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The Features of IPv6 Signaling

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Abstract

In this draft, we describe the features and requirements of IPv6 signaling protocol and explain the needs of QoS signaling in IPv6 network. We also explain mapping of IPv6 signaling with IPv4 in some detail.

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](#).

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[1. Introduction](#)

Many signaling mechanisms are defined and developed to support Quality of Service (QoS) in IP networks. Those are chosen by users to satisfy their needs, objectives, and implementation costs. Also most of the signaling protocols are based on the underlying network infrastructure, i.e. IP networks, but they don't depend on the minor version of the network. For example, one signaling protocol designed for the IPv4 network can be used in IPv6 network without modifying the specification of the signaling mechanism. Rather than to do like that, the signaling protocol adopt itself to the different version of network implementation by defining option fields like IP version information field and related information like IPv4 addresses (32 bits) or IPv6 addresses (128 bits).

Actually, IPv6 has many features to support QoS and other capabilities for the emerged networks. We will describe about that in [section 2](#). Also, those features can be used to help existing IPv4 based signaling mechanisms or used to substitute some functions of existing signaling protocols in order to make the signaling protocols more fully using the power of IPv6 features.

In this draft, we describe the features and requirements of IPv6 signaling protocol to explain the needs of QoS signaling in IPv6 network. Deployment point of view, we also explain three stages of evolution scenarios and mapping of IPv6 signaling with IPv4 in some

detail. Finally, the delivering methods of signaling messages in IPv6 network are presented in appendix.

2. The Needs of QoS Signaling in IPv6 networks

2.1. IP related Signaling Protocols

There are already many signaling protocols in IP networks to provide some control delivering mechanism with or without QoS support. We can classify the signaling mechanisms regarding the actual nodes that are affected by that signaling protocol.

A signaling protocol may concern with a pair of node that may be host or router. Like ICMP, that kind of signaling protocol is just for the information notification. On the other hand, like SIP described in [[RFC 2543](#)], some signaling may be transferring the QoS related information that can be used to a node to determine the control of resource of the node.

There are other kinds of signaling protocols that effect on the nodes on a path of source to destination path. With regarding the QoS, currently RSVP [[RFC 2205](#)](or RSVP-TE [[RFC 3209](#)]) and LDP[[RFC 3036](#)](or CR-LDP [[RFC 3212](#)]) is defined to provide QoS in intermediate node of the path in the IP networks. We just use the term "IP network" because any kind of sub layer mechanism can be used to support the transport of IP packets.

Other signaling protocols are defined between the neighbors those are connected with link. We will not mention about this case because this case is treated with special case of above two cases.

We will regard the signaling protocols that use IP or higher layer and related with QoS mechanisms.

2.2. QoS related Signaling Protocols

Usually the QoS mechanisms are supported in the IP layer or the Transport layer (for example, TCP or UDP). To simplify the discussion, we will just regard the three signaling protocols, RSVP-TE, CR-LDP, SIP. These signaling protocols are covering the classification in [section 2.1](#) and also these signaling mechanisms can be used for the some or all of QoS supporting features described in 2.3. Also we note that these are running on the IP and TCP (UDP) layer. We will explain these signaling protocols as briefly as possible to make our discussion further.

- o RSVP-TE (including RSVP-TE extension for GMPLS [RSVP-TE 07])

RSVP-TE, originated by RSVP is used for the IntServ model described in [[RFC 2210](#)]. Both RSVP and RSVP-TE are implemented on the IP layer. RSVP is defined to support QoS in IP network with fine granularity, but this leads the scalability problems. RSVP-TE has some additional concepts, like label distribution, aggregated flow, and explicit route. But RSVP-TE doesn't support multicasting environment.

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- o CR-LDP (including CR-LDP extension for GMPLS [CR-LDP 06])

CR-LDP, from LDP, is used for the almost same purpose of RSVP-TE. But this signaling protocol use the TCP (and UDP) layer instead of IP layer in RSVP-TE. So this signaling protocol uses the features of TCP protocol.

- o SIP and H.323

To provide the multimedia services, like voice or moving pictures, SIP and other protocols are defined to provide the server and client side QoS mechanism. This protocol use ether TCP or UDP.

2.3. The Features of QoS related Signaling in IPv6 Networks

We will choose some existing signaling protocols to explain our idea. To validate the further discussion, we must describe the features of signaling mechanisms in IPv6 network with supporting QoS.

