Status of this Memo

This document is a submission to the IPng Working Group of the Internet Engineering Task Force (IETF). Comments should be submitted to the ipng@sunroof.eng.sun.com mailing list.

Distribution of this memo is unlimited.

This document is an Internet-Draft. Internet Drafts are working documents of the Internet Engineering Task Force (IETF), its Areas, and its Working Groups. Note that other groups may also distribute working documents as Internet Drafts.

Internet Drafts are draft documents valid for a maximum of six months, and may be updated, replaced, or obsoleted by other documents at any time. It is not appropriate to use Internet Drafts as reference material, or to cite them other than as a "working draft" or "work in progress."

To learn the current status of any Internet-Draft, please check the "id-abstracts.txt" listing contained in the internet-drafts Shadow Directories on ds.internic.net (US East Coast), nic.nordu.net (Europe), ftp.isi.edu (US West Coast), or munnari.oz.au (Pacific Rim).

Abstract

This document specifies ICMP messages for identification of and forwarding to adjacent IPv6 nodes, including Mobility, Next Hop Determination and Router Discovery.
1. Additional ICMP Packets

The datagram format and basic facilities are already defined for ICMP as modified for IPv6 [IPv6-ICMP].

Up-to-date values of the ICMP Type field are specified in the most recent "Assigned Numbers" [RFC-1700]. This document concerns the following values:

- 33 Where-Are-You Solicitations
- 34 I-Am-Here Advertisements
- 35 Mobile Registration Request
- 36 Mobile Registration Reply
1.1. Where-Are-You Solicitations

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Checksum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Type              33

Code               Up-to-date values are specified in the most recent "Assigned Numbers" [RFC-1700]. Current values are assigned as follows:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>RESERVED</td>
</tr>
<tr>
<td>1</td>
<td>General</td>
</tr>
<tr>
<td>2</td>
<td>Router</td>
</tr>
<tr>
<td>3</td>
<td>Service (reserved)</td>
</tr>
</tbody>
</table>

Checksum          The ICMP Checksum.

Extensions        zero or more Extensions. This field is variable in length. The Extensions SHOULD be included in the order described. These Extensions are described in a later chapter.

The contents of the Reserved field MUST be zero on transmission, and MUST be ignored on receipt. Future backward-compatible changes to the protocol may specify the contents of the Reserved field or of additional octets at the end of the message.
1.1.1. General Solicitation

The General Solicitation MUST contain at least the following values:

Link Header (if any):

- **Destination**: the link equivalent of the Solicited-Nodes IPv6 Multicast Address. The mapping is described in \[IPv6-Address\].

IPv6 Header:

- **Destination**: the calculated Solicited-Nodes IPv6 Multicast Address. The scope is intra-link.

  This is calculated by starting with the exclusive-or of each byte of the target IPv6 Unicast Address, then adding the result to the base Solicited-Nodes multicast (FF02::7:0).

  For example, to calculate the destination value for target A::B:C, the exclusive-or is E. The calculated destination would be FF02::7:E.

- **Source**: any IPv6 Unicast Address associated with the sending interface. It MUST NOT contain the Unspecified Address.

- **Hop Limit**: 1

ICMP fields:

- **Code**: 1 for General Solicitation.

Extensions:

- **Other-Identifier**: any IPv6 Unicast Address of the target. The Prefix Size and Metric are always zero.

- **Maximum-Receive-Unit**: for interfaces which do not have a fixed hardware MTU.

- **Media-Access**: for interfaces which are not point-to-point links.

- **Node-Heard**: for each Router Advertisement that has been heard, in order of preference.

Simpson expires in six months
In the unlikely event that not all extensions fit in a single solicitation, as constrained by the MTU of the link, the remaining extensions are removed.

The use of the General Solicitation is described in [D-Send].
1.1.2. Router Solicitation

The Router Solicitation MUST contain at least the following values:

**Link Header (if any):**

- **Destination:** the link equivalent of the All-Routers IPv6 Multicast Address. The mapping is described in [IPv6-Address].

**IPv6 Header:**

- **Destination:** the All-Routers IPv6 Multicast Address (FF02::3). The scope is intra-link.
- **Source:** any IPv6 Unicast Address associated with the sending interface. It MAY contain the Unspecified Address, when the node has not yet determined an IPv6 Unicast Address.
- **Hop Limit:** 1

**ICMP fields:**

- **Code:** 2 for Router Solicitation.
- **Extensions:**
  - **Maximum-Receive-Unit:** for interfaces which do not have a fixed hardware MTU.
  - **Media-Access:** for interfaces which are not point-to-point links.

