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MAG Multipath Binding Option
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Abstract

This specification defines extensions to the Proxy Mobile IPv6 protocol for allowing a mobile access gateway to register more than one proxy care-of-address with the local mobility anchor and to simultaneously establish multiple IP tunnels with the local mobility anchor. This capability allows the mobile access gateway to utilize all the available access networks for routing mobile node's IP traffic.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on March 10, 2018.

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1. Introduction

Multihoming support on IP hosts can greatly improve the user experience. With the simultaneoous use of multiple access networks, multihoming brings better network connectivity, reliability and improved quality of communication. Following are some of the goals and benefits of multihoming support:

- Redundancy/Fault-Recovery
- Load balancing
- Load sharing
- Preferences settings

According to [RFC4908], users of Small-Scale Networks can take benefit of multihoming using mobile IP [RFC6275] and Network Mobility (NEMO) [RFC3963] architecture in a mobile and fixed networking environment. This document is introducing the concept of multiple Care-of Addresses (CoAs) [RFC5648] that have been specified since then.

The motivation for this work is to extend Proxy Mobile IPv6 protocol with multihoming extensions [RFC4908] for realizing the following capabilities:

- using GRE as mobile tuneling, possibly with its key extension [RFC5845] (a possible reason to use GRE is given on Section 3.2).
- using UDP encapsulation [RFC5844] in order to support NAT traversal in IPv4 networking environment.
- Prefix Delegation mechanism [RFC7148].
- Using the vendor specific mobility option [RFC5094], for example to allow the MAG and LMA to exchange information (e.g. WAN interface QoS metrics) allowing to make appropriate traffic steering decision.

Proxy Mobile IPv6 (PMIPv6) relies on two mobility entities: the mobile access gateway (MAG), which acts as the default gateway for the end-node and the local mobility anchor (LMA), which acts as the topological anchor point. Point-to-point links are established, using IP-in-IP tunnels, between MAG and LMA. Then, the MAG and LMA are distributing traffic over these tunnels. All PMIPv6 operations are performed on behalf of the end-node and its corespondent node, it thus makes PMIPv6 well adapted to multihomed architecture as

considered in [RFC4908]. Taking the LTE and WLAN networking environments as an example, the PMIPv6 based multihomed architecture is depicted on Figure 1. Flow-1,2 and 3 are distributed either on Tunnel-1 (over LTE) or Tunnel-2 (over WLAN), while Flow-4 is spread on both Tunnel-1 and 2.

