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Mobility Capability Negotiation as a 5G Mobility Pattern
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Abstract

Mobility support is an important network capability for mobile node, and 5G introduces the Mobility Pattern used by the Access and Mobility Management Function (AMF) to optimize mobility support provided to the UE. More specific, The AMF determines and updates Mobility Pattern of the UE according to the subscription of the UE, statistics of the UE mobility, network local policy, and the UE assisted information, or any combination of them with the help of NWDAF. Based on different requirements, multiple mobility management protocols have been developed under IPv6. However, different protocols have different functional requirements on the network element or the host and then a scheme should be used in order to support the negotiation and selection of adopted mobility management protocol when a host (or UE) accesses to a new network. In this draft, this issue is analyzed.

Table of Contents

1. Introduction

In order to clearly analyze the possible cases and actual requirements, the following category labels of the mobility management protocols are defined:

- o Mobile IPv6 (MIPv6) protocol: the mobility management scheme based on [RFC6275].
- o Proxy Mobile IPv6 (PMIPv6) protocol: the mobility management scheme based on [RFC5213].
- o MIPv6 suit protocols: based on MIPv6, there are multiple extension protocols have been standardized. These protocols can be classified into two types: protocols for the function extension and protocols for the performance enhancement. The protocols for the function extension are proposed to support some specific scenarios or functions, such as Dual-stack Mobile IPv6 (DSMIPv6) [RFC5555] for mobility of the dual-stack nodes, Multiple Care-of-address (MCoA) [RFC5648] for hosts with multiple access interfaces and Network Mobility (NEMO) [RFC3963] for mobility of sub-network.

The other type is proposed to enhance the performance of the mobility management, such as Fast Mobile IPv6 (FMIP6) [RFC5268] for fast handover, Hierarchical Mobile IPv6 (HMIPv6) [RFC5380] for hierarchical mobility optimization. In the MIPv6 suit protocols, location update is initiated by the host and the tunnel is also terminated at the host.

- PMIPv6 suit protocols: in order to reduce the protocol cost and enhance the handover performance further, the network-based mobility management protocols were proposed and PMIPv6 was standardized as a basis. Based on PMIPv6, a series of its extensions were proposed, such as Dual-stack Proxy Mobile IPv6 (DS-PMIPv6) [RFC5844], and Distributed Mobility Management Proxy Mobile IPv6 (DMM-PMIPv6) [RFC7333]. Be different from the MIPv6 suit protocols, the location update in PMIPv6 suit protocols is triggered by the network entity and the tunnel is established between network entities. Then the host needs to do nothing about the signaling exchange during the movement, particularly, the mobility is transparent to the IP layer of the host.
- Network-based protocols: generally, it means the mobility management protocols which do not require the involvement of the mobile node in order to accomplish mobility. It includes PMIPv6 suit protocols and other network-based solutions, such as GPRS Tunnelling Protocol (GTP) [TS.29274][TS.29281].
- Host-based protocols: generally, the mobility management protocols which require the involvement of the mobile node in order to accomplish mobility. It includes MIPv6 suit protocols and other host-based solutions, such as Host Identity Protocol (HIP) [RFC7401] and IKEv2 Mobility and Multihoming Protocol (MOBIKE) [RFC4555].
- AMF: Access and Mobility Management Function, is responsible for processing the control signaling between the User Equipment (UE) and the core network. It inherits the mobility management function and access control function. It is the most important control module in the 5G core network. It has the ability to process user registration requests, authenticate user identity, and when the UE sends the location movement, it handles the UE's location update and other functions.
- Mobility Pattern: The Mobility Pattern is a concept that may be used by the AMF to characterise and optimise the UE mobility. Due to the uneven space-time distribution of mobile data traffic and frequent user switching in the 5G system, the 5G core network function still has the problem of unbalanced load. Especially, when the UE accesses the 5G communication system or the UE moves between 5G base stations, the access network needs to allocate the access and handover requests of the UE to the AMF to carry and process them. Allocating UEs to those with relatively large remaining resources can achieve load balancing of different AMFs,

thereby effectively accelerating service response speed and improving the stability of the communication system.

Figure 1 illustrates the scopes of the above different category labels.

```
+----------------+        +----------------+
| Network-based  |        | Host-based     |
|+--------------+|        |+--------------+|
||PMIPv6 suit   ||        ||MIPv6 suit    ||
||+------------+||        ||+------------+||
|||PMIPv6      |||        |||MIPv6       |||
||+------------+||        ||+------------+||
|+--------------+|        |+--------------+|
+----------------+        +----------------+
```

Figure 1: Scopes of different protocol category labels

In reality, the host-based protocols and network-based protocols will be co-existing and multiple protocol deamons will be configured on the network entities and host. That means a scheme is needed to support the negotiation and selection of mobility management protocol when the host accesses into a new access network initially or handover happens [Paper-CombiningMobilityStandards].

This document tries to present the principles for the protocol selection and analyze the possible scenarios which should be supported by the further solution.

