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Mobility Anchor Selection in DMM: Use-case Scenarios
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Abstract

This document presents and discusses different use-case scenarios of mobility anchor selection in Distributed Mobility Management (DMM).

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1. Terminology

IP-handover:

a handover of a mobile node at the IP level resulting in an IP address change at the mobile node.

New flow:

a flow that did not undergo any IP-handover.

Handover flow:

a flow that did undergo one or more IP-handovers.

New traffic:

the data traffic of the new flows.

Handover traffic:

the data traffic of the handover flows.

Current access router:

the access router where the mobile node is currently attached at the IP level.

DMM default mode of mobility anchor selection:

new flows are always anchored at the current access router which acts as the mobility anchor for these flows after an IP-handover.

2. Introduction

Distributed Mobility Management (DMM) aims at overcoming the shortcomings of the existing IP mobility protocols, such as Mobile IPv6 [RFC6275] and Proxy Mobile IPv6 [RFC5213], that are considered centralized. It brings the mobility anchor closer to the mobile node, down at the access routers level. This is the enabler of a concept that is so-called dynamic mobility, where the mobile node changes its mobility anchor for new flows. New flows are always initiated using the mobile node's current IP address which is configured using the prefix provided by the current access router. The data traffic of these flows is then routed optimally until the mobile node undergoes an IP-handover. However, upon an IP-handover, tunneling mechanisms are needed with that access router, which is then considered the mobility anchor of those flows initiated using its prefix during the whole lifetime of those flows. In what follows, this is considered the DMM default mode of mobility anchor selection.

If most of the flows are short enough to not undergo one or more IP-handovers, it is expected that most of the data traffic is routed optimally. However, this assumption is not always valid and the mobility anchor for new flows, when initiated, could be selected in a more appropriate manner.

When a flow is initiated, it is assigned a mobility anchor that lasts during its whole lifetime. Thus, selecting the most appropriate mobility anchor for a flow when initiated can significantly enhance the mobility management performance, e.g. less overhead, shorter end-to-end delay. Thus, a DMM solution should allow selecting and using the most appropriate mobility anchor among a set of distributed ones [I-D.ietf-dmm-best-practices-gap-analysis]. In order to achieve this, different metrics and contexts should be taken into consideration. Distributing the mobility anchor functionalities at the access routers level allows considering several contexts such as the mobile node's mobility context, the application context, and the network context.

Hereafter in this document, the considered contexts are presented and then the different use-case scenarios are discussed.

3. Considered contexts

3.1. Mobile node context

The mobile node's mobility has an important effect on the mobility anchor selection. For example, a mobile node with high mobility undergoes frequent IP-handovers. When considering DMM default mode of mobility anchor selection, almost all the traffic of such mobile node is handover traffic, moreover, the number of simultaneous anchors and tunnels may increase. On the other hand, flows of mobile nodes with low mobility are more likely to be initiated and terminated before undergoing an IP-handover.

In addition, the mobile node's location with respect to the different mobility anchors influences selecting one of them for new flows. For example, locating the mobility anchor as close as possible to the mobile node results in a shorter tunnel, and hence less tunneling overhead, when tunneling mechanisms are required. The most appropriate mobility anchor is the closest one to the mobile node during the longer portion of the flow lifetime. At the instant of initiating a new flow, the current access router is the closest one to the mobile node. However, the mobile node may undergo an IP-handover and attach to another access router. Whether the longer portion of the flow is before or after the IP-handover has an effect on selecting the most appropriate mobility anchor for this flow.

Moreover, a mobile node may have one or more "typical locations" where it attaches to the network most of the time, e.g. at home. This helps expecting the mobile node's location for relatively long durations and, consequently, in selecting the most appropriate mobility anchor by using information about typical location(s). Note that some statistics show that users spend more than 60% of their time at home and work [Cisco-VNI].

Finally, the mobile node's attachments history is needed in order to take into consideration the mobile node's mobility and location as described above.

