Mobile RSVP

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Abstract

Real time applications like video conferencing, IP telephony, Video on-demand, etc. require QoS guarantees from the underlying communication network. One way of providing such QoS guarantees is through over-provisioning by reserving resources for the application. Resource Reservation protocol(RSVP) has been traditionally used for advanced resource reservations in wireline networks. In order to provide the same QoS for mobile hosts, RSVP needs to be integrated with Mobile IP, which is the current Internet standard for supporting mobile hosts. Mobile IP ensures correct routing of packets to a mobile host as the host changes its point of attachment to the Internet. This paper discusses various mechanisms used for providing QoS for mobile IP through RSVP.

1 Introduction

RSVP is a resource reservation protocol designed for providing Integrated Services over Internet. RSVP protocol can be used to reserve resources along the network path between senders and receivers inorder to provide QoS guarantees for a particular application. RSVP is a receiver-initiated resource reservation protocol. There are mainly two types of messages in RSVP. Sender in a session sends PATH message to the receiver. As the PATH message traverses towards receiver, RSVP-enabled routers on the path will setup the PATH state. Receiver, after receiving the PATH message, sends RESV message back to the sender along the same path traversed by PATH message. RESV message carries the resource requirements of the receiver for a particular flow. If enough resources are available in the routers, reservation will be established on the intermediate routers. Figure 1 shows the reservation process in RSVP.

When a sender sends a packet destined to a mobile host(MH), it will be handed over to the Home Agent(HA). Once the reservation is complete and soft-state is established, periodic refresh messages are sent across the reservation path to keep reservation alive. Reservations are released either by time-out (absence of refresh messages) or explicit PATH Tear message. RSVP solves the problem of QoS support in case of static wireline networks through advanced resource reservations. For wireless networks solutions have been proposed to provide QoS support over Mobile IP.

Mobile IP enables a mobile host(MH) to change its point of access to the Internet while maintaining its session with the correspondent node using IP. Each mobile host is registered with local agent using a permanent ip address called the home address. Whenever the MH visits a foreign network it is assigned a temporary care-of-address(CoA) that is then used to route packets to it. The home agent is informed of this new CoA by the MH. Whenever a packet for the MH arrives at the home agent it tunnels it to the foreign agent using IP-in-IP encapsulation which then decapsulates the packet and delivers it to MH.