- o QoS support

Information with QoS controlling is important context of signaling packet. With aggregated flow concept, IPv6 signaling mechanisms can provide finer QoS granularity than DiffServ model, and more scalable than IntServ model.

- o Resource Reservation

The key role of signaling protocol is to allocate and reserve the network resource for the purpose of meeting end-to-end QoS requirements along the entire path. The signaling protocol MUST be able to deal with such resource allocation requests.

- o Priority Flow Control

Each node has many flows with different priority of various data rates and QoS requirements. These flows are classified and scheduled with the capability of making intelligent decisions on how resource allocation SHOULD be controlled.

- o Explicit route

In IPv6 specification, there is a route extension header to use explicit route. Explicit route is important for traffic engineering in IPv6 networks, so we can use of this option header. In doing so, signaling packet specify the route with route extension header and data packet is just switched according to flow label in each router on the path specified with signaling packet. There is already ROUTE object in RSVP-TE specification [[RFC 3209](#)]. In the case of CR-LDP, some TLVs are defined to be used for this purpose.

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- o Scalability

The performance of the signaling protocol SHOULD not largely depend on the scale of the network to which IPv6 is applied (e.g. the number of nodes, the number of physical links etc). The signaling function SHOULD keep constant performance as much as possible regardless of network size. Aggregating flows can reduce resource allocation and runtime management overhead.

- o Flow Label Information Distribution

To make use of flow label field [Flow Label 02] of IPv6 basic header and identify the flow label between the routers on specific path, label-binding information SHOULD be delivered between the related routers. The related routers are on the path of the flow. Label value is only meaningful between a pair of routers. And the label value is predetermined before forwarding data packet along the path.

- o Label Stacking

In Label Switching, label stacking concept is addressed. To enable the label stacking, the signaling protocol is defined to notify the stacking information. But we don't consider the concept in this version.

2.4. The Requirements of QoS Signaling Protocol in IPv6 Networks

Besides of features of signaling, we SHOULD consider the following requirements of QoS signaling in IPv6 networks.

- o Make use of IPv6 features

IPv6 have many features to make use of that to provide some new functions. For example, one can want to use the IPv6 Routing Option header to send signaling packet along the desired path rather than the shortest path. This is reasonable because the IPv6 routers may be implement routing option header processing component so we can use that without any additional functional implementations. Also we can think about the hop-by-hop header to notify routers that the packets have some signaling and reservation information. These things are already considered in other signaling mechanism. That means we can use the IPv6 native features or don't use of them. There is another viewpoint related with this. If the same information is transferred with IPv6 header and payload, there may exist the consistency problems. So some people want to make one of choices, not both of them.

- o Backward compatibility

The existing signaling protocols such as RSVP, RSVP-TE, CR-LDP and so on are implemented in IPv4 network. These signaling protocols MUST be operated in IPv6 network. Therefore, they MUST support backward compatibility for operating both IPv6 and IPv4.

- o Easy to implement

There are two aspects related with this issue. First, we can consider the compatibility of the new signaling with existing signaling. So the implementation can be done with minimum modification of previous architecture and components. Second we can omit some functions of previous signaling so that we just make a light-weight signaling mechanism. We are still studying about this carefully because it makes some effects with other various factors such like the capabilities of this new signaling and the signaling translation between two heterogeneous AS's. We can think above two factors simultaneously and SHOULD make some trade-off.

- o Signaling interworking between IPv6 and IPv4

To be gradually deployed, we can consider the situation of mixed nodes that some implement the IPv6 signaling and others implement the IPv4 signaling. In this environment, we consider signaling interworking issues. So we will explain mapping of IPv6 signaling with IPv4 in [section 3](#).

- o Traffic parameters for QoS negotiation

There are many traffic parameters such as peak data rate, peak burst size, committed data rate, committed burst size, excess burst size and so on. The QoS signaling applies the traffic parameters per aggregated flow. To make use of this, state of QoS information SHOULD be maintained per aggregated flow. Also the adding and deleting of a flow with respect to the aggregated flow SHOULD be carefully managed. An aggregated flow is not just used for label-related switching, but also used for classification information in routers on path. So the traffic parameter information SHOULD be stored in the router with the information related with an aggregated flow identifier(s).

