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Mobility Extensions to RSVP in an RSVP-Mobile IPv6 Framework
<[draft-shen-nsis-rsvp-mobileipv6-00.txt](#)>

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1 Abstract

This memo first gives a brief review of a RSVP and Mobile IPv6 interoperation framework proposed in [[1](#)] and compared its features with the Performance Requirements set forth by Requirements of a QoS Solution for Mobile IP [[2](#)]. The subsequent part of the memo presents specification details including message formats, processing rules and algorithms that form the framework. The vast majority of these specifications has been verified by a prototype implementation. It is expected that this work could serve as a useful input in dealing with NSIS protocol and mobility issue.

2 Terminology

MS - Mobile Sender A Mobile Node that is acting as a Flow Sender.

MR - Mobile Receiver A Mobile Node that is acting as a Flow Receiver.

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SNCR - Sender Nearest Common Router the first common router on the old path and new path after a handoff caused by MN functioning as a MS.

RNCR - Receiver Nearest Common Router the first common router on the old path and new path after a handoff caused by MN functioning as a MR.

NCR - Nearest Common Router could be either a SNCR or a RNCR.

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](#).

[3](#) Introduction

The increasing interest in supporting QoS sensitive applications in a mobile environment has led to extensive work on interoperation of QoS signaling and mobility mechanisms. Typically the issue is addressed in the context of RSVP and Mobile IP . This memo is a follow-up of our previous proposal on an Interoperation Framework for using RSVP in an Mobile IPv6 network[1].

In this memo, we first give a brief review of the framework and evaluate it against the Requirement of a QoS Solution for Mobile IP [\[2\]](#) that was formed after our framework proposal. Then we present the specification details concerning New Message/Object Formats, processing rules as well as (Nearest Common Router) NCR Decision Algorithms which have been developed extensively since the previous framework memo.

It is known that the IETF Next Step In Signaling (NSIS) WG has been chartered to look at a future resource signaling protocol and the NSIS framework is well likely to cover the interaction with general mobility mechanism as well. In view of the fact that, RSVP is recommended to be used as a starting point for NSIS, and Mobile IP is likely the pre-dominant mobility mechanism for IP macro-mobility, we expect this work to be a useful input to the area of NSIS and mobility interaction. In addition, we provide a separate discussion on several issues related to general NSIS and mobility interaction in [\[3\]](#). The similar topic is also covered as part of a framework proposal by Handcock et. al. [\[4\]](#).

It is worth noting that, the vast majority of signaling logic and processing rules disclosed herein have been verified by a prototype implementation modified from the latest ISI RSVP release.

[4](#) Framework and Requirements Review

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The essential point of our framework[1] is to maintain a unique flow identifier regardless of node mobility. To achieve this specifically within the Mobile IP and RSVP context, we have chosen to use MN HAS in RSVP SESSION object and RSVP SENDER_TEMPLATE object. While the correct routing of signaling packets is ensured by using MN CoAs.

A brief review of our RSVP-Mobile IPv6 framework is given below. We assume a generic scenario where both communication parties could be mobile. So we will use the terms Mobile Sender (MS) and Mobile Receiver (MR) instead of MN to reflect the situation more accurately, wherever necessary. The illustration of framework operation in each of the MR and MS case is divided into three signaling phases according to different functionalities, although they indeed overlap in terms of actual signaling timing.

[4.1](#) Framework Review: Mobile Sender (MS) Case

[4.1.1](#) Resource Establishment in the New Path

When the MS obtains a new care-of address upon handoff, it immediately sends a PATH message containing its mobility information (which is its new CoA) towards the CN. This PATH message triggers the establishment of PATH state in the RSVP routers on the path until it reaches the Sender Nearest Common Router (SNCR). The SNCR finds the PATH message arriving with a previous hop address different from the one stored in the path state, upon which it immediately replies with a RESV message towards the MN using the new path. The reserved resources between the SNCR and the CN can be reused.

[4.1.2](#) Resource Release in the Obsoleted Path

In addition to the above, the SNCR sends a RESVTEAR message towards the previous hop stored in the old path state. The RESVTEAR message triggers the removal of the reserved resources on the old path which are no longer needed.

[4.1.3](#) Refresh Handling in the Common Path

The SNCR also forwards the received handoff PATH message to the next hop in any case so as to update the mobility information in all RSVP routers on the rest of the path. This is to ensure correct routing of subsequent refresh messages.