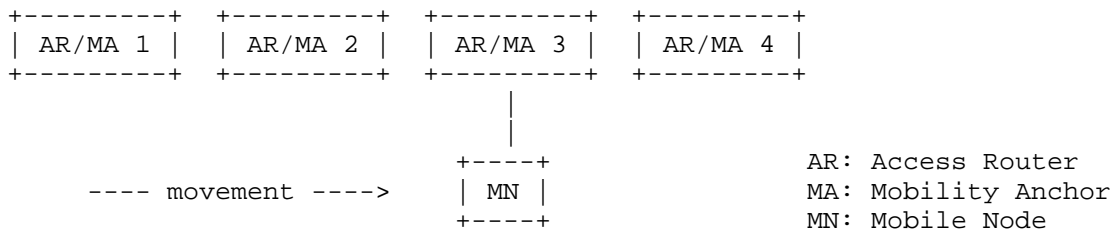


Figure 1: Mobile node's movement in DMM network

3.2. Application context

Based on the application, the need of IP continuity and the flow characteristics can be estimated. While applications that require IP continuity cause the establishment of tunnels in the access network upon an IP-handover, applications that can tolerate an IP address change at the application layer, e.g. SIP-based sessions, do not [I-D.ietf-dmm-requirements]. The mobility anchor selection is less important in the latter case due to the capability of changing the IP address. In fact, there is no need for tunneling and hence no need for a mobility anchor since the application can tolerate any change in the IP address; hence, all the traffic is routed using standard routing schemes.

In addition, the flow characteristics are highly dependent on the application. Some applications generate in general long flows such as multimedia (e.g. video streaming), online gaming, large files downloading, etc. (see Table 1 below); others generate in general short flows such as TCP connections for HTTP and SMTP sessions. Long flows are more likely to undergo one or more IP-handovers and therefore the mobility anchor selection can play an important role to enhance the mobility management performance. On the other hand, short flows are more likely to be initiated and terminated before an IP-handover.

In the following table, we present some examples on different types of applications. For each application, we mention the expected (or probable) traffic and mobility characteristics as well as the possible types of devices used for such application. The objective of this list of applications is to show later some possible real mapping(s) for the different use-case scenarios.

Application	Traffic Type	Mobility Nature	User Device	Comments
RT Gaming	Long flows with IP continuity req	Stationary or mobile (depending on game)	Laptop, tablet, smartphone, game console	For game consoles, the device and traffic characteristics could be easily predicted
Audio/Video conferencing	Long flows with IP continuity req	Stationary or mobile	Smartphone, tablet, laptop	
Live streaming IPTV	Long flows with IP continuity req	Stationary or mobile	Large screen TV, laptop, tablet, smartphone	If a large screen TV, client is stationary. Otherwise, client is mobile
Waze	Long flows without IP continuity req	Mobile	Smartphone, dedicated car GPS (future)	A typical location (Ski resort)
GoPro	Long flows with IP continuity req	Mobile	GoPro camera	
Video Report	Long flows with IP continuity req	Stationary or mobile	Mobile surveillance, HD camera	

Video streaming in vehicles	Long flows with IP continuity req	Mobile	Car TV, tablet, smartphone	If the car is mainly used in specific neighborhood a typical location is irrelevant
Camcorder download	Long flows with IP continuity req	Stationary or mobile	Camcorder	
HTTP and SMTP sessions	Short flows with IP continuity req	Stationary or mobile	Smartphone, tablet, laptop	

Table 1

3.3. Network context

When a mobility anchor is assigned to a flow (when the flow is initiated), it acts as a mobility anchor for this flow the whole flow's lifetime. It is responsible to forward the flow's data packets if the mobile node is physically attached to it. It is responsible, in addition, to encapsulate and de-capsulate the flow's data packets if the mobile node is not attached to it and tunneling mechanisms are used.

Even with distributed mobility anchors, the distribution of the active mobile nodes in the network is not necessarily even. As a result, some mobility anchors are overloaded more than others. It is then reasonable to take into consideration the estimated (or projected) level of load of the mobility anchors as well as the access network characteristics/resources when selecting one of them for a new flow (the metrics for measuring this level are left for specific implementations).

4. Use-case scenarios

4.1. Extremely mobile nodes without any typical location

Extreme mobility could be due to either a high mobile node's speed, or a small access router's coverage area, or both.

Scenario 1: running applications generating typically short flows

Short flows are more likely to be initiated and terminated before the mobile node undergoes an IP-handover. Even if a flow experiences an IP-handover, it is expected that the flow does not last long after the IP-handover. In other words, most of the mobile node's traffic is new traffic in this scenario. As a result, the closest mobility anchor to the mobile node during the longest portion of a flow is its current access router. It is recommended then to always anchor new flows at the current access router, which is the DMM default mode of mobility anchor selection.

A well known example on short flows is the TCP connections for HTTP and SMTP sessions.

Scenario 2: running applications generating typically long flows

For extremely mobile nodes, it is more likely that a flow experiences an IP-handover soon after being initiated. And since the flows are long-lived, it is expected that a flow lasts for a long duration after the IP-handover(s). As a result, it could be said that most of the traffic is handover traffic in this scenario. Whatever is the mobility anchor selection criterion, most of (almost all) the mobile node's data traffic needs tunneling mechanisms. Thus, the mobility anchor selection cannot play a significant role regarding the route optimization or the tunneling overhead reduction.