- o Mobility support

To provide the QoS in mobile environment, we SHOULD consider the mobility of nodes and dynamic behavior of related flows. In signaling, we are concerning two problems. First the flow management can be considered with per aggregated flow or per flow. In some point, snapshot of network can be described with many aggregated flows and related QoS management. But as time goes, some flow of mobile node

departs one aggregated flow and join the other aggregated flow. Second the support of micro mobility issues. To make use of old flow related resources as much as possible, we should define Nearest Common Router (NCR) and provide the finding mechanism. This work is under working. We just consider the need of modification or adaptation of that mechanism in our work.

- o Inter-operation with other QoS-supporting networks

In this version, we cannot consider this issue.

[3. Mapping of IPv6 Signaling with IPv4](#)

The current Internet will smoothly transit from IPv4 to IPv6. Deployment point of view, we consider three stages of evolution scenarios

- first stage (stage 1): IPv4 ocean and IPv6 island
- second stage (stage 2): IPv6 ocean and IPv4 island
- third stage (stage 3): IPv6 ocean and IPv6 island

In first stage shown in Figure 1, MPLS-based core network (e.g., IPv4 ocean) and IPv6 access network (e.g., IPv6 island) is deployed. In this environment, core signaling such as RSVP-TE and CR-LDP is used in IPv4 ocean and access signaling such as RSVP and RSVP-TE is used in IPv6 island. To support end-to-end QoS signaling, these protocols SHOULD perform the mapping of IPv6 signaling with IPv4. Flow label information of IPv6 header is translated to FEC (Forwarding Equivalent Class) information of MPLS. For this reason, signaling interworking function is needed. Using this QoS signaling, flow information is transmitted unchanged from source to destination and the required resource is reserved and end to end path is established.

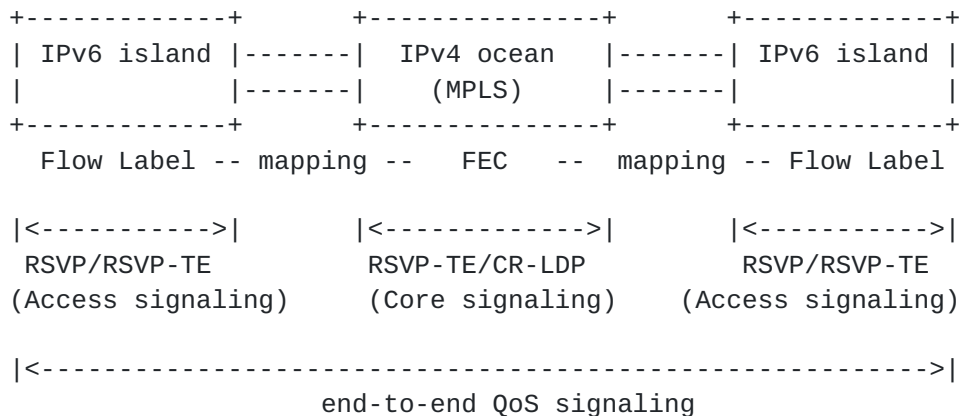
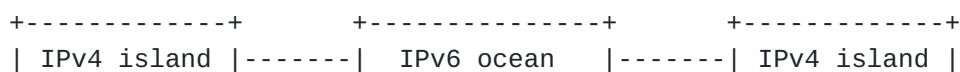


Figure 1. Signaling mapping (stage 1)

In second stage shown in Figure 2, IPv6 network will dominate over IPv4 network. This network is composed of IPv6-based core network (e.g., IPv6 ocean) and IPv4-based access network (e.g., IPv4 island). The existing IPv4 network is operated in MPLS. In this environment, core signaling such as RSVP-TE and CR-LDP is used in IPv6 ocean and access signaling such as RSVP and RSVP-TE is used in IPv4 island. FEC information of IPv4 is translated to flow label information of IPv6.