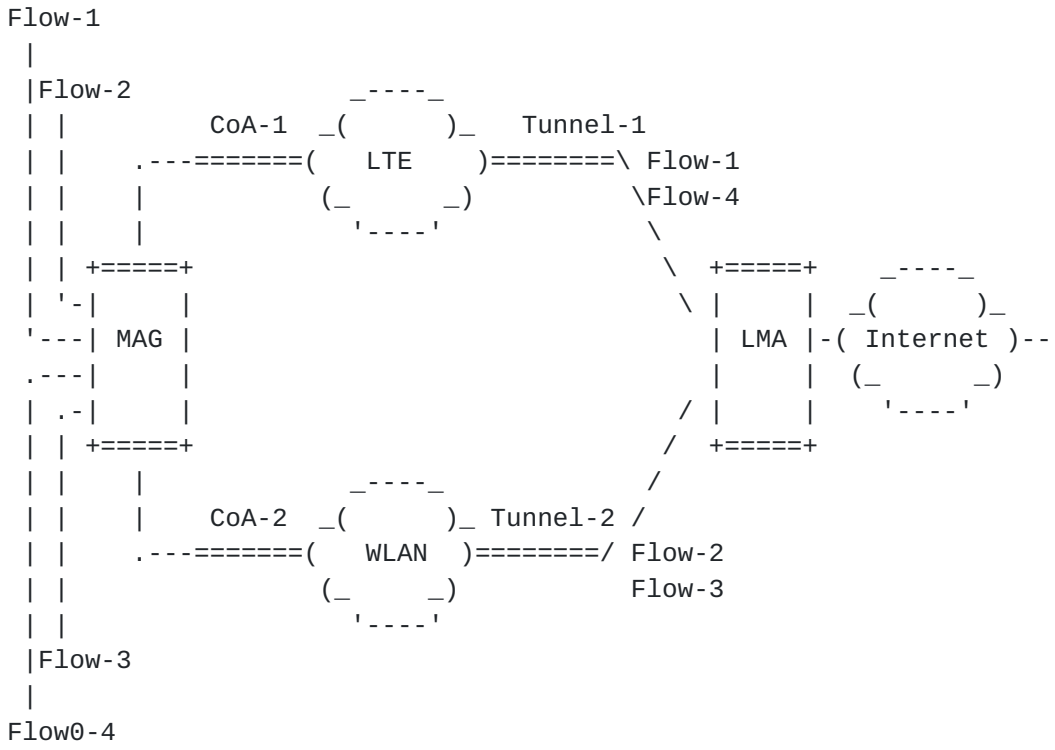

Figure 1: Multihomed MAG using Proxy Mobile IPv6

The current version of Proxy Mobile IPv6 does not allow a MAG to register more than one proxy Care-of-Adresse to the LMA. In other words, only one MAG/LMA link, i.e. IP-in-IP tunnel, can be used at the same time. This document overcomes this limitation by defining the multiple proxy Care-of Addresses (pCoAs) extension for Proxy Mobile IPv6.

2. Conventions and Terminology

2.1. Conventions

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 [RFC2119].

2.2. Terminology

All mobility related terms used in this document are to be interpreted as defined in [RFC5213], [RFC5844] and [RFC7148]. Additionally, this document uses the following terms:

IP-in-IP

IP-within-IP encapsulation [RFC2473], [RFC4213]

3. Overview

3.1. Example Call Flow

Figure 2 is the callflow detailing multi-access support with PMIPv6. The MAG in this example scenario is equipped with both WLAN and LTE interfaces and is also configured with the multihoming functionality. The steps of the callflow are as follows:

Steps (1) and (2): the MAG attaches to both WLAN and LTE networks; the MAG obtains respectively two different proxy care-of-addresses (pCoA).

Step (3): The MAG sends, over the WLAN access, a Proxy Binding Update (PBU) message, with the new MAG Multipath Binding (MMB) and MAG Identifier (MAG-NAI) options to the LMA. The request can be for a physical mobile node attached to the MAG, or for a logical mobile node configured on the mobile node. A logical mobile node is ALWAYS-ATTACHED mobile node configuration enabled on the MAG. The mobility session that is created (i.e. create a Binding Cache Entry) on the LMA will be marked with multipath support.

Step (4): the LMA sends back a Proxy Binding Acknowledgement (PBA) including the HNP and other session parameters allocated for that mobility session.

Step (5): IP tunnel (IP-in-IP, GRE ...) is created over the WLAN access.

Steps (6) to (8): The MAG repeats steps (3) to (5) on the LTE access. The MAG includes the HNP, received on step (4) in the PBU. The LMA

update its binding cache by creating a new mobility session for this MAG.

Steps (9) and (10): The IP hosts MN_1 and MN_2 are assigned IP addresses from the mobile network prefix delegated by the MAG.