[4.2](#) Framework Review: Mobile Receiver (MR) Case

[4.2.1](#) Resource Establishment in the New Path

When the MR obtained a new care-of address upon handoff, it is

required to inform the Receiver Nearest Common Router (RNCr) of its mobility information in order to trigger a quick handoff PATH message from the RNCr. This avoids waiting for a handoff PATH message from the CN, which requires at least a round trip time between MR and CN. This is achieved by the use of a new RSVP PATHREQ message. It may optionally be piggybacked in a PATH message sent by the MN when it acts as both MS and MR. In the following discussion, we assume the former method, or a separate PATHREQ message is used. The PATHREQ message which carries MR's mobility information (the new CoA) will be sent toward the CN and will be examined by each intermediate RSVP node until it reaches RNCr. The RNCr then triggers a Local Repair for the receiver route change that is, the router sends a handoff PATH message associated with the unique flow identifier, to the MN's new care-of address. This serves to establish resource state in the new path as soon as possible.

[4.2.2](#) Resource Release in the Obsolete Path

In addition to the above, RNCr also sends a PATHTEAR message towards the MN's old care-of address. The PATHTEAR message triggers the removal of the resources on the old path which are no longer needed.

[4.2.3](#) Refresh Handling in the Common Path

RNCr also forwards the PATHREQ message to the next hop until it reaches the CN so as to update the mobility information in all the RSVP routers on the common path. This is to insure correct routing of subsequent refresh messages.

4.3 Requirements Review: Evaluate the Framework Against Requirements

A quick examination of the Requirement of a QoS Solution for Mobile IP [2] shows that the above framework addressed all three performance requirements set forth, namely

- o Minimize the interruption in QoS at the time of handover.
- o Localize the QoS (re)establishment to the affected parts of the packet path in the network.
- o Releasing after handover the QoS state (if any) along the old packet path.

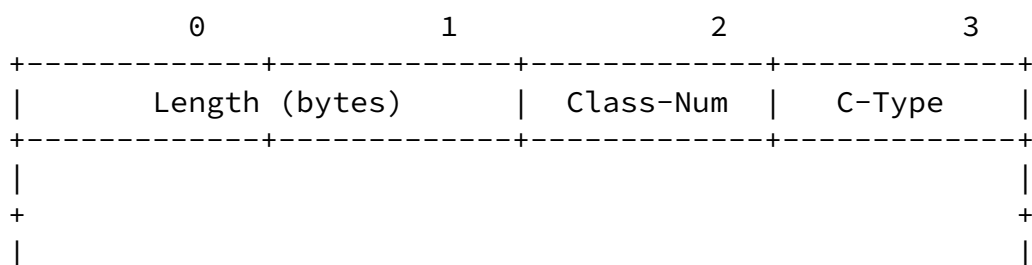
The first and second requirements are addressed by the use of NCR in establishing resource state within new path incurred by handoff. The third requirement is met by explicitly issuing of corresponding state teardown messages at the NCRs. In the following sections we present specification details concerning New Message/Object Formats, NCR

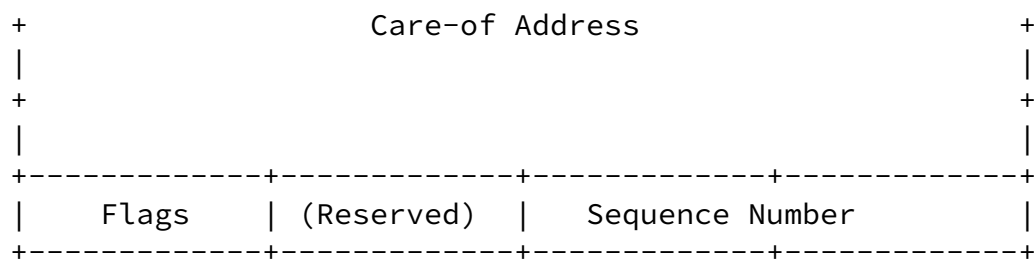
Algorithms and Processing rules that form the above RSVP-Mobile IPv6 framework.

5 Formats of New RSVP Objects and Messages

5.1 Formats of SENDER_MOBILITY Object and RECEIVER_MOBILITY Object

New MOBILITY objects are defined in order to convey MN's mobility information to RSVP. In the simplest case for Mobile IP, it contains the MN's current care-of address. By including these new objects, the RSVP process does not need to get the mobility information of the MN from the IP header of the RSVP messages, the clear interface between the IP layer and the RSVP process is maintained.





Flags: 8 bits

0x01: NCR Identified

When set, indicates that the NCR has been identified.