The use of the Router Solicitation is described in [D-Send].
1.2. I-Am-Here Advertisements

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Checksum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sequence Number</th>
<th>LifeTime</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extensions ...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Type 34

Code Up-to-date values are specified in the most recent "Assigned Numbers" [RFC-1700]. Current values are assigned as follows:

0 RESERVED
1 General
2 Router
3 Service (reserved)
4 Local Redirect
5 Remote Redirect

Checksum The ICMP Checksum.

Sequence Number the number of Advertisement messages sent since the node was initialized. The value MUST include this advertisement. That is, the first Advertisement contains the value one, and the value zero indicates that the number has rolled over.

LifeTime the seconds remaining before the advertised information is considered expired. The maximum time is approximately 18.2 hours.

Extensions zero or more Extensions. This field is variable in length. The Extensions SHOULD be included in the order described. These Extensions are described in a later chapter.
1.2.1. General Advertisement

The General Advertisement MUST contain at least the following values:

**IPv6 Header:**

- **Destination**: the Source specified in the solicitation, when the Source is not the Unspecified Address, the node is not serving several clients, and the node is not operating as a Mobile Node.
  
  Otherwise, the All-Nodes IPv6 Multicast Address (FF02::1). The scope is intra-link. These decisions are described in [D-Send] and [Mobility].

- **Source**: the Destination specified in the solicitation.

- **Hop Limit**: 1

**ICMP fields:**

- **Code**: 1 for General Advertisement.

- **Lifetime**: the interface’s configured AdvertisementLifetime.

**Extensions:**

- **Maximum-Receive-Unit**: for interfaces which do not have a fixed hardware MTU.

- **Media-Access**: for interfaces which are not point-to-point links.

- **Other-Identifier**: for each of that node’s known IPv6 Unicast Addresses other than the IPv6 Unicast Address specified in the IPv6 Source field. The Prefix Size and Metric are always zero.

  This supports multiple addresses per interface, as well as multi-homed nodes. This enables the recipient node to determine the best next-hop, when the next-hop is on another interface attached to the same advertising node.

- **Node-Heard**: for the sender of the General Solicitation.
In addition, each Router Advertisement that has been heard, in order of preference.

In the unlikely event that not all extensions fit in a single advertisement, as constrained by the MTU of the link, the remaining extensions are removed.

The use of the General Advertisement is described in [D-Send].
1.2.2. Router Advertisement

The Router Advertisement MUST contain at least the following values:

IPv6 Header:

Destination the All-Nodes IPv6 Multicast Address (FF02::1). The scope is intra-link.

Source the Primary Identifier of the router.

The same IPv6 Unicast Address is used for all interfaces. When a router has more than one interface on the same link, or a multi-homed host can hear the same router on more than one link, it is necessary to unambiguously know which router sent this advertisement. The individual cluster prefixes for the links are distinguished in the Routing-Information extension.

Hop Limit 1

ICMP fields:

Code 2 for Router Advertisement.

Lifetime the interface’s configured AdvertisementLifetime.

Extensions:

Hop-Limit the current Internet Time-To-Live. Up-to-date values are specified in the most recent "Assigned Numbers" [RFC-1700].

Maximum-Receive-Unit for interfaces which do not have a fixed hardware MTU.

Media-Access for interfaces which are not point-to-point links.

Mobility-Support for interfaces which support Mobile Registration, either as a Foreign Agent or Home Agent.

In the absence of this extension, all routers are expected to support decapsulation and forwarding from an interface, without explicit registration by a Mobile Node.

Simpson expires in six months
Change-Identifier for each of that interface’s IPv6 Unicast or Cluster Addresses which has changed from a value previously advertised with the Routing-Information or Other-Identifier extensions. Included at least once, and repeated until the original LifeTime expires.

Routing-Information for each of that interface’s associated IPv6 Unicast Addresses whose Advertise flags are TRUE.

Other-Identifier for each of that node’s other IPv6 Unicast or Cluster Addresses which have not already been included through prefix subsumption. This may be another address for the same interface, or may identify another interface on the same node.

When a number of interfaces, such as point-to-point interfaces, may be aggregated with the same prefix, only one extension need be included.

Node-Heard for each Router Advertisement that has been heard, in order of preference.

In the unlikely event that not all extensions fit in a single advertisement, as constrained by the MTU of the link, multiple advertisements are sent, with each containing as many remaining extensions as can fit.