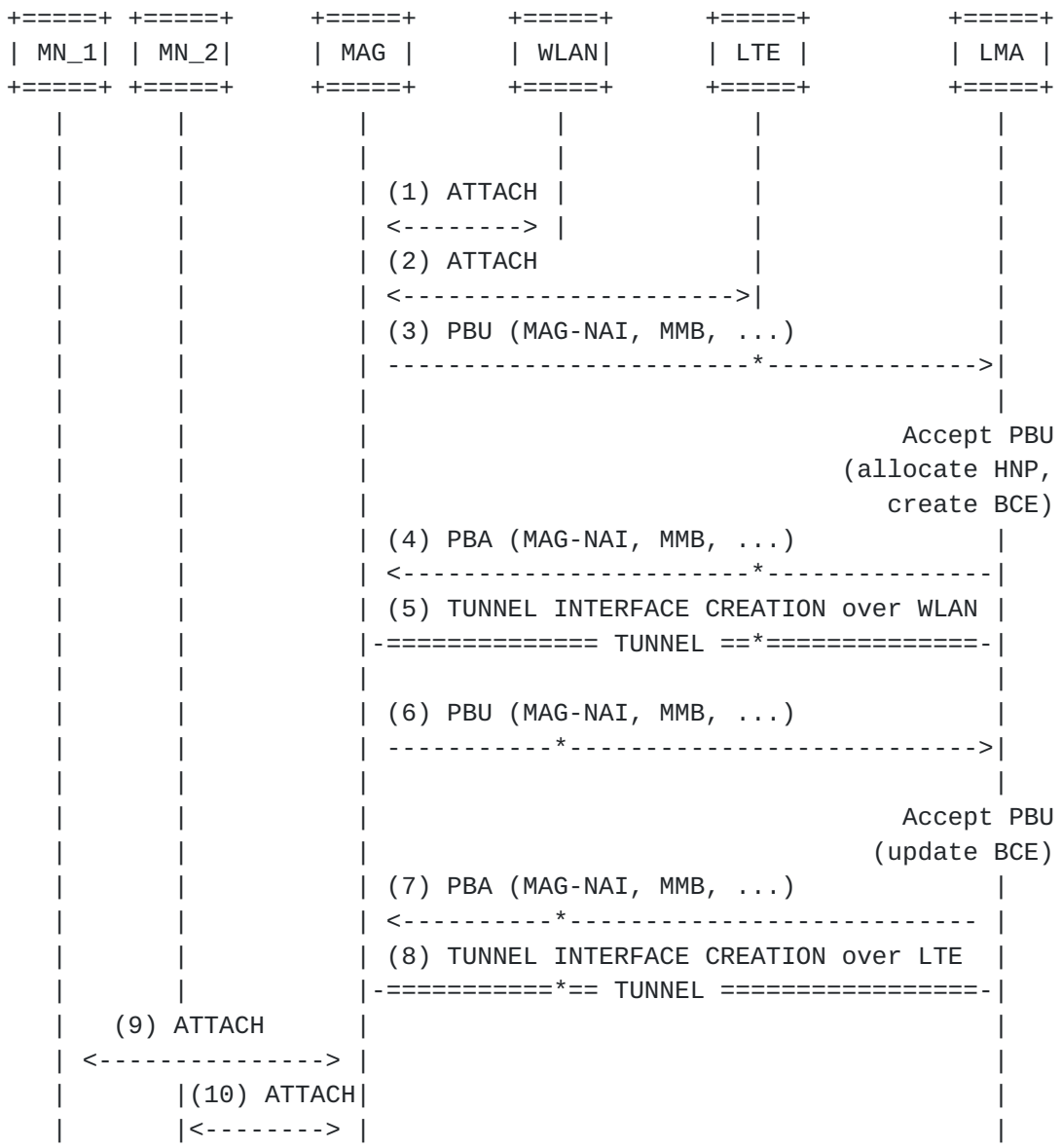

Figure 2: Functional Separation of the Control and User Plane

3.2. Traffic distribution schemes

When the MAG has registered multipath binding with the LMA, there will be multiple established overlay tunnels between them. The MAG and the LMA can use any one, or more of the available tunnels paths for routing the mobile node's IP traffic. This specification does not recommend, or define any specific traffic distribution scheme, however it identifies two well-known approaches that implementations can potentially use. These approaches are, Per-flow and Per-packet Traffic distribution schemes.

Per-Flow Traffic Distribution:

- In this approach the MAG and the LMA associate each of the IP flows (upstream and downstream) to a specific tunnel path. The packets in a given IP flow are always routed on the same overlay tunnel path; they are never split and routed concurrently on more than one tunnel path. It is possible a given flow may be moved from one tunnel path to another, but the flow is never split. The decision to bind a given IP flow to a specific tunnel path is based on traffic distribution policy. This traffic distribution policy is either statically configured on both the MAG and the LMA, or dynamically negotiated over Proxy Mobile IPv6 signaling. The Flow Binding extension [RFC6089] and Traffic Selectors for Flow Bindings [RFC6088] defines the mechanism and the semantics for exchanging the traffic policy between two tunnel peers and the same mechanism and the mobility options are used here.

Per-Packet Traffic Distribution:

- In this approach, packets belonging a given IP flow will be split and routed across more than one tunnel paths. The exact approach for traffic distribution, or the distribution weights is outside the scope of this specification. In a very simplistic approach, assuming the established tunnel paths have symmetric characteristics, the packets can be equally distributed on all the available tunnel paths. In a different scenario when the links have different speeds, the chosen approach can be based on weighted distribution (Ex: n:m ratio). However, in any of these chosen approaches, implementations have to be sensitive to issues related to asymmetric link characteristics and the resulting issues such as re-ordering, buffering and the impact to the application performance. Care must be taken to ensure there is no negative impact to the application performance due to the use of this approach.