2. Motivations

As illustrated above, these protocols may co-exist in reality and simultaneously be used in an access network or even the same entity to support ubiquitous connection and mobility support in 5G. Due to their different requirements on the network entity or host, a scheme is needed to support the negotiation and selection of adopted mobility management protocol when the host accesses to a new network, as a implementation of Mobility Pattern. Generally, two problems should be solved:

- o What principles should be followed for the protocol negotiation and selection?
- o What procedure should be adopted for the protocol negotiation and selection?

This scheme is needed because network entity and host may have different capabilities and preferences (may be decided by the capability and mobility pattern of the host). This scheme aims to

guarantee that the optimum and most suitable protocol will be used, although the selection procedure and notification scheme can be implementation-dependent.

3. Possible Cases

From both host and network aspects, their capabilities of mobility management may have multiple cases as shown in Figure 2. We mainly analyze that host and network support single protocol for clear description, if multiple protocols are supported simultaneously by the host or network side, multiple cases exist at the same time but the logic is same as that in the case with single protocol supported. Specifically, the following cases should be considered.

1) Network supports network-based protocol, host supports network-based protocol

In this case, there are the following sub-cases:

a) Host supports PMIPv6 suit protocol, Network supports PMIPv6 suit protocol

- o if host supports PMIPv6 and network supports PMIPv6, PMIPv6 is selected.
- o if host supports PMIPv6 and network supports extended PMIPv6 protocol, extended PMIPv6 protocol is selected if no host involvement is needed, otherwise the plain PMIPv6 is selected (we assume that the extension protocols are backward-compatible with the related plain protocol).
- o if host supports extended PMIPv6 protocol and network supports PMIPv6, PMIPv6 is selected (we assume that the extension protocols are backward-compatible with the related plain protocol).
- o if host supports extended PMIPv6 protocol and network supports extended PMIPv6 protocol, the identical extension protocol is selected, otherwise, PMIPv6 is selected (we assume that the extension protocols are backward-compatible with the related plain protocol).

```
+-------------+-----------+-------------------------- +
|             |           |PMIPv6                      |
|             |           |-----------------+----------+
|Network-based|PMIPv6 suit|                 |DS-PMIPv6 |
|             |           |                 +----------+
|             |           |PMIPv6 extensions|FPMIPv6   |
|             |           |                 +----------+
|             |           |                 |DMM-PMIPv6|
|             |           |                 +----------+
|             |           |                 |...       |
|             |-----------+-----------------+----------+
|             | Others    |GTP                         |
|             |           |----------------------------+
|             |           |...                         |
+-------------+-----------+----------------------------+
|             |           |MIPv6                       |
|             |           |-----------------+----------+
|Host-based   |MIPv6 suit |                 |DS-MIPv6  |
|             |           |                 +----------+
|             |           |                 |FMIPv6    |
|             |           |                 +----------+
|             |           |MIPv6 extensions |HMIPv6    |
|             |           |                 +----------+
|             |           |                 |NEMO      |
|             |           |                 +----------+
|             |           |                 |DMM-MIPv6 |
|             |           |                 +----------+
|             |           |                 |...       |
|             |-----------+-----------------+----------+
|             | Others    |HIP                         |
|             |           |----------------------------+
|             |           |MOBIKE                      |
|             |           |----------------------------+
|             |           |...                         |
+-------------+-----------+----------------------------+
```

Figure 2: Possible capacities of host and network

b) Host supports PMIPv6 suit protocol, Network supports other network-based protocol

- o if host supports PMIPv6 and network supports other network-based protocol, other network-based protocol is selected if no host involvement is needed, otherwise failure.
- o if host supports extended PMIPv6 protocol and network supports other network-based protocol, other network-based protocol is selected if no host involvement is needed, otherwise failure.

c) Host supports other network-based protocol, Network supports PMIPv6 suit protocol

- o if host supports other network-based protocol and network supports PMIPv6, PMIPv6 is selected.
- o if host supports other network-based protocol and network supports extended PMIPv6 protocol, extended PMIPv6 protocol is selected if no host involvement is needed, otherwise failure.

d) Host supports other network-based protocol, Network supports other network-based protocol

- o the identical protocol is selected, otherwise follow network capability if the protocols are different.

2) Network supports network-based protocol, host supports host-based protocol

In this case, there are the following sub-cases:

a) Host supports PMIPv6 suit protocol, Network supports MIPv6 suit protocol

- o if host supports PMIPv6 and network supports MIPv6, failure.
- o if host supports PMIPv6 and network supports extended MIPv6 protocol, failure.
- o if host supports extended PMIPv6 protocol and network supports MIPv6, failure.
- o if host supports extended PMIPv6 protocol and network supports extended MIPv6 protocol, failure.

b) Host supports PMIPv6 suit protocol, Network supports other host-based protocol

- o if host supports PMIPv6 and network supports other host-based protocol, failure.
- o if host supports extended PMIPv6 protocol and network supports other host-based protocol, failure.

c) Host supports other network-based protocol, Network supports MIPv6 suit protocol

- o if host supports other network-based protocol and network supports MIPv6, failure.
- o if host supports other network-based protocol and network supports extended MIPv6 protocol, failure.

d) Host supports other network-based protocol, Network supports other host-based protocol

- failure.