The use of the Router Advertisement is described in [D-Send].
1.2.3. Local Redirect

The Local Redirect MUST contain at least the following values:

IPv6 Header:

Destination the Source specified in the packet being redirected.

Source the Primary Identifier of the router.

Hop Limit 1

ICMP fields:

Code 4 for Local Redirect.

Sequence the last Sequence from the target node Advertisement.

Lifetime the remaining Lifetime from the target node Advertisement.

Extensions:

Maximum-Receive-Unit for interfaces which do not have a fixed hardware MTU, the Maximum-Receive-Unit extension from the target node Advertisement.

Media-Access for interfaces which are not point-to-point links, the Media-Access extension from the target node Advertisement.

Other-Identifier for each IPv6 Unicast or Cluster Address associated with the target node. The Metric is always zero.

When the redirect applies to an entire cluster, the Prefix Size is set to the size of the cluster prefix. This enables the recipient node to determine the best next-hop without multiple redirects for each cluster.

Transit-Information one or more, when the redirect is limited to a specific Quality of Service. The Metric is always zero.
Redirected-Header The target header.

In the unlikely event that not all extensions fit in a single redirect, as constrained by the MTU of the link, the remaining extensions are removed. Only a single redirect is sent.

The use of the Local Redirect is described in [D-Send].
1.2.4. Remote Redirect

The Remote Redirect MUST contain at least the following values:

IPv6 Header:
- Destination: the Source specified in the packet being redirected.
- Source: the Destination specified in the packet being redirected.
- Hop Limit: from the Router Advertisement.

An Authentication Header is required.

ICMP fields:
- Code: 5 for Remote Redirect.
- Sequence: the last Sequence from the target node Advertisement.
- Lifetime: the remaining Lifetime from the target node Advertisement.

Extensions:
- Change-Identifier for each of that interface’s IPv6 Unicast or Cluster Addresses which is now reached via a Care-Of-Address.

Redirected-Header: The target header.

In the unlikely event that not all extensions fit in a single redirect, as constrained by the MTU of the link, the remaining extensions are removed. Only a single redirect is sent.

The use of the Remote Redirect is described in [Mobility].
1.3. Mobile Registration Request

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Checksum</th>
<th>LifeTime</th>
<th>Identification</th>
<th>Home Agent</th>
<th>Care-Of-Address</th>
<th>Extensions...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IPv6 Header:

Destination
The IPv6 Unicast Address of the Agent, when known.
Otherwise, the Mobile-Agents IPv6 Multicast Address (FF02::11). The scope is intra-link.
Examination of the Care-Of-Address is used to deliver the datagram to the correct Agent.

Source
any IPv6 Unicast Address associated with the sending interface.

A Mobile Node MUST use the transient Care-Of-Address when assigned; otherwise, the Home-Address is used.

ICMP fields:

Type
35

Code
Bitmask of optional capabilities:
1 - retain prior registrations
2 - registering through Foreign Agent
LifeTime

The seconds remaining before the registration is considered expired. A value of zero indicates a request for de-registration. A value of all ones indicates infinity.

Identification

A sequence number assigned by the Mobile Node. This is used to assist in matching Requests with Replies.

A Network Time Protocol [RFC-1305] formatted value is preferred. The low-order 32 bits of the NTP format represent fractional seconds, and those bits which are not available from a time source SHOULD be generated from a good source of randomness.

A battery-backed clock is the usual source of this value. In more robust implementations, Global Positioning System or authenticated NTP values MAY be used. The elapsed time since system startup or another such monotonically increasing counter MAY be used, but is considered less secure, as it could repeat each time the machine is restarted, or when a poor source of randomness is used for the low-order bits. See [Eastlake] for a discussion of sources of randomness.

It is possible to use an entirely random "nonce" in this field, or to generate nonces from previous registration exchanges. We have not standardized this procedure because of intellectual property concerns. It is also incompatible with the expected venue of the protocol, and presents difficulties with interoperability and security validation.

The value MUST NOT be the same as an immediately preceeding request, and SHOULD NOT repeat during the lifetime of the Mobility Security Association between the Mobile Node and the Home Agent.

Home Agent

The IPv6 Unicast Address of a Home Agent.

Care-Of-Address

The IPv6 Unicast Address for the decapsulation end of a tunnel.

Extensions:
Other-Identifier the Home-Address of the Mobile Node. The Metric is always zero.

When the request applies to an entire cluster, the Prefix Size is set to the size of the cluster prefix.