4. Protocol Extensions

4.1. MAG Multipath-Binding Option

The MAG Multipath-Binding option is a new mobility header option defined for use with Proxy Binding Update and Proxy Binding Acknowledgement messages exchanged between the local mobility anchor and the mobile access gateway.

This mobility header option is used for requesting multipath support. It indicates that the mobile access gateway is requesting the local mobility anchor to register the current care-of address associated with the request as one of the many care-addresses through which the mobile access gateway can be reached. It is also for carrying the information related to the access network associated with the care-of address.

The MAG Multipath-Binding option has an alignment requirement of 8n+2. Its format is as shown in Figure 3:

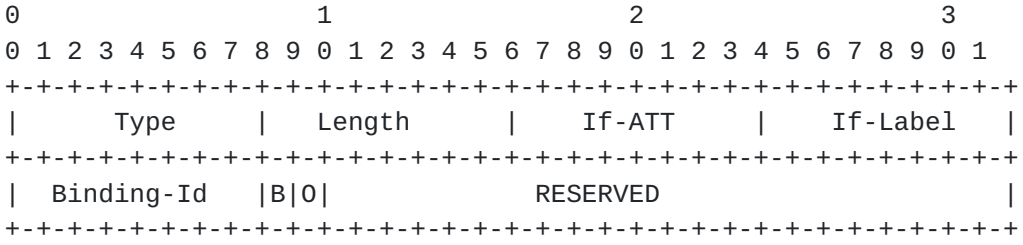

Figure 3: MAG Multipath Binding Option

Type

<IANA-1> To be assigned by IANA.

Length

8-bit unsigned integer indicating the length of the option in octets, excluding the type and length fields.

Interface Access-Technology Type (If-ATT)

This 8-bit field identifies the Access-Technology type of the interface through which the mobile node is connected. The permitted values for this are from the Access Technology Type registry defined in [RFC5213].

Interface Label (If-Label)

This 8-bit unsigned integer represents the interface label.

The interface label is an identifier configured on the WAN interface of the MAG. All the WAN interfaces of the MAG that are used for sending PBU messages are configured with a label. The labels merely identify the type of WAN interface and are primarily used in Application routing policies. For example, a Wi-Fi interfaces can be configured with a label RED and a LTE interface with a label BLUE. Furthermore, the same label may be configured on two WAN interfaces of similar characteristics (Ex: Two Ethernet interfaces with the same label).

Interfaces labels are signaled from the MAG to LMA in the PBU messages and both the LMA and MAG will be able to mark each of the dynamically created Binding/Tunnel with the associated label. These labels are used in generating consistent application routing rules on the both the LMA and the MAG. For example, there can be a policy requiring HTTP packets to be routed over interface that has Label RED, and if any of the RED interfaces are not available, the traffic needs to be routed over the BLUE interface. The MAG and the LMA will be able to apply this Routing Rule with the exchange of Labels in PBU messages and by associating the application flows to tunnels with the matching labels.

Binding-Identifier (BID)

This 8-bit unsigned integer is used for identifying the binding. The permitted values are 1 through 254. The values, 0 and 255 are reserved.

The MAG identifies each of the mobile node's binding with a unique identifier. The MAG includes the identifier in the PBU message and when the PBU request is accepted by the LMA, the resulting Binding is associated with this binding identifier.

Bulk Re-registration Flag (B)

This flag, if set to a value of (1), is to notify the local mobility anchor to consider this request as a request to update the binding lifetime of all the mobile node's bindings, upon accepting this specific request. This flag MUST NOT be set to a value of (1), if the value of the Registration Overwrite Flag (O) is set to a value of (1).

Binding Overwrite (O)

This flag, if set to a value of (1), notifies the local mobility anchor that upon accepting this request, it should replace all of

the mobile node's existing bindings with this binding. This flag MUST NOT be set to a value of (1), if the value of the Bulk Re-registration Flag (B) is set to a value of (1). This flag MUST be set to a value of (0), in de-registration requests.

Reserved

This field is unused in this specification. The value MUST be set to zero (0) by the sender and MUST be ignored by the receiver.

4.2. MAG Identifier Option

The MAG Identifier option is a new mobility header option defined for use with Proxy Binding Update and Proxy Binding Acknowledgement messages exchanged between the local mobility anchor and the mobile access gateway. This mobility header option is used for conveying the MAG's identity.

This option does not have any alignment requirements.