However, there are number of consequences regarding the control plane e.g. number of simultaneous anchors/tunnels for a mobile node and the related contexts and signaling loads. First, let us consider the DMM default mode of mobility anchor selection. Since new flows are always anchored at the current access router, each flow initiated between two consecutive IP-handovers is anchored at a different mobility anchor. With extremely mobile node, long flows are expected to experience several IP-handovers and their mobility anchors are expected to be maintained for a long duration. As a result, the number of simultaneous anchors/tunnels for a mobile node may increase as well as the related contexts and

signaling loads. This affects the control plane negatively.

As the DMM default mode does not achieve data plane optimization in the scenario described above, it is reasonable to consider a more centralized approach for mobility anchor selection in order to reduce the negative effects on the control plane. If data packets are going to be tunneled in both cases, managing a single tunnel to a single mobility anchor would be better than managing several tunnels to several mobility anchors at the same time.

It is worth mentioning that the discussion above is considering applications that require IP-address continuity. On the other hand, there is no issue regarding the applications that allow an IP address change and manage mobility at the application layer since they do not need mobility anchors as mentioned before.

Some examples on this scenario are (cf. Table 1) RT gaming, audio/video conferencing, live streaming IPTV, video report, video streaming in vehicles, and camcorder download.

Scenario 3: running applications generating both long and short flows

In this case, short and long flows can be distinguished when selecting a mobility anchor for a flow, based on scenario 1 and scenario 2. Short flows are always anchored at the current access router; long flows are anchored based on a more centralized approach. In this way, data packets of short flows are generally routed optimally and long flows do not introduce a large number of simultaneous anchors/tunnels.

4.2. Mobile nodes with one or more typical locations

Scenario 4: running applications generating typically short flows

As the flows are short, there is no expected benefit from having a typical location. If initiated when the mobile node is not at its typical location, such flows are more likely to end quickly before the mobile node goes back to its typical location. Otherwise, they would be initiated and terminated when the mobile node is at its typical location. As a result, the current access router is always the best mobility anchor for new flows and hence the DMM default mode of mobility anchor selection fits well this scenario.

When the car is used mainly for short distance usages, Waze (cf. Table 1) could be an example on this scenario.

Scenario 5: running applications generating typically long flows

In this scenario, having a typical location is expected to be beneficial for the mobile node's mobility anchor selection. As mentioned before, the best mobility anchor for a flow is the closest one to the mobile node during the longer portion of this flow. Then, the best mobility anchor for a flow could be in some cases that of the typical location even if the flow is not initiated there. For example, if the mobile node initiates a long flow and then comes back (undergoing an IP-handover) quickly to its typical location, the longer portion of the flow would be after the IP-handover. Thus, it is reasonable to select the typical location's mobility anchor for such flow when initiated. This results in tunneling part of the flow's data traffic when initiated but in routing optimally most of it afterwards.

The analysis described above would be still valid if the mobile node has more than one typical location. However, the benefits may not be in some cases as great as those of the one typical location scenario, depending on the mobile node's movements. If there is no clear benefit from selecting one out of the mobility anchors, the network context (i.e. level of load on each mobility anchor) comes into play leaning towards selecting the mobility anchor that is less loaded. Another refinement is to add the time of day to the statistics collection in the mobile node's attachments history. If it is noticed that one of the typical locations is more popular than the others, this helps in selecting a mobility anchor according to the time of attachment.

Some examples on this scenario are (cf. Table 1) RT gaming, audio/video conferencing, live streaming IPTV, GoPro, video report, video streaming in vehicles, and camcorder download.

Scenario 6: running applications generating both long and short flows

If it is possible, the short and long flows should be distinguished as follows. While short flows are assigned the closest mobility anchor which is the current access router, long flows are assigned the typical location's mobility anchor. In this case, the mobile node uses several IP addresses simultaneously e.g. the one related to the typical location for all long flows and the current IP address for short flows. Hence, the mobile node needs a source address selection mechanism in order to distinguish between the different IP addresses when initiating a flow.

4.3. Fairly stationary nodes

Scenario 7: running similar or different applications

In fact, a fairly stationary node has one typical location for almost all the time. The mobile node selects always the typical location's mobility anchor, which is the current access router most of the time.

Some examples on this scenario are (cf. Table 1) RT gaming, audio/video conferencing, live streaming IPTV, video report, and camcorder download.

5. Security Considerations

TBD.

6. IANA Considerations

This document has no actions for IANA.

7. Acknowledgements

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