Maximum-Receive-Unit
for interfaces which do not have a fixed hardware MTU.

Media-Access for interfaces which are not point-to-point links.

Mobile-Home Authentication
Immediately follows all non-authentication extensions.

When forwarded by a Foreign Agent, all extensions are copied without modification. Those extensions which are specific to the Foreign Agent are ignored by the Home Agent.

The use of the Registration Request is described in [Mobility].

Simpson expires in six months [Page 16]
1.4. Mobile Registration Reply

The Source and Destination of the Request message are swapped for the Reply message.

Note that the Source of the original Mobile Registration Request must be saved in order for a Foreign Agent to return the reply to the correct Mobile Node.

ICMP fields:

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Type 36
- Code

One of the following codes:

- 0 service will be provided.
- denied by Foreign Agent,
  - 16 reason unspecified.
  - 17 administratively prohibited.
  - 18 insufficient resources.
  - 19 Mobile Node failed authentication.
  - 20 Home Agent failed authentication.
  - 21 Request LifeTime too long.

- denied by Home Agent,
  - 32 reason unspecified.
  - 33 administratively prohibited.
  - 34 insufficient resources.
  - 35 Mobile Node failed authentication.
  - 36 Foreign Agent failed authentication.

Up-to-date values of the Code field are specified in the most recent "Assigned Numbers" [RFC-1700].
LifeTime
The seconds remaining before the registration is considered expired. A value of zero confirms a request for de-registration. A value of all ones indicates infinity.

The value MAY be changed by the Home Agent.

Identification
Copied from the Request message.

Extensions:

Other-Identifier the Home-Address of the Mobile Node. The Metric is always zero.

When the reply applies to an entire cluster, the Prefix Size is set to the size of the cluster prefix.

Mobile-Home Authentication
Immediately follows all non-authentication extensions.

Note that the Care-Of-Address and Home Agent are not present in the message. This provides a separate calculation value for mutual authentication.

When forwarded by a Foreign Agent, all extensions are copied without modification. Those extensions which are specific to the Foreign Agent are ignored by the Home Agent.

The use of the Registration Reply is described in [Mobility].
2. Extensions

Extensions allow variable amounts of information to be carried within each Solicitation or Advertisement packet. Some extensions are common to both packet types.

The end of the list of Extensions is indicated by the Payload Length of the IPv6 packet.

```
+---------------+----------+--------+
| Extension     | Length   | Data ...|
+---------------+----------+--------+
```

Extension        This document concerns the following values:

0     Single Pad (no length field)
1     Multiple Pads (with length field)
2     Change-Identifier
3     Other-Identifier
4     Node-Heard
5     Routing-Information
6     Service-Information (reserved)
7     Transit-Information
13    Hop-Limit
14    Maximum-Receive-Unit
15    Media-Access
16    Mobility-Support
17    Home-Address (obsolete)
32    Mobile-Home Authentication
64    Minimal Encapsulation (obsolete)
65    GRE Encapsulation
254   Redirected-Header

Up-to-date values are specified in the most recent "Assigned Numbers" [RFC-1700].

Length           the length of the Data field. The Length does not include the Extension and Length octets.

The Single Pad (extension 0) is a special case, which has neither Length field nor Data field.

Data             zero or more octets. The format and length of the Data field is determined by the Extension and Length fields.

When an extension is encountered which is not recognized, it is
ignored. The Length field is used to skip the data field in searching for the next extension.

Every extension is aligned such that internal fields fall on natural boundaries, except that fields larger than 64-bits need only be aligned to 64-bit boundaries.

Any unused portion of the datagram between such Extensions is padded as appropriate. The final Extension in a datagram does not require trailing padding.

2.1. Single Pad

```
+++-+-+-+-+-+-+-+
|   Extension   |
+++-+-+-+-+-+-+-+
```

Extension 0

2.2. Multiple Pads

```
+++-+-+-+-+-+-+-+---------------------------------------------------------+
|   Extension   |    Length     |   Data ...                           |
+++-+-+-+-+-+-+-+---------------------------------------------------------+
```

Extension 1

Length the length of the Data field.

Data zero or more bytes of zeroes.
2.3. Change-Identifier

+-----------------+-----------------+-----------------+-----------------+-----------------+
| Extension       | Length          | 0               | Prefix Size     | ~               |
+-----------------+-----------------+-----------------+-----------------+-----------------+
|                 |                 |                 |                 | Identifier      |
+-----------------+-----------------+-----------------+-----------------+-----------------+

Extension        2
Length            34
Prefix Size       the number of bits in the Identifier which define the cluster prefix width for the link. The value ranges from 0 to 126.
If the Identifier does not indicate a valid prefix, the value is zero.
Non-routers MUST set this field to zero.
Identifier       an IPv6 Unicast or Cluster Address.