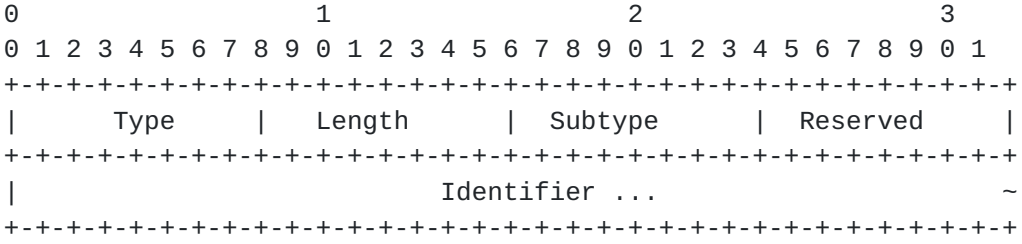

Figure 4: MAG Identifier Option

Type

<IANA-2> To be assigned by IANA.

Length

8-bit unsigned integer indicating the length of the option in octets, excluding the type and length fields.

Subtype

One byte unsigned integer used for identifying the type of the Identifier field. Accepted values for this field are the registered type values from the Mobile Node Identifier Option Subtypes registry.

Reserved

This field is unused in this specification. The value MUST be set to zero (0) by the sender and MUST be ignored by the receiver.

Identifier

A variable length identifier of type indicated in the Subtype field.

4.3. New Status Code for Proxy Binding Acknowledgement

This document defines the following new Status Code value for use in Proxy Binding Acknowledgement message.

The LMA SHOULD use this error code when rejecting a Proxy Binding Update message from a MAG requesting a multipath binding. Following is the potential reason for rejecting the request:

- The LMA does not support multipath binding.

CANNOT_SUPPORT_MULTIPATH_BINDING (Cannot Support Multipath Binding): <IANA-4>

4.4. Signaling Considerations

- The MAG when requesting multipath support MUST include the MAG Multipath Binding Option (Section 4.1) in each of the PBU messages that it sends through the different WAN interfaces. The inclusion of this option serves as a hint that the MAG is requesting Multipath support. Furthermore, the MAG Identifier option MUST also be present in the PBU message.

- If the LMA is a legacy LMA that does not support this specification, the LMA will skip the MAG Multipath Binding option (and MAG NAI option) and process the rest of the message as specified in the base Proxy Mobile IPv6 specification ([RFC5213]). Furthermore, the LMA will not include the MAG Multipath Binding option (or the MAG NAI Option)in the PBA message. The MAG on receiving the PBA message without the MAG Multipath Binding option SHOULD disable Multipath support for the mobile node.

- If the mobile node is not authorized for Multipath support, then the LMA will reject the request by sending a PBA message with the Status field value set to CANNOT_SUPPORT_MULTIPATH_BINDING (Section 4.3). The LMA will echo the MAG Multipath Binding option and the MAG NAI option in the PBA message. The MAG on receiving this message SHOULD disable Multipath support for the mobile node.

- If the request for multipath support is accepted, then the LMA SHOULD enable multipath support for the mobile node and SHOULD also echo the MAG Multipath Binding option and the MAG NAI option in the corresponding PBA message.

5. IANA Considerations

This document requires the following IANA actions.

- Action-1: This specification defines a new mobility option, the MAG Multipath-Binding option. The format of this option is described in Section 4.1. The type value <IANA-1> for this mobility option needs to be allocated from the Mobility Options registry at <http://www.iana.org/assignments/mobility-parameters>. RFC Editor: Please replace <IANA-1> in Section 4.1 with the assigned value and update this section accordingly.

- Action-2: This specification defines a new mobility option, the MAG Identifier option. The format of this option is described in Section 4.2. The type value <IANA-2> for this mobility option needs to be allocated from the Mobility Options registry at <http://www.iana.org/assignments/mobility-parameters>. RFC Editor: Please replace <IANA-2> in Section 4.2 with the assigned value and update this section accordingly.

- Action-3: This document defines a new status value, CANNOT_SUPPORT_MULTIPATH_BINDING (<IANA-3>) for use in Proxy Binding Acknowledgement message, as described in Section 4.3. This value is to be assigned from the "Status Codes" registry at <http://www.iana.org/assignments/mobility-parameters>. The allocated value has to be greater than 127. RFC Editor: Please replace <IANA-3> in Section 4.3 with the assigned value and update this section accordingly.

