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Using Higher Layer Triggers for Low Latency Handoffs in MIPv4 draft-antoine-mip4-lowlatency-handoff-triggers-00

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Abstract

This document introduces the use of triggers coming from layers higher than the link layer to initiate the Low Latency Handoff in Mobile IPv4 (MIPv4) . The Low Latency Handoff for MIPv4 assumes availability of Layer 2 (L2) triggers that contain Layer 3 (L3) information for the Mobile Node (MN) to handoff. However, the low latency draft does not describe the method by which the L2 trigger is

produced neither does it explicitly describe by what mechanism the L3 information present in the L2 trigger is acquired. The Low Latency Handoff for MIPv4 relies on availability of the L2 trigger. However relying only on the link information to initiate a handoff does not generally gather enough information for the MN to handoff to the most suitable available access network. Information from higher layers such as Higher Layer Triggers can be used to command a MN to quickly move from one access to another one. Using Higher Layer Triggers to initiate the handoff enables the implementation of policy based handoff to garantee load balancing of the wireless networks and Quality of Services to the end users.

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1. Introduction

Low Latency Handoffs in MIPv4 [LOWLATMIP4] introduces a method that achieves low latency for Mobile IPv4 in support of real-time services. The two methods presented in to achieve low latency are based on reception of various Layer 2 triggers on the MN and the Foreign Agent (FA). The Layer 2 trigger introduced in [LOWLATMIP4] informs L3 of a particular event before L2 handoff actually takes place. The Low Latency Handoff in MIPv4 is only initiated just before the L2 handoff takes place as indicated by the L2 triggers. L2 trigger usually occurs when the signal strength reaches a critical level that requires a handoff to take place. However, handoff may be needed upon reception of parameters other than the ones related to the relative signal strength received. L2 trigger indicating that the MN has just entered the coverage area of a WLAN network is not enough indication to handoff to the most suitable network at the most suitable time. A Mobile Node which is simultaneously connected to several networks, does not necessarily have enough information to initiate the handoff from its default network to a most prefered access network. Due to lack of additional information, the MN may stay connected to an acces network that may turn out to be more costly for the MN than another available one. The lack of information, can cause the MN to stay connected to one access network that does not offer the MN the best quality of service. This lack of informmation, prevents the management of load sharing mechanisms on different access networks to suit several subscribers having different profiles. Higher Layer Triggers or Handoff Commands in response to a policy decision can trigger the MN handoff to the most preferable available network at the most suitable time. The Higher Layer Trigger or Handoff Command comes from a Network Node or from the MN itself. Higher Layer Trigger or a Handoff Command may trigger a MIPv4 handoff even without indication of a pending L2 handoff. Implementing the Higher Layer Handoff Trigger is compatible with [LOWLATMIP4]. One can design a system in which a Higher Layer Trigger or a Handoff Command is used to generate a L2 trigger that subsequently initiates the Low Latency Handoff in MIPv4. In case urgent handoff is needed as indicated by a pending L2 handoff, the low latency takes place even if no Higher Layer Trigger has been received.

2. Terminology

This section introduces the Handoff Command and the Higher Layer Handoff Trigger.

Handoff Command - It is a message sent by an entity in the network to instruct the MN to initiate a handoff.

Higher Layer Handoff Trigger - It is a trigger that comes from a layer higher than Layer 2. The Higher Layer Handoff Trigger can come from Layer 3 or the application layer. The Higher Layer Handoff Trigger may have been generated locally by the entity receiving the trigger. It may also have been generated by a Network Node other than the node receiving the trigger. The Higher Layer Handoff Trigger may be received as an IP message initiated from the network (Handoff Command). The entity receiving the Higher Layer Handoff Trigger is either the MN or the FA or another entity in the network such as the Access Router (AR) that could subsequently interacts directly with the MN at layer 2. The Higher Layer Handoff Trigger can generate the Layer 2 trigger.

3. Motivation

The Higher Layer Trigger or Handoff Command coming from the Network or the MN serves to implement policy based network controlled handoffs. A network operator can command a set of users to handoff to different networks to provide load sharing on its different access networks. The network operator can selectively command Mobile Nodes to handoff to different access networks to provide a level of Quality of Service to different users according to their user profiles. The Higher Layer Trigger that comes from the MN application can initiate handoff when the quality of the application becomes poor. For a Voice over IP application for example, the perceived quality of the voice can serve as a Trigger to the MN to initiate a handoff to a better network. Figure 1 and 2 illustrate the initiation of the Low Latency Handoff by a Higher Layer Trigger from the network or the MN itself.