For Router Advertisements, gives advance indication that an address or prefix will no longer be routable. Applications SHOULD cease to accept new connections with the old value. Existing connections SHOULD issue a Remote Redirect.

For Remote Redirects, provides a Care-Of-Address to a Correspondent.
### 2.4. Other-Identifier

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
<th>Prefix Size</th>
<th>Metric</th>
<th>Identifier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td>~</td>
</tr>
</tbody>
</table>

- **Extension**: 3
- **Length**: 22
- **Prefix Size**: the number of bits in the Identifier which define the cluster prefix width for the link. The value ranges from 0 to 126.
  - If the Identifier does not indicate a valid prefix, the value is zero.
  - Non-routers MUST set this field to zero.
- **Metric**: the preference level for use of this node to forward packets to the Identifier. Lower values indicate greater preference.
  - Non-routers MUST set this field to zero.
- **Identifier**: an IPv6 Unicast or Cluster Address.

For usage, see the specific message description.
2.5. Node-Heard

Extension | Length | Prefix Size |
-----------|--------|------------|
          | 0      |            |
-----------|--------|------------|
Sequence Number | Remaining LifeTime |
               |                 |
-----------|--------|------------|
Primary Identifier |
                  |                 |
-----------|--------|------------|
MRU | Speed |
         | 0     |            |
-----------|--------|------------|
Quality |
         |
-----------|--------|------------|
Advertisement Count |
               |
-----------|--------|------------|
Error Count |
            |
-----------|--------|------------|

Extension 4
Length 38
Prefix Size the number of bits in the Primary Identifier which define the cluster prefix width for the link. The value ranges from 0 to 126.
If the Primary Identifier does not indicate a valid prefix, the value is zero.
Sequence Number the last heard sequence number from the node.
Remaining LifeTime the seconds remaining before the entry is considered expired.
Primary Identifier the primary IPv6 Unicast or Cluster Address for the node, taken from the Source field of the Advertisement heard.
MRU the maximum size packet that the node will receive over the link.

Simpson expires in six months [Page 23]
### Speed

The speed of the link over which the advertisement or solicitation was heard. Higher values indicate greater speed. The speed value is related to \( \text{int} \left( \frac{10 \times \ln \left( \text{speed} / 100 \right)}{\ln 10} \right) \) in bits per second.

<table>
<thead>
<tr>
<th>Value</th>
<th>Speed</th>
<th>Quality</th>
<th>Advertisement Count</th>
<th>Error Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>link is down</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - 9</td>
<td>reserved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>300 or less</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>1,200</td>
<td>96</td>
<td>1,544,000 T1</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>2,400</td>
<td>99</td>
<td>2,048,000 E1</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>4,800</td>
<td>106</td>
<td>4,000,000 Token Ring</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>7,200</td>
<td>110</td>
<td>6,312,000 T2</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>9,600</td>
<td>115</td>
<td>10,000,000 Ethernet</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>14,400</td>
<td>119</td>
<td>16,000,000 Token Ring</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>19,200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>28,800</td>
<td>130</td>
<td>44,736,000 T3</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>38,400</td>
<td>142</td>
<td>155,520,000 STS-3,STM-1</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>57,600</td>
<td>202</td>
<td>622,080,000 STS-12,STM-4</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>64,000</td>
<td>216</td>
<td>2,488,320,000 STS-48,STM-16</td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>128,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>153,600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>256,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Quality

An indication of the signal quality received from this node. Higher values indicate greater quality.

### Advertisement Count

The number of advertisements that have been heard from the identified node.

### Error Count

The number of errors which have been detected on the link with the identified node.

This extension is included in an Advertisement message to indicate a node which has been heard.

The MRU, Speed, Quality, Advertisement Count, and Error Count are primarily used for selecting among multiple paths in a wireless environment.
### 2.6. Routing-Information

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
<th>Preference</th>
<th>C</th>
<th>Prefix Size</th>
<th></th>
</tr>
</thead>
</table>

```
Extension        5
Length           18
Preference       the preference level for use of this node to forward packets having a Source longest match with the Identifier. Higher values indicate greater preference.
C                Cluster bit. When this bit is set to 1, the IPv6 Cluster is entirely confined to the link. When forwarding, a node MAY use the prefix to determine whether a target node is on the link.
Prefix Size      the number of bits in the Identifier which define the cluster prefix width for the link. The value ranges from 0 to 126.
Identifier       one of the IPv6 Unicast or Cluster Addresses for this interface.
```

This extension is found in Router Advertisements.