Figure 1: MOBILITY Object

In accordance with the simplex nature of RSVP, two types of MOBILITY objects are defined, namely, SENDER_MOBILITY objects and RECEIVER_MOBILITY objects. Figure 1 shows the format for the MOBILITY object. The length field indicates the total object length in bytes.

The Class Num and the C-Type for the MOBILITY object would have to be assigned by IANA. SENDER_MOBILITY objects and RECEIVER_MOBILITY objects shall have different Class Nums. The contents of the MOBILITY object contain:

- o Mobility information which is MS or MR's current care-of address.
- o An NCR Flag bit which indicates whether the appropriate NCR has been located. The bit carries an initial value of 0 and is set to 1 by the NCR.
- o A two-byte Sequence Number field which increases by one after each handoff and thus indicates how up-to-date the mobility information is.

5.2 Format of PATHREQ Message

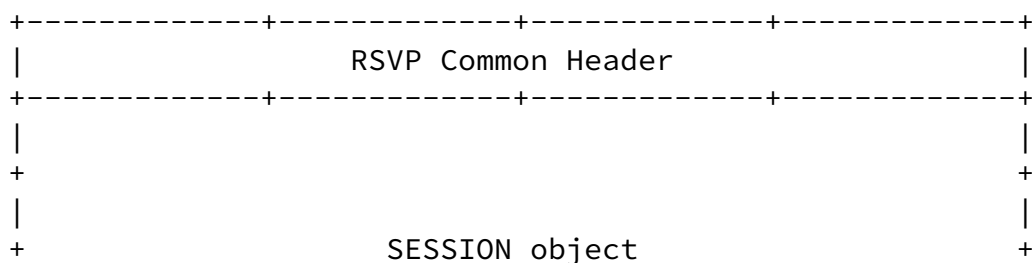
The new PATHREQ message is defined to allow the MR to request a PATH message from RNCr immediately after it performs a handoff. Figure 2 shows the format of a PATHREQ message, it contains:

- o An RSVP common header, in which the message type for PATHREQ message has to be assigned by IANA.
- o A SESSION object containing the MR's home address.
- o A SENDER_TEMPLATE object containing the MS's home address.
- o A RECEIVER_MOBILITY object containing the MR's current care-of address.
- o A SENDER_MOBILITY object containing the MS's current care-of address.

Inclusion of the above four objects makes RSVP aware of the care-of address and home address of both MS and MR thus covers the most complicated case where both communication parties are MNs and acts as Sender and Receiver simultaneously. In case either party is stationary, the corresponding MOBILITY object will not be applicable and the home address above is replaced by the corresponding fixed address.

6 Nearest Common Router (NCR) Decision Algorithm

The decision for NCRs is divided into two parts: SNCR and RNCr. Generally, decision for SNCR is triggered by receiving of PATH