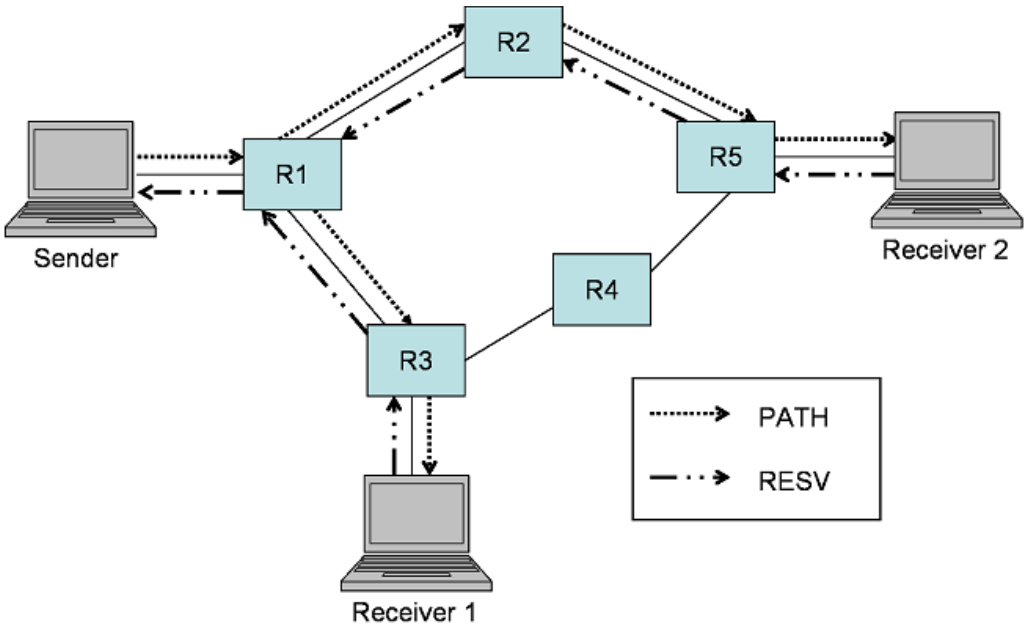

Figure 1: RSVP Message Exchange

When an MH using Mobile IP undergoes handover from one access router to another, the path traversed by MH's packet stream in the network may change. Such a change may be limited to a small segment of the end-to-end path near the last hop, or it could also be an end-to-end change. Further, the packets belonging to MH's ongoing session may start using a new care-of-address after handover. Hence, they may not be recognized by some forwarding functions in the nodes even along that segment of the end-to-end path that remains unaltered after handover. Finally, handover may occur between the subnets that are under different administrative control. It is therefore essential to establish proper QoS support for the MH's packet stream along the new packet path.

Several important performance requirements are identified for providing QoS with Mobile IP.

1. Minimize the disruption in QoS during handover.
2. Localize the QoS re-establishment to only the effected parts of the packet path.
3. Release any old QoS state after the handover as soon as possible.
4. Deal with multiple QoS mechanisms if new packet path traverses different network domain.

RSVP can be used to provide QoS for mobile hosts using Mobile IP, but several issues have to be addressed before it could be used. Due to the tunneling between the home agent and the foreign agent, the RSVP packets are invisible to the intermediate routers in the tunnel. Hence no reservations are established on these routers. It also leads to the 'triangular routing problem' i.e. the datagram packets from the sender to the mobile host take the tunneled path while the packets from the mobile host to the sender are routed as per normal routing through the foreign agent.

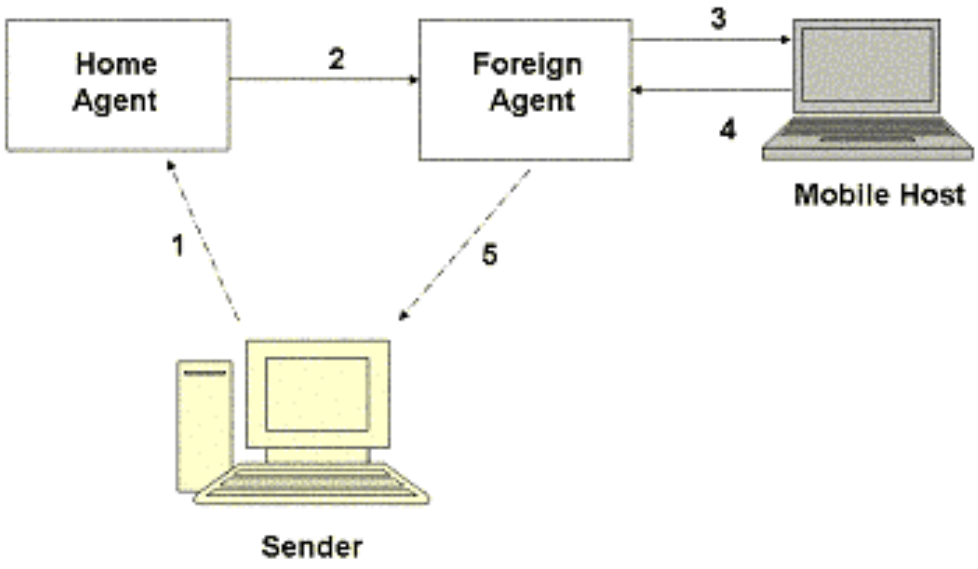

Figure 2: Triangular Routing Problem in Mobile IP

When a sender sends a packet destined to a mobile host(MH) (Figure 2), it will be handed over to the Home Agent(HA) of the MH, which is the agent for the original cell to which the MH belongs(Step 1). It the MH is visiting a foreign location, address of Foreign Agent (FA) would have been registered with the HA. So, HA forwards packet to FA(Step 2). FA delivers the packet to the MH(Step 3). If MH has to send a packet to the sender it hands over the packet to the FA (Step 4) and it will be routed to the sender with out the intervention of HA (Step 5). As this routing creates a Triangle among HA,FA and sender, this is called Triangular Routing.