---

Simpson expires in six months [Page 25]
2.7. Transit-Information

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
<th>QoS</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>6</td>
<td>a quality of service for which transit will be accepted.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>the preference level for use of this link to forward packets of the indicated Quality of Service. Lower values indicate greater preference.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For redirects, this indicates that the redirect is limited to only the particular service. If this extension is not included, the redirect includes all services.</td>
<td></td>
</tr>
</tbody>
</table>

Simpson expires in six months
2.8. Hop-Limit

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
<th>Hops</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>1</td>
<td>the currently recommended IPv6 Hop Limit.</td>
</tr>
</tbody>
</table>

Up-to-date values are specified in the most recent "Assigned Numbers" [RFC-1700].
2.9. Maximum-Receive-Unit

+-----------------+------------------+
| Extension       | Length           |
| MRU             |                  |
+-----------------+------------------+

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
<th>MRU</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>2</td>
<td>the maximum size packet that the node will receive over the link.</td>
</tr>
</tbody>
</table>

This extension MUST be included in those messages sent from an interface for which there is no dependable MTU, such as Frame-Relay or Asynchronous Transfer Mode.

It MUST NOT be included in messages such as the Remote Redirect which pass through intermediate nodes.
2.10. Media-Access

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
<th>Family</th>
</tr>
</thead>
</table>
| Media Address ...

Extension 15

Length >= 2

Family the Address Family Number.

Up-to-date values are specified in the most recent "Assigned Numbers" [RFC-1700].

Media Address the media address which is used to access this node.

This field is variable in length.

The Media Address is always specified in Canonical order.

This extension MUST be included in those messages sent from an interface on a multi-access media.

It MUST NOT be included in a message sent from a point-to-point interface, or in messages such as the Remote Redirect which pass through intermediate nodes.
### 2.11. Mobility-Support

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
<th>F</th>
<th>Reserved</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>&gt;= 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Extension**: 16
- **Length**: >= 1
- **F**: Foreign Agent bit. When this bit is set to 1, Mobile Registration through the Foreign Agent is required, even when the Mobile Node has acquired a transient Care-Of-Address.
- **Reserved**: Sent as zero; ignored on reception.

This extension is found in Router Advertisements.
2.12. Mobile-Home Authentication Extension

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Authenticator</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>variable length (128 bits for MD5), 64-bit aligned.</td>
<td>A hash value taken over a stream of bytes consisting of the shared secret, followed by (concatenated with) the fields in the Mobile Registration message beginning with the Type field, including all prior extensions, and the Type and Length of this extension, but not including the Authenticator field itself.</td>
</tr>
</tbody>
</table>

This extension is found in all Mobile Registration Requests and Replies.

The value differs depending on the direction the message is sent, since the Mobile Registration Request and Reply have different fields.
2.13. GRE Encapsulation Extension

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>0</td>
</tr>
</tbody>
</table>

This extension is found in Router Advertisements and Mobile Registration Requests. GRE is described in [RFC-1701].
2.14. Redirected-Header

<table>
<thead>
<tr>
<th>Extension</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6 Header(s) ...</td>
<td></td>
</tr>
</tbody>
</table>

Extension 254
Length >= 64
IPv6 Header(s) variable length, 64-bit aligned.

This extension is included in the Local or Remote Redirect to verify the traffic that is being redirected.
Security Considerations

Whenever Ran gets them done.

References

[D-Send]  
[Eastlake]  
[IPv6-Address]  
[IPv6-ICMP]  
[Mobility]  
[RFC-1305]  
[RFC-1700]  
[RFC-1701]

Acknowledgements

Many thanks to Fred Goldstein, K1IO (DEC, BBN) for his pioneering work on Radio Shortest Path First (RSPF) for Amateur Packet Radio.

Thanks also for suggestions and contributions from the Simple-IP Working Group and the Mobile-IP Working Group.

Special thanks for implementation review by Alex Conta (DEC), Dan McDonald (Naval Research Laboratory), and Fred Rabouw (Network Systems Netherlands).

Author’s Address

Questions about this memo can also be directed to:

William Allen Simpson  
Daydreamer  
Computer Systems Consulting Services  
1384 Fontaine

Simpson expires in six months