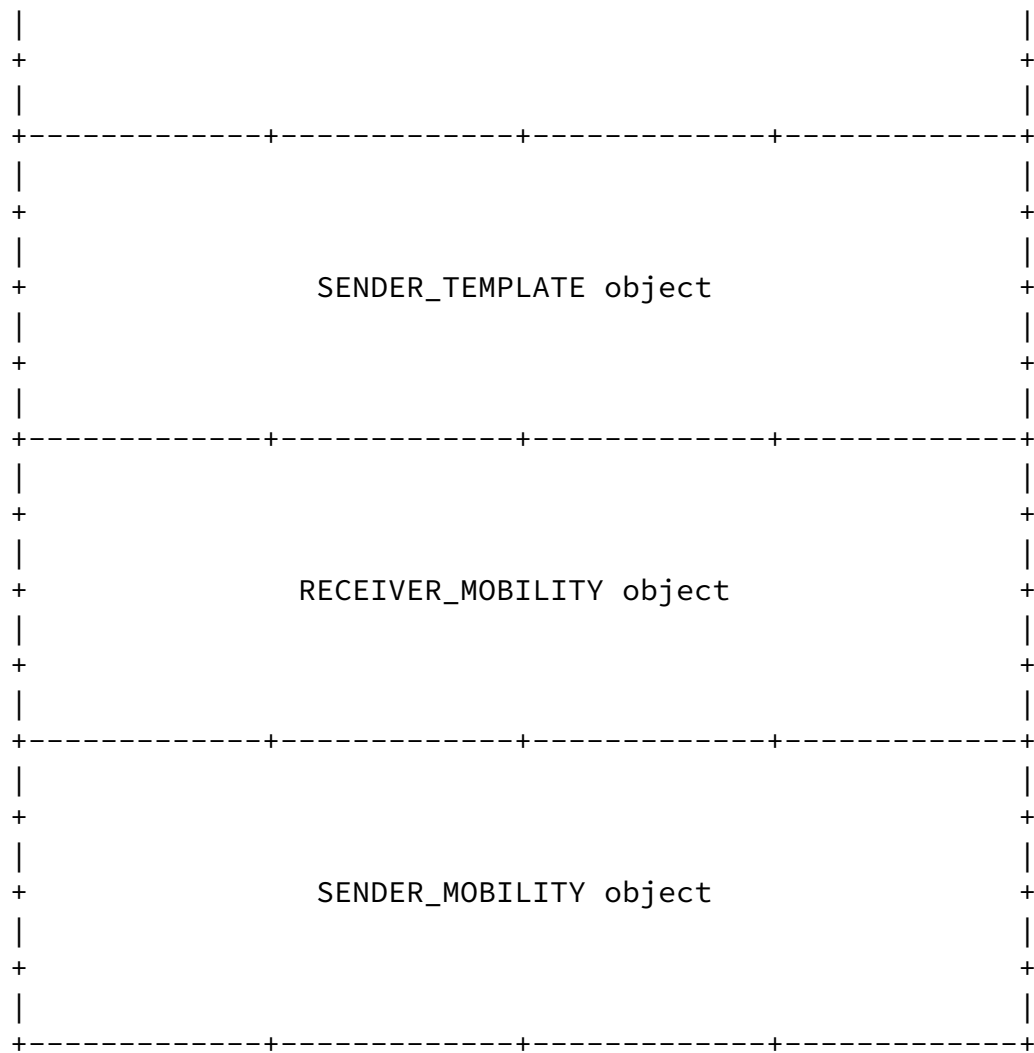


Figure 2: PATHREQ Message

messages; decision for RNCR is triggered by receiving of PATHREQ messages; RNCR and SNCR may be physically collocated in the same router, or could be in two different network entities.

RSVP decides that it is the SNCR if all of the following conditions are met.

- o A PATH message which contains a SENDER_MOBILITY object is received.
- o The NCR Flag bit in the received SENDER_MOBILITY object is Zero.
- o There is a matching PSB found for the PATH message.
- o The matching PSB does not include a SENDER_MOBILITY object or the matching PSB contains a SENDER_MOBILITY object which has a sequence number lower than that of the received SENDER_MOBILITY object.

6.2 Decision Algorithm for Receiver NCR (RNCR)

RSVP decides that it is the RNCR if all of the following conditions are met.

- o A PATHREQ message which contains a RECEIVER_MOBILITY object is received.
- o The NCR Flag bit in the received RECEIVER_MOBILITY object is Zero.
- o There is a matching PSB found for the SESSION object in the received PATHREQ message.
- o The matching PSB does not include a RECEIVER_MOBILITY object or the matching PSB contains a RECEIVER_MOBILITY object which has a sequence number lower than that of the received RECEIVER_MOBILITY object.

7 Processing Rules for PATHREQ Message and PATH Message with MOBILITY Object

7.1 Processing Rule for New PATHREQ Message

The PATHREQ message is sent by a MR when it changes its care-of address. The general processing rules when RSVP receives a PATHREQ message are as follows:

- o RSVP searches for PSBs in the opposite direction whose SESSION object matches the corresponding object in the PATHREQ

message.

- o If there are no matching PSBs, the PATHREQ message is simply forwarded to the next RSVP node. The source address and destination address of the forwarded PATHREQ message are determined as follows:
 - The source address is retrieved from RECEIVER_MOBILITY object which contains the receiver's care-of address.
 - The destination address is retrieved from SENDER_MOBILITY object which contains the sender's care-of address, if it exists. Otherwise, the destination address is retrieved from SENDER_TEMPLATE object which contains the sender's fixed or home address.
- o Otherwise there are matching PSBs found. For each matching PSB,
 - If RECEIVER_MOBILITY information is found in the PSB and the sequence number of that RECEIVER_MOBILITY is higher than that of the received RECEIVER_MOBILITY object, discard the received PATHREQ message.
 - Otherwise, if RECEIVER_MOBILITY is not found in the PSB or RECEIVER_MOBILITY is found in the PSB but with a lower sequence number:
 - The PSB is updated with the new RECEIVER_MOBILITY object.
 - If SENDER_MOBILITY exists either or both in PSB or PATHREQ, compare their sequence number, update PSB with the newer SENDER_MOBILITY object if applicable.
 - Check the NCR Flag bit in the received RECEIVER_MOBILITY object:
 - If the NCR Flag bit is 1, and the RSVP node is not the sender, forward the PATHREQ message to the next RSVP node using the same source and destination address decision rules as stated above when there is no matching PSB.
 - If the Flag bit is 0, the RSVP node is identified as RNCR. It does the following:

Sets the NCR Flag bit into 1; Constructs a handoff PATH message that includes the RECEIVER_MOBILITY object, and

sends it to the receiver's current care-of address obtained from the same RECEIVER_MOBILITY object; Constructs a PATHTEAR message containing the old RECEIVER_MOBILITY object, if exists, to the receiver's old care-of address; If the RSVP node is not sender of the flow, it further forwards the PATHREQ message to the next RSVP node using the same source and destination address construction rule as stated above when there is no matching PSB.