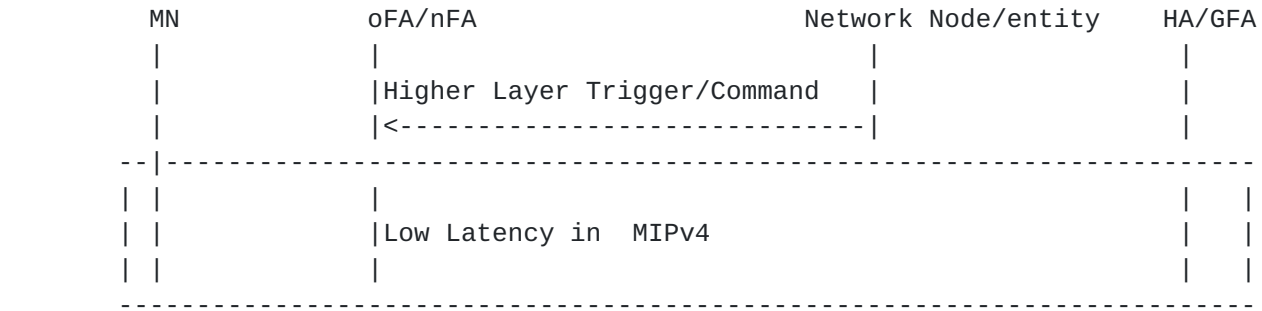

Figure 1: Network initiated, source/target triggered.

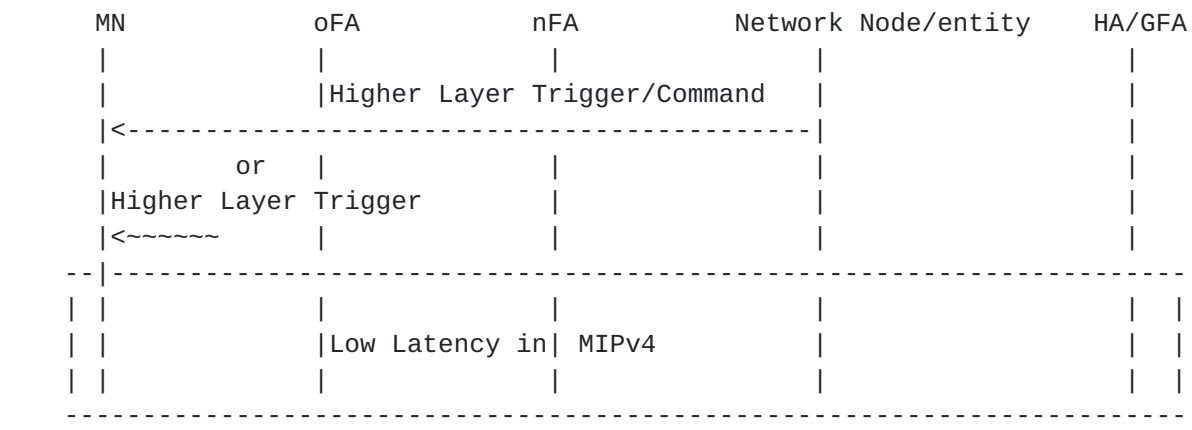

Figure 2: Mobile initiated.

4. Inadequacies of relying on Layer 2 triggers alone for Low Latency Handoffs

The Low Latency Handoff in MIPv4 relies on L2 triggers as an indication of a pending L2 handoff to initiate the early MIPv4 registration before the L2 handoff actually takes place. L2 triggers although not exactly define in [LOWLATMIP4] correspondent to events such as perception of signal noise ratio at the MN or Link Up, Link Down, reception of an agent solicitation... Reception of L2 triggers alone is not always sufficient information to rely upon for the initiation of the Layer 3 handoff. Handoff Commands can be used to force a handoff even if the signal quality is very good on all of the MN's interfaces. In such scenarios, the handoff triggers coming from a higher layer protocol can be used to initiate the L3 handoff presented in [LOWLATMIP4].

5. Scenarios

A few scenarios can illustrate the application of handoff triggers from higher layers to initiate the Low Latency Handoff in MIPv4.

5.1. Scenario 1

The handoff trigger comes locally from a Layer 3 or above of the MN due to variations or degradation in the application for example. Application degradation may be due to increased load in the MN's serving network. The MN can interpret such degradation as a hint for an eventual need to handoff to a different access network. The MN may generate a scan to obtain the identifier of other networks available (BSSID identifier for example of the Access Point that is a potential handoff target). The MN resumes the actions with a Proxy

Router Solicitation (PrRtSol) as in the Pre-Registration Low Latency Handoff in MIPv4 case. Note that scanning of potential new access networks may not result in finding a target access network to handoff to as the MN may not be in an overlapping networks coverage area. In that case, the hint received (from L3 or the application) would have not triggered the handoff.