Inorder to deal with the first problem a solution using RSVP tunnel is proposed in [7] (Figure 3). When a mobile host (MH) moves to a new location, foreign agent (FA) of the new location registers itself with the home agent (HA). When there is a RSVP reservation between the MH and a sender, to keep the reservation alive, an RSVP tunnel has to be created between the HA and FA and RSVP messages can be transparently tunneled through it. When the sender sends PATH message, HA starts establishing RSVP session with the FA by sending an RSVP message for tunnel creation, and forwards PATH message sent by the sender to FA. Foreign agent forwards the PATH sent by the sender to the MH. MH replies with a RESV. On receiving RESV, FA sends RESV for the Tunnel PATH message to the HA. After getting RESV Confirmation message from HA, it forwards RESV sent by the MH, and reservation completes.

Mobile IPv6 provides a solution to the second problem through built-in route optimization. The CoA is used as destination address in the header instead of the home address. So the packets are routed directly to the mobile host through the foreign agent. The CN acquires the CoA of the mobile host through a binding update message sent by the mobile host after it migrates to a foreign location.

New reservations can now be made using the CoA of the mobile host without using the tunnel. This however adds signalling overhead and delay during the handoff. Inorder to avoid this handoff

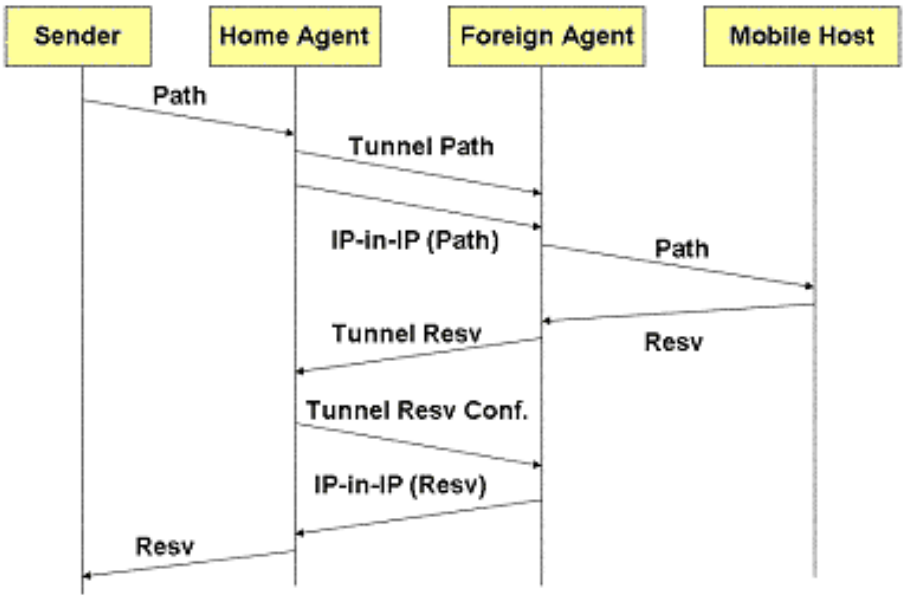

Figure 3: RSVP Tunnel

latency resources could be reserved in advance for the foreign location that the mobile host visits.

Several issues need to be addressed while integrating RSVP with Mobile IP which are discussed in the following sections.

2 Resource Pre-reservation

Whenever a mobile host moves into a foreign location, new resource reservation needs to be established for the new path between the sender and the mobile host. If the new location does not have enough resources then the QoS service will be disrupted. Also, before the reservation takes place the packets will be offered best effort service. In order to prevent such disruptions resources need to be pre-reserved before the actual handoff takes place.There is an inherent tradeoff involved between the resources that are used up because of the pre-reservations and the handoff latency. Several approaches have been proposed in the literature to pre-reserve resources for every location that the mobile host could visit during the lifetime of the connection.