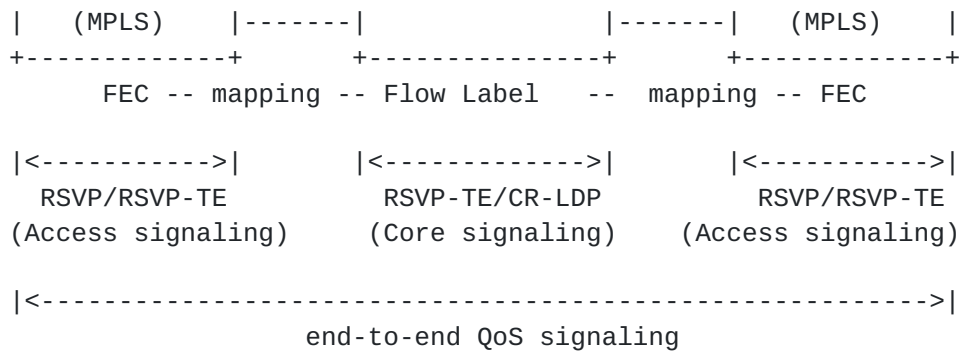


Figure 2. Signaling mapping (stage 2)

In third stage shown in Figure 3, IPv6 protocol is implemented both core network (e.g., IPv6 ocean) and access network (e.g., IPv6 island). Signaling protocol like RSVP-TE MAY be used without signaling translation.

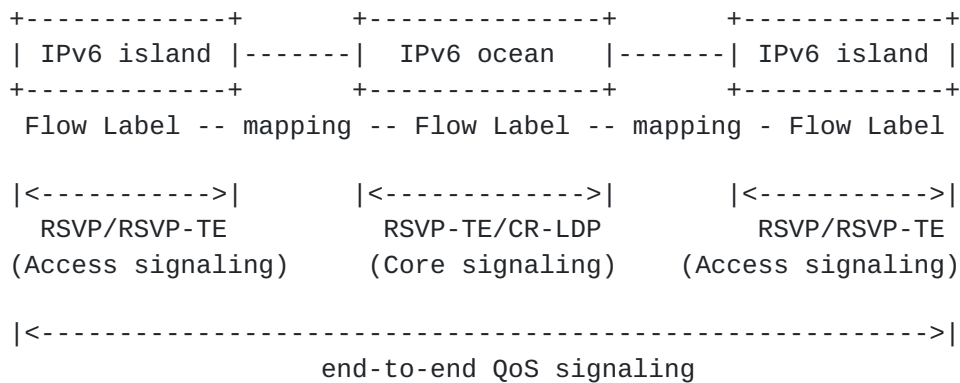


Figure 3. Signaling mapping (stage 3)

4. Other Issues

The problems arise from the tunneling such like mobile IPv6 mechanisms are not fully exploited in this version of document. Also the more detail procedure of signaling packet processing in CR-LDP and RSVP-TE in case of the explicit route information is carried in Routing Option header should be considered. We are studying about these issues.

5. IANA Considerations

The value field described in [appendix](#) SHOULD be registered and maintained by IANA. The New values SHOULD be to be assigned via IETF Consensus as defined in [\[RFC 2434\]](#).

6. Security Considerations

This document does not have any security concerns. The security requirements using this document are described in the referenced documents.

Appendix. The delivering methods of signaling messages in IPv6 network

In this appendix, we will describe the delivering methods of existing signaling protocols in IPv6 networks via using IPv6 extension headers. The use of these methods in existing signaling protocols is discussed in the last of this section.

1. RSVP/RSVP-TE for IPv6 (including RSVP-TE extension for GMPLS)

o Using Router Alert Option

Router alert option [\[RFC 2711\]](#) within the IPv6 Hop-by-Hop option header has the semantic "routers should examine the datagram more closely". Using this option, IPv6 datagram containing signaling messages are indicated and taken actions.

The router alert option has the following format:

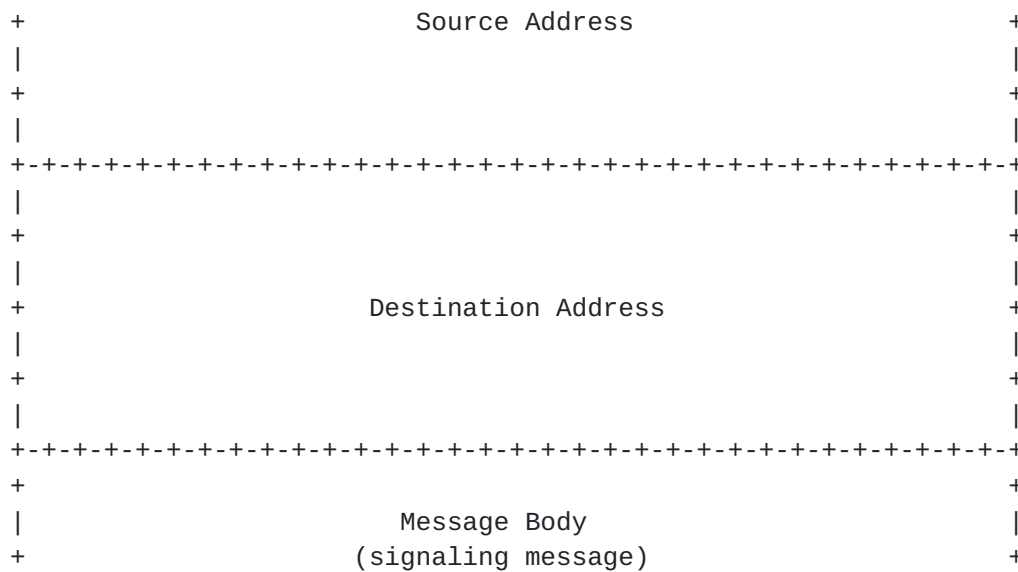
```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|0 0 0|0 0 1 0 1|0 0 0 0 0 1 0|           Value (2 octets)           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
                        length = 2

```

The first three bits of the first byte are zero and the value 5 in the remaining five bits is the Hop-by-Hop Option Type number. [\[RFC 2460\]](#) specifies the meaning of the first three bits. By zeroing all three, this specification requires that nodes not recognizing this option type should skip over this option and continues processing the header and that the option must not change en route.

There MUST only be one option of this type, regardless of value, per Hop-by-Hop header.



```
Version          4-bit Internet Protocol version number = 6.
```

| | |
|---------------|----------------------------|
| Traffic Class | 8-bit traffic class field. |
|---------------|----------------------------|

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| | |
|------------|--------------------|
| Flow Label | 20-bit flow label. |
|------------|--------------------|

| | |
|----------------|---|
| Payload Length | 16-bit unsigned integer. Length of the IPv6 payload, i.e., the rest of the packet following this IPv6 header, in octets |
|----------------|---|

| | |
|-------------|---|
| Next Header | 8-bit selector. Identifies the type of signaling message immediately following the IPv6 header. Uses the same values as the IPv4 Protocol field [RFC 1700 et seq.]. |
|-------------|---|

| | |
|-----------|---|
| Hop Limit | 8-bit unsigned integer. Decrementd by 1 by each node that forwards the packet. The packet is discarded if Hop Limit is decremented to zero. |
|-----------|---|

| | |
|----------------|--|
| Source Address | 128-bit address of the originator of the packet. |
|----------------|--|

| | |
|---------------------|--|
| Destination Address | 128-bit address of the intended recipient of the packet (possibly not the ultimate recipient, if a Routing header is present). |
|---------------------|--|

For this method, we MUST assign the new Next Header value of IPv6 header. Currently, RSVP is already assigned the value 46 decimal in [[RFC 1700](#)].

For example, if the Next Header value of IPv6 header is 46 decimal the following ISMP message is RSVP message. The Next Header value of other unassigned signaling messages SHOULD be assigned by IANA.

This second method may be used for the signaling protocols which are running on the IP layer.

Compared with the method using router alert option, this method is very simple because of no additional extension header. Therefore, the complexity of processing is reduced but this new function MUST be implemented within IPv6 header.

Note) The signaling protocols, like SIP, that are used for end-to-end path may use the option TLVs to indicate the presence of the signaling information. We already know that the real-time service cannot be served without support of intermediate node. If some end-to-end sessions are need to be guaranteed to their perceived QoS, the intermediate nodes those are on the path may use the information to do something related with QoS implicitly.

2. CR-LDP for IPv6 (including CR-LDP extension for GMPLS)

In the case of RSVP-TE, if the header of a packet is indicating "This packet carries the signaling information." then the intermediate routers and the end host can make different treatment on just only look at the IP header.

On the other hand, like CR-LDP, the protocol running on the TCP(UDP) layer may also make use of the benefit that IP header already notify the existence of signaling information in the payload of IP packet. Originally in the CR-LDP protocol, the signaling information is transferred along the path per hop. If a router sees the notification of signaling information in the IP header, it can forward the signaling packet and processing the signaling information simultaneously. So the forwarding direction of packet can be done faster than old mechanisms.

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