5.2. Scenario 2

A Mobile Node is using a WLAN connection and is simultaneously in the coverage area of WLAN and 3G with a good signal reception in WLAN. The Link Up on the 3G interface is not necessarily a trigger providing sufficient information to initiate the Pre-registration with L3 handoff towards 3G. However a network policy may require the MN to execute a handoff due to various network conditions and policies pre-established. To achieve policy based network control handoff, several techniques can be designed: The MN can collect information and send it to the network which ultimately takes the decision to instruct the MN or the FA (by a Handoff Command) to handoff to a preferred type of available network. The criterion initiating the handoff is not restricted to the signal noise ratio perceived at lower layers. Instead the set of criteria can include other parameters such as the link characteristics of available networks, the load on the MN serving network and neighbouring access networks, the level of quality of service perceived...(Such a scenario is the most appealing for network operators as it enables the network to initiate and assist the handoff). One may design a system in which Higher Layer Triggers are used to initiate the Low Latency Handoff in MIP.

6. Using Higher Layer Triggers to initiate the Low Latency Handoff in MIPv4

6.1. Pre-Registration handoff

The MN MAY perform regular scans to obtain information about its available networks. The MN MAY report regularly to a network entity such information. The network entity might then take the decision to instruct the MN to handoff. The handoff trigger from higher layer protocol could be received at the FA (Network initiated) or at the MN (Mobile initiated).

6.1.1. Network initiated:

The MN reports to a central entity (Policy Decision Point) the IP addresses of its available FAs obtained through scanning. Upon decision to instruct the MN to handoff to a particular access

network, the network entity will send a Handoff Command to a FA to initiate handoff to the target access network. The termination of the Handoff Command can be the oFA (for the source trigger handoff) or the nFA (for the target trigger handoff). The Handoff Command could contain the IP address of the nFA it is instructed the MN to move to. The Handoff Command in turn generates the Layer 2 source or target trigger in use in the Low Latency Handoff in MIPv4. The Handoff Command when implemented provides a means to pass the IP address of the new FA (nFA) or the old FA (oFA) for use in the L2 trigger. A method by which the Handoff Command from layer 3 generates a Layer 2 trigger at the FA is not described in this document.

6.1.2. Mobile initiated:

The Mobile Initiated Pre-registration handoff can result from a Higher Layer Handoff Trigger that originated locally on the MN or from a Handoff Command sent from another node in the network. The Handoff Command may contain limited information such as the type of the preferred network to move to (i.e 3G or WLAN or WiMAX, the load on each network, the QoS ...). When the MN receives an instruction to handoff it can then issue a new scan to obtain the BSSID identifier of the Access Point that is a potential handoff target. The reception of the BSSID of the target AP can be the layer 2 trigger that then initiates the Mobile Initiated Pre-registration Handoff as in [LOWLATMIP4].

6.2. Post-Registration Handoff

The application of Handoff Command towards the Post registration handoff is restricted. As the Post Registration Handoff effectively starts with the loss of L2 connectivity with the oFA L2-Link Down (L2-LD) it makes it more difficult to initiate it with Higher Layer Triggers.

7. Security Considerations

This document introduces a framework describing the use of triggers coming from layers higher than the link layer to initiate the Low Latency Handoff in Mobile IPv4. The Handoff Layer Triggers MUST be secured to provide reliable information to the Low Latency for MIPv4. The mechanism causing the delivery of the Triggers MUST also be secured and MUST not introduce any vulnerability to the low Latency handoff for MIPv4. Securing the delivery of Higher Layer Triggers prevents an attacker in the network to send bogus messages causing the MN undesired handoffs. A Security Association SHOULD exist between the Network Node sending the Command and the recipient (the

FA or the MN) of the Higher Layer Trigger. The establishment of these Security Associations are out of the scope of this document.

8. Conclusion

This document introduces the use of triggers from layers higher than layer 2 to initiate the Low Latency Handoff in MIPv4. The trigger issued from the application or the network layer may in turn generate the Layer 2 trigger. Layer 2 trigger is not necessarily received as an indication of a stronger or lower signal received at the MN from the access network. The Higher Layer Trigger coming from the network is a Handoff Command which makes it possible to implement policy decision based handoff. According to a policy decision the system may command the MN to handoff to the most preferable Access Network. The policy based handoff decision may be taken locally on the MN or may be implemented on a different node in the network.

9. Acknowledgements

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10. Normative References

[LOWLATMIP4]
K. El Malki, Editor., "Low Latency Handoffs in Mobile IPv4", October 2005.

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