In MRSVP [6] the mobile host provides a mobile specification(MSpec) that lists the foreign locations that the mobile host could visit in the future. Advance resource reservations for the connection are to be made in all the locations specified in the MSpec. MRSVP distinguishes between active and passive reservations(Figure 4). Active reservations are made by the mobile

proxy in the current location and is used by the connection flow. Passive reservations are made by adjacent proxies to provide fast handoff and they can be utilised by best effort traffic when not in use. Whenever the mobile host moves to a new location, a mobile proxy in that location informs the neighbouring remote proxies to make passive reservations for the connection. The figure below shows the messages that are exchanged as part of the reservation process.

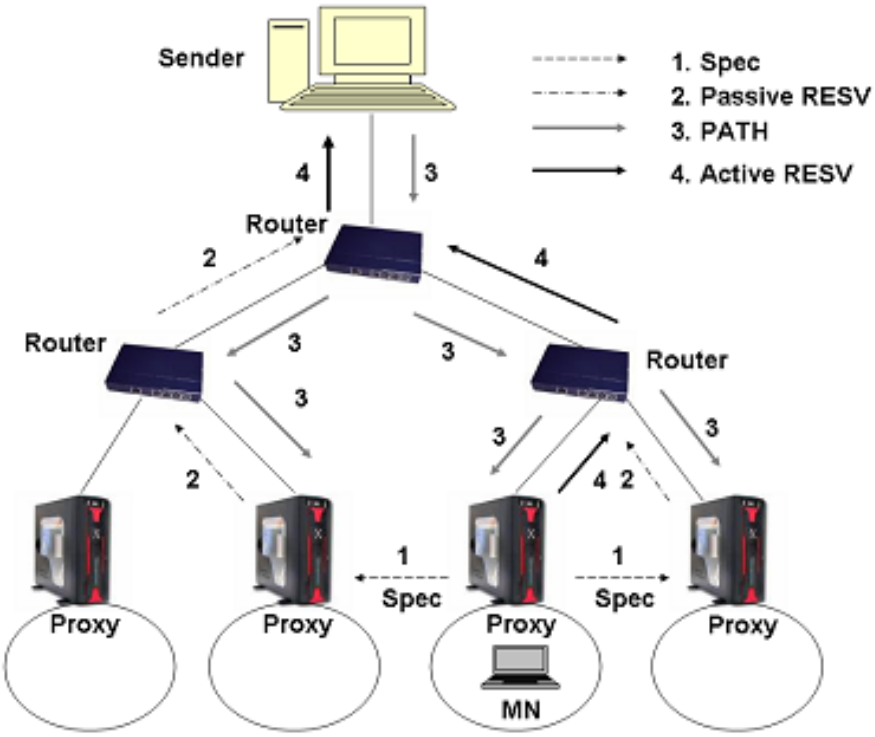

Figure 4: MRSVP : Active/Passive Reservations

Chen et al. [1] proposed use of IP multicast for fast QoS path re-establishment. Here the IP multicast group (Figure 5) membership is used to make or tear reservations. Whenever the mobile host moves to a new location, the local proxy will inform the adjacent mobile proxies to join the muliticast group. In this way the mobile proxy where the MH may visit in the future will receive PATH messages from the sender and will be able to make passive reservations. IP multicast makes QoS reservations and migration easier. Whenever a mobile host wants to free the reservations, its mobile proxy leaves the multicast group. Hence it receives no PATH messages in the future and the reservation state is teared off after timeout.

Bandwidth pre-reservation decreases the handoff dropping rate but at the same time the probability of call blocking increases. Hence it is essential to reserve minimal resources at the right time to balance the tradeoff involved. This has been the main focus area for providing QoS support for mobile hosts.

Solutions proposed for extending in RSVP in mobile networks invariably considered multiple destinations, be it forming a multicast group or creating one active and many passive reservations.