6. Security Considerations

This specification allows a mobile access gateway to establish multiple Proxy Mobile IPv6 tunnels with a local mobility anchor, by registering a care-of address for each of its connected access networks. This essentially allows the mobile node's IP traffic to be routed through any of the tunnel paths based on the negotiated flow policy. This new capability has no impact on the protocol security. Furthermore, this specification defines two new mobility header options, MAG Multipath-Binding option and the MAG Identifier option. These options are carried like any other mobility header option as specified in [RFC5213]. Therefore, it inherits security guidelines

from [RFC5213]. Thus, this specification does not weaken the security of Proxy Mobile IPv6 Protocol, and does not introduce any new security vulnerabilities.

7. Acknowledgements

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8. References

8.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC3963] Devarapalli, V., Wakikawa, R., Petrescu, A., and P. Thubert, "Network Mobility (NEMO) Basic Support Protocol", RFC 3963, DOI 10.17487/RFC3963, January 2005, <https://www.rfc-editor.org/info/rfc3963>.

[RFC5094] Devarapalli, V., Patel, A., and K. Leung, "Mobile IPv6 Vendor Specific Option", RFC 5094, DOI 10.17487/RFC5094, December 2007, <https://www.rfc-editor.org/info/rfc5094>.

[RFC5213] Gundavelli, S., Ed., Leung, K., Devarapalli, V., Chowdhury, K., and B. Patil, "Proxy Mobile IPv6", RFC 5213, DOI 10.17487/RFC5213, August 2008, <https://www.rfc-editor.org/info/rfc5213>.

[RFC5648] Wakikawa, R., Ed., Devarapalli, V., Tsirtsis, G., Ernst, T., and K. Nagami, "Multiple Care-of Addresses Registration", RFC 5648, DOI 10.17487/RFC5648, October 2009, <https://www.rfc-editor.org/info/rfc5648>.

[RFC5844] Wakikawa, R. and S. Gundavelli, "IPv4 Support for Proxy Mobile IPv6", RFC 5844, DOI 10.17487/RFC5844, May 2010, <https://www.rfc-editor.org/info/rfc5844>.

[RFC5845] Muhanna, A., Khalil, M., Gundavelli, S., and K. Leung,

"Generic Routing Encapsulation (GRE) Key Option for Proxy Mobile IPv6", RFC 5845, DOI 10.17487/RFC5845, June 2010, <https://www.rfc-editor.org/info/rfc5845>.

[RFC6088] Tsirtsis, G., Giarreta, G., Soliman, H., and N. Montavont, "Traffic Selectors for Flow Bindings", RFC 6088, DOI 10.17487/RFC6088, January 2011, <https://www.rfc-editor.org/info/rfc6088>.

[RFC6089] Tsirtsis, G., Soliman, H., Montavont, N., Giaretta, G., and K. Kuladinithi, "Flow Bindings in Mobile IPv6 and Network Mobility (NEMO) Basic Support", RFC 6089, DOI 10.17487/RFC6089, January 2011, <https://www.rfc-editor.org/info/rfc6089>.

[RFC6275] Perkins, C., Ed., Johnson, D., and J. Arkko, "Mobility Support in IPv6", RFC 6275, DOI 10.17487/RFC6275, July 2011, <https://www.rfc-editor.org/info/rfc6275>.

[RFC7148] Zhou, X., Korhonen, J., Williams, C., Gundavelli, S., and CJ. Bernardos, "Prefix Delegation Support for Proxy Mobile IPv6", RFC 7148, DOI 10.17487/RFC7148, March 2014, <https://www.rfc-editor.org/info/rfc7148>.

8.2. Informative References

[RFC2473] Conta, A. and S. Deering, "Generic Packet Tunneling in IPv6 Specification", RFC 2473, DOI 10.17487/RFC2473, December 1998, <https://www.rfc-editor.org/info/rfc2473>.

[RFC4213] Nordmark, E. and R. Gilligan, "Basic Transition Mechanisms for IPv6 Hosts and Routers", RFC 4213, DOI 10.17487/RFC4213, October 2005, <https://www.rfc-editor.org/info/rfc4213>.

[RFC4908] Nagami, K., Uda, S., Ogashiwa, N., Esaki, H., Wakikawa, R., and H. Ohnishi, "Multi-homing for small scale fixed network Using Mobile IP and NEMO", RFC 4908, DOI 10.17487/RFC4908, June 2007, <https://www.rfc-editor.org/info/rfc4908>.

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