2119.

This document uses the following terms:

Domain A collection of networks sharing a common network administration.

Home domain

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As defined in [4].

Visited domain
The domain where the mobile node has one or more points of attachment.

Home Agent (HA)
As defined in [1].

Correspondent Node (CN)
As defined in [1].
Home Network
   As defined in [1].

Mobile Node (MN)
   As defined in [1].

Mobility Binding
   As defined in [1].

3. Mobile IP Hand-offs based on Link Layer Information

There are different bearer access technologies available which provide different link layer information. Different bearer access technologies are current and future technologies like IEEE 802.11a/b/g, hiperLAN2, GSM, GPRS and UMTS. These technologies implement various link layers for data communication.

Different link layer information requires a generic platform which combines link layer information from different link layer systems. However, a list of different link layer parameters from various network systems are required that simplifies the control of Mobile IP handoffs between different access domains.

Link layer parameters can be divided in Link Information, Environment Information, Neighborhood Information, Link Layer Management Information. The most important Link Information parameters are signal strength, signal quality and throughput. Signal quality is more appropriate than signal strength due to the fact that signal quality contains information about the S/N ratio. Throughput requires measurements during data transmission. However, signal strength is appropriate to force Mobile IP handoffs between different bearer access technologies.

4. Policy based Mobile IP Handoff Decision (POLIMAND)

The interaction between link layer information and the network layer to control Mobile IP handoffs is handled by POLIMAND. POLIMAND uses link layer information to decide if there is a handoff from one visited domain to another domain required. The following figure shows the interaction between link layer and POLIMAND to force Mobile IP handoffs in the network layer.

```
+---------------------+
| OSI Layer 4-7       |
+---------------------+
| Network Layer (MIP) |
+---------------------+
| POLIMAND            |
+---------------------+
| Data Link Layer     |
+---------------------+
| Physical Layer      |
+---------------------+
```

Figure 1: Interaction between POLIMAND and network layer to control Mobile IP handoffs.
Mobile IP handoffs based on link layer information.

POLIMAND forces the Mobile IP handoff to change the visited domain of the mobile node. Thus, a policy is required when the handoff has to be forced by POLIMAND. POLIMAND combines different bearer access technologies to control Mobile IP handoffs based on link layer information. This is handled by POLIMAND with respect of current bearer access technologies.

![Interaction of POLIMAND between link layer and network layer with respect of current bearer access technologies.](figure2.png)

**Figure 2:** Interaction of POLIMAND between link layer and network layer with respect of current bearer access technologies.

### 4.1 Link Layer Parameters for POLIMAND

Different link layer parameters can be used by POLIMAND to force Mobile IP handoffs between different bearer access technologies. The following link layer parameters are important for POLIMAND to decide if a handoff has to be forced.

#### 4.1.1 Signal Strength

The signal strength parameter is available in most of the various bearer access technologies, such as IEEE 802.11a/b/g, GSM, W-CDMA and HiperLAN/2. This parameter can be used to control Mobile IP handoffs between these access technologies. However, signal strength does not contain any information about the quality of the signal.

#### 4.1.2 Signal Quality

The signal quality is a link parameter that is also available in most of the bearer access technologies. This parameter contains the required information about the signal to noise ratio that is important to define the quality of the link. The link quality is appropriate to control Mobile IP handoffs to support seamless roaming with a reduction of packet loss during data transmission.

#### 4.1.3 Throughput

The throughput is a link layer parameter that is appropriate to control Mobile IP handoffs. The throughput contains information about the available bandwidth of a link. This is important information to force a Mobile IP handoff to a visited domain that provides the required bandwidth for data transmission. However, this parameter is not available in different bearer access technologies.
Furthermore, throughput requires a measurement during data transmission.

### 4.2 Policy Based Decision Function

POLIMAND defines a policy when the attached access network is no longer available or it does not fulfill the required or the predefined quality parameters. Signal strength is appropriate to force Mobile IP handoffs between different bearer access technologies.

For Mobile IP handoffs between IEEE 802.11b and GPRS the signal quality is the most important link layer parameter in wireless LAN systems that can be measured by the mobile node to receive information about the radio condition within the wireless network system. The measured value is handled by POLIMAND that is part of the mobile node integration.

POLIMAND defines thresholds for the signal quality when the S/N ratio is not adequate for lossless data transmission. The thresholds consider the link layer characteristics when the mobile node roams between different foreign networks. These thresholds are part of a hysteresis that is described in the following paragraph.

### 4.3 Hysteresis for POLIMAND

POLIMAND uses a hysteresis to decide when a handoff has to be forced. The hysteresis is required to avoid ping-pong effects in marginal areas between wireless domains. Ping-pong effects are responsible for high packet loss during handoffs when the velocity is low or wrily.

However, a hysteresis is required in general to force Mobile IP handoffs before the wireless link breaks. Therefore, POLIMAND uses a low watermark and a high watermark.

Especially, for Mobile IP handoffs between IEEE 802.11b and GPRS, the low watermark defines when the mobile node leaves the coverage area of wireless LAN. In this case POLIMAND forces a handoff to GPRS to continue data transmission during the mobile node leaves a wireless hotspot area.

The high watermark defines when the mobile node is in the coverage area of a wireless hotspot area. In this case, POLIMAND forces a handoff to WLAN to continue the data transmission via hotspot domain.

These watermarks have to be measured and define the function of the hysteresis.

### 5. Interaction between POLIMAND and Network Layer

POLIMAND uses link layer information to define when a Mobile IP handoff has to be forced. The control of Mobile IP handoffs is done by POLIMAND and can be handled by the generation of hints for the Mobile IP protocol.
5.1 Using POLIMAND for Mobile IP Hints

POLIMAND generates a hint for Mobile IP to force a handoff between visited domains when the signal quality of the current link is below the predefined threshold. This hint allows the control of Mobile IP handoffs that is based on link layer information. This is handled by POLIMAND by suppressing Mobile IP agent advertisements.

5.2 Suppressing Agent Advertisements for Mobile IP Handoffs

Agent advertisements are required to detect movements of the mobile node. When a mobile node does not detect agent advertisements of the network where it is currently attached, the mobile node forces a handoff to another network that is currently available. The control of agent advertisements has an impact on the connectivity of the mobile node.

POLIMAND suppress agent advertisements when the link quality of the current connection is below the predefined threshold. This forces the mobile node to establish a handoff to another bearer due to the fact that agent advertisements of the attached domain are no longer available. The following figure shows that agent advertisements are controlled by POLIMAND based on link layer information. When the link quality is above the predefined threshold of link quality the advertisements are transmitted to the network layer where Mobile IP uses these advertisements for movement detection.

Figure 3: Mobile IP agent advertisements controlled by POLIMAND based on link layer information.

POLIMAND suppresses agent advertisements when the link quality of the current connection is below the predefined threshold. This forces the mobile node to establish a handoff to another bearer due to the fact that agent advertisements of the attached domain are no longer available.

Figure 4: Mobile IP agent advertisements suppressed by POLIMAND to force Mobile IP handoff.
6. Security Considerations

This draft does not specifically address any security concerns. It is assumed that all layers that have described in this draft interact with other layers without any security considerations.

7. Intellectual Property Considerations

This proposal is in full conformity with [6].

Siemens may have patent rights on technology described in this document which employees of Siemens contribute for use in IETF standard discussions. In relation to any IETF standard incorporating any such technology, Siemens hereby agrees to license on fair, reasonable and non-discriminatory terms, based on reciprocity, any patent claims it owns covering such technology, to the extent such technology is essential to comply with such standard.

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References


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