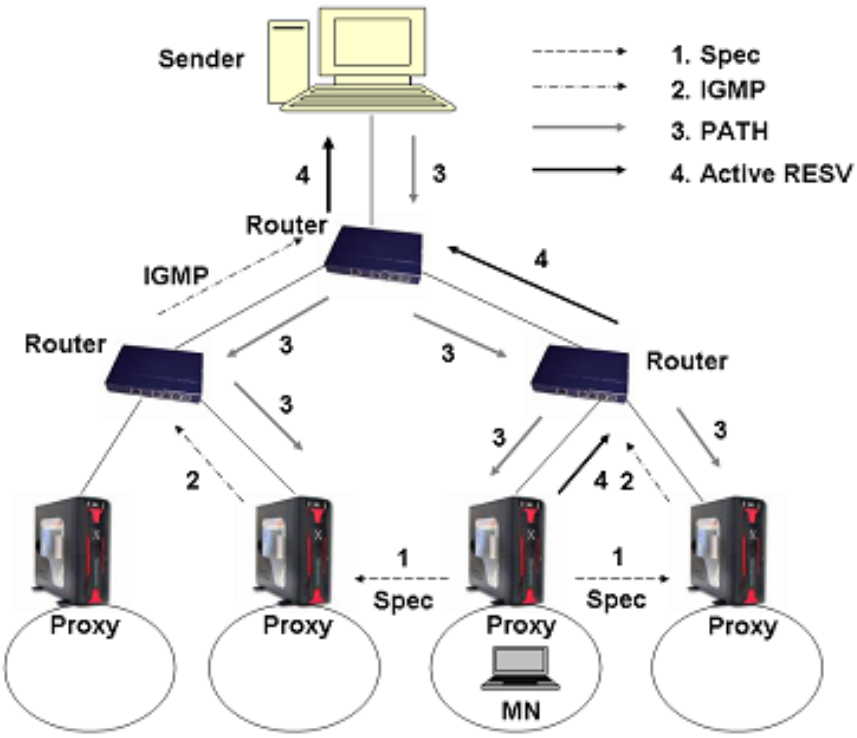

Figure 5: MRSVP with IP Multicast

Current RSVP filters don't support this kind of traffic efficiently, so a new filter, Shared Destination Filter, has been proposed[scalableQoS]. Using this a single reservation can support multiple downstream receivers.

3 Common Path Identification

In many cases the handover changes only a small segment of the end-to-end path of the mobile host near its extremity. It is therefore essential that the path change is limited to only the effected part and double provisioning must be avoided. A new RSVP path may be established either due to roaming or due to pre-reservations made inorder to reduce handoff latency. This new path may overlap significantly with the old reservation path and hence only the affected part must be established. Also in case of pre-reservations, adjacent proxies could use a single reservation for the common upstream path. The router at which these path merge is referred to as the Merge point, crossover router(CR), etc. This router must be smart enough to combine the RESV messages for active and passive reservations and forward a single RESV message upstream. Separate downstream reservations from CR to respective mobile proxies will only be needed now. In case the tunneling solution in MIPv6 with route optimization is used, then the reservation states need to be changed to reflect the new care-of-address of the mobile host.

4 Mobile Proxy

RSVP's soft state need to be refreshed periodically. The mobile host needs to send refresh messages to maintain this state. This depletes the limited battery power of already starved mobile device. One possible solution is to increase the period of refresh but that will lead to increased latency in the timeout path tears. Other more feasible solution is to have a non-battery powered device to handle this job for the mobile host. This device is referred to as the mobile proxy in the literature. Another possible advantage of having a mobile proxy is to make the mobile host unaware of the QoS mechanism deployed in the network. The mobile host specifies its QoS requirements in a generic way to the mobile proxy which then uses appropriate signalling messages to provide the QoS reservations. Mobile proxies differ in their functionalities and capabilites. The mobile proxy is normally located at the access point of the mobile network.

5 Conclusion

In this paper we surveyed problems in extending RSVP to wireless/mobile networks. We discussed problems such as handoff latency, QoS availablity in the new locations etc.., We also discussed solutions that are built upon Mobile IP. In order to reduce handoff latency, some solutions propose advanced reservation based on prediction about the movement of mobile host. Some methods have been discussed which propose creation of multicast addressies,new filters to deal with multiple destinations.

6 REFERENCES

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