3) Network supports host-based protocol, host supports network-based protocol

In this case, there are the following sub-cases:

a) Host supports MIPv6 suit protocol, Network supports PMIPv6 suit protocol

- if host supports MIPv6 and network supports PMIPv6, PMIPv6 is selected in default and MIPv6 is selected if host prefers it.
- if host supports MIPv6 and network supports extended PMIPv6 protocol, extended PMIPv6 is selected in default, then PMIPv6 is selected with the lower priority and MIPv6 is selected if host prefers it.
- if host supports extended MIPv6 protocol and network supports PMIPv6, PMIPv6 is selected in default, then extended MIPv6 protocol is selected if host prefers it and network also supports, otherwise MIPv6 is selected with the lowest priority.
- if host supports extended MIPv6 protocol and network supports extended PMIPv6 protocol, extended PMIPv6 protocol is selected in default, then PMIPv6 is selected, then extended MIPv6 protocol is selected if host prefers and network also supports, otherwise MIPv6 is selected with the lowest priority.

b) Host supports MIPv6 suit protocol, Network supports other network-based protocol

- if host supports MIPv6 and network supports other network-based protocol, other network-based protocol is selected if no host involvement is needed, otherwise failure.
- if host supports extended MIPv6 protocol and network supports other network-based protocol, other network-based protocol is selected if no host involvement is needed, otherwise failure.

c) Host supports other host-based protocol, Network supports PMIPv6 suit protocol

- if host supports other host-based protocol and network supports PMIPv6, PMIPv6 is selected in default, otherwise failure.
- if host supports other host-based protocol and network supports extended PMIPv6 protocol, extended PMIPv6 protocol is selected if no host involvement is needed, otherwise failure.

d) Host supports other host-based protocol, Network supports other network-based protocol

o other network-based protocol is selected if no host involvement is needed, otherwise failure.

4) Network supports host-based protocol, host supports host-based protocol

In this case, there are the following sub-cases:

a) Host supports MIPv6 suit protocol, Network supports MIPv6 suit protocol

o if host supports MIPv6 and network supports MIPv6, MIPv6 is selected.
o if host supports MIPv6 and network supports extended MIPv6 protocol, MIPv6 is selected.
o if host supports extended MIPv6 protocol and network supports MIPv6, MIPv6 is selected.
o if host supports extended MIPv6 protocol and network supports extended MIPv6 protocol, the identical protocol is selected, otherwise MIPv6 is selected.

b) Host supports MIPv6 suit protocol, Network supports other host-based protocol

o if host supports MIPv6 and network supports other host-based protocol, failure.
o if host supports extended MIPv6 protocol and network supports other host-based protocol, failure.

c) Host supports other host-based protocol, Network supports MIPv6 suit protocol

o if host supports other host-based protocol and network supports MIPv6, failure.
o if host supports other host-based protocol and network supports extended MIPv6 protocol, failure.

d) Host supports other host-based protocol, Network supports other host-based protocol

o the identical other host-based protocol is selected, otherwise failure.

5) Network supports host-based protocol and network-based protocol, host supports host-based protocol and network-based protocol

- o follow the network based protocol in default if the host can support, otherwise select the protocol both network and host can support if host prefers.

4. Protocol Selection Principles

Two different schemes may be used for the protocol negotiation and selection: host-initiated and network-initiated. Within the MIPv6/ PMIPv6 protocols, the priority of the function-extension protocols should be higher than the performance-enhancement protocols. Generally, the following principles should be followed:

- o In default: Network based scheme if it can be supported
- o Priority 1: Follow network capability
- o Priority 2: Follow host preference
- o Priority 3: Support the functional extensions
- o Priority 4: Support the performance enhancements

5. General Procedure

The protocol negotiation may be included in the MN_ATTACH Function [MN-AR.IF] and the implementation may be based on a new signaling message or extended messages (e.g., ICMPv6, Diameter, and RADIUS). Besides these, some other protocols may also be used in some specified scenarios, such as extended IEEE 802.21 primitives. Then the selected protocol will be included as a parameter in AMF during the node handover.

The general procedure for the protocol selection should be:

- o During initiation, network-based protocol may be used as a default mobility management protocol once the network supports it.
- o If the host prefers host-based protocols, a negotiation is executed to handover from network-based protocol to host-based protocol.
- o After initial attachment, a profile will be generated in the management store to record the selected or preferred protocol of this host.
- o When the handover happens, the network will check the selected or preferred protocol during the authentication process. But the network also needs to notify the host if the selected protocol cannot be supported herein.

When the host accesses to the network, an authentication should be executed before the mobility management service is provided. In order to support the mobility management protocol selection, a new information should be recorded by the network after the successful authentication during the initial attachment. The newly introduced

information in AMF shows the selected mobility management protocol and should be updated when the used protocol changes.

6. Security Considerations

Generally, this function will not incur additional security issues. The detailed influence should be analyzed in the future.

7. IANA Considerations

A new authentication option or other signaling message option may be used based on the specific implementation.

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