[7.2](#) New Processing Rules for PATH Message

To deal with node mobility, PATH messages shall carry MOBILITY objects. If the MS performs a handoff, a SENDER_MOBILITY object will be included in the PATH messages. If the MR performs a handoff and reports it to the sender through PATHREQ message, the subsequent PATH message will carry the RECEIVER_MOBILITY object.

The following states new/modified processing rules for PATH messages in addition to existing rules specified in [RFC 2209](#) due to the introduction of new MOBILITY objects.

- o When RSVP creates a new PSB for a new PATH message with MOBILITY objects, the following rules apply in addition to/in place of existing rules where applicable:
 - If SENDER_MOBILITY object is included in the PATH message, it is also copied to the newly created PSB.
 - If RECEIVER_MOBILITY object is included in the PATH message, it is also copied to the newly created PSB.
 - When the PATH message is forwarded to the next RSVP node. The source address and destination address of the forwarded PATH message are determined as follows:
 - The source address is retrieved from SENDER_MOBILITY object which contains the sender's care-of address, if it exists. Otherwise, the source address is retrieved from

SENDER_TEMPLATE object which contains the sender's fixed or home address.

- The destination address is retrieved from RECEIVER_MOBILITY object which contains the receiver's care-of address, if it exists. Otherwise, the destination address is retrieved from SESSION object which contains the receiver's fixed or home address.

- o Otherwise, if matching PSB is found, the following rules apply in addition to/ in place of existing rules where applicable:
 - First, if a RECEIVER_MOBILITY object is included in the PATH message, the RSVP node determines whether it carries the most updated information based on the sequence number of the object. If the existing PSB contains no RECEIVER_MOBILITY information or the received RECEIVER_MOBILITY information is newer than the existing one, the PSB updates its RECEIVER_MOBILITY information.
 - Second, if a SENDER_MOBILITY object is included in the PATH message, the RSVP node determines whether it carries the most updated information based on the sequence number of the object. If the received SENDER_MOBILITY is older than the existing one in PSB, stops processing the PATH message and discards it. Otherwise, if the existing PSB contains no SENDER_MOBILITY information or the received SENDER_MOBILITY information is newer than the existing one,
 - The PSB updates its SENDER_MOBILITY information.
 - The NCR Flag bit in the received SENDER_MOBILITY object is checked. If it is not set, the RSVP node is identified as SNCR. It does the following:

Sets the NCR Flag bit to 1; Sends a RESV message to the previous hop which leads to the MS's current care-of address; Sends a RESVTEAR message to the previous hop which leads to the MS's old care-of address; If the RSVP node is not receiver of the flow, it further forwards the PATH message to the next RSVP node using the same source

and destination address decision rules as stated above when there is no matching PSB.

- Otherwise the RSVP node is not SNCR. If the RSVP node is not receiver of the flow, it forwards the PATH message to the next RSVP node using the same source and destination address decision rules as stated above when there is no matching PSB.

[8](#) Future Work

In traditional operation of RSVP, a flow identifier is virtually also used as a reservation identifier. This seems to be fine in fixed networks. In mobile environments however, it might sometimes be desirable to separate these two, while the flow identifier could be changing from time to time, the reservation identifier remains

constant all the time [3,4]. It should be noted that our proposed framework does not in any sense exclude this possibility. More specifically, in cases where the reservation identifier is defined differently than the flow identifier, our use of HAs as reservation identifier does not exclude the use of addresses other than HAs, such as the CoAs as flow identifier. In this case, it is expected that the signaling logic explained in this memo will still largely be applicable, although certain modifications are likely to be needed. The applicability of this approach in our framework is currently under study.

[9](#) Acknowledgments

We would like to thank Mr. Donglin Shi for helpful discussion during the prototype implementation of this work.

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[2] H. Chaskar (Editor), "Requirements of a QoS Solution for Mobile IP," [draft-ietf-mobileip-qos-requirements-02.txt](#) , June 2001. Work

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