ANALYSIS OF RESOURCE RESERVATION PROTOCOL (RSVP) FOR P2P NETWORKS

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ABSTRACT: High speed networks support use of dedicated resources through Resource Reservation Protocol (RSVP). With RSVP, the network resources are reserved and released thereby providing a mechanism to achieve a good quality of service (QoS). The requests to reserve a path are transmitted in the network b/w the data senders and receivers. The reservation request is then accepted depending upon the availability of resources. With dedicated resources for a data flow, the network performance improves especially for the communication sensitive to delay. This paper provides an analysis of the RSVP protocol used in peer-to-peer (P2P) networks where each system works simultaneously as a client and a server. We perform experimentation for Voice and Video Conferencing applications incorporated in various scenarios implemented using OPNET IT Guru Academic Edition v 9.1. Our experimentation results show that the RSVP protocol reduces the packet end-to-end delay, however, the impact is dependent upon the amount of data being transmitted along the reservation path.

Key words: *RSVP, QoS, Computer Networks, Multimedia Applications, P2P, Network Delay.*

INTRODUCTION

High speed communication networks rely heavily on the communication media as well as the protocols implemented for transmission of data. In order to truly harness the power of the communication media, the protocols at various layers play a vital role. For example, the routing protocols facilitate in finding the shortest path between two nodes of a computer network while taking into account several metrics. The metrics describing the basic requirements for an efficient delivery of data are termed as Quality of Service (QoS) (ITU-T, 1994; IETF, 1997-a; ITU-T, 2007; Ferguson and Huston, 1998; IETF, 1998-a). The use of an effective routing protocol however does not guarantee the QoS as required for an efficient transmission of data in the network.

Some applications with multimedia and graphics transmission are sensitive to delay. The basic requirement for such applications is to make it possible to communicate data in an interactive/real-time environment. An inefficient delivery of data packets certainly deteriorates the application performance running on the user end. This is where the Resource Reservation Protocol (RSVP) (IETF, 1997-b; Cisco-Inc., 2009; Allied-Telesis-Inc., 2005) can be effectively utilized. The RSVP protocol performs reservation and release of network resources in order to provide an efficient delivery of data in the network.

Using RSVP, the request to reserve the resources is generated by a host in the form of a message and sent to another receiver host that in turn responds with another message. When a router receives the message, it may decide to reserve the resources and communicate to other routers in order to effectively handle the packets. The reservation of the resources such as communication bandwidth for a data flow ensures efficient delivery of data for that particular data flow thereby improving the performance of the running application.

In this paper, we perform a comparative analysis of the working of RSVP protocol in conjunction with multimedia applications including voice and video conferencing. We use a peer-to-peer (P2P) based network in which each system acts as a client and a server. The reservation messages are generated by the hosts and depending upon the flow of data, some of the requests are accepted. Consequent to the reservation of network bandwidth, the network performance of the considered application improves. For the analysis of RSVP protocol, we use the metrics of the RSVP control traffic generated and the packet end-to-end delay. Our simulation has been performed using the OPNET IT Guru Academic Edition v 9.1 (OPNET, 2011).

Most of the existing research work addresses the architectural features of RSVP by suggesting new design policies or implementation mechanisms (Feher *et al.*, 1999; Feher *et al.*, 2002; Elsayed *et al.*, 2002; Belhoul *et al.*, 2009; Wang *et al.*, 2010; Wu *et al.*, 2011) . Our research work presented in this paper differs from their work to a large extent as we evaluate the impact of the RSVP protocol using different scenarios implemented with multimedia applications.

Working mechanism of RSVP protocol: The RSVP protocol facilitates to attain QoS by reserving resources along the data flow path (IETF, 1997-b; Cisco-Inc., 2009; Allied-Telesis-Inc., 2005). To accomplish that, the RSVP session b/w each source and destination is represented by a data flow and uses the parameters corresponding to the IP addresses and port numbers of the source and the destination.

Messages Transmission: Using RSVP protocol, the sender and the destination both communicate using messages. Corresponding to a data flow, the sender initially transmits a *Path* message that passes through all hops existing along the path from source to destination. Upon receipt of the *Path* message, each receiving router creates a path state, and replaces the previous hop address in the packet to its own address. This ensures that the reverse path from the destination to the source is correctly registered in the routers. At the final destination, the *Path* message is received and in turn a *Resv* message is transmitted back. This is a kind of a request to reserve the resources along the path.

A reservation style in the *Resv* request specifies the data flows for which a reservation of resources would be made. A filter specification in the *Resv* message describes the bandwidth and the buffer size for the packets for which the reservation would be performed. Similarly, a flow specification describes the QoS that is required for the destination.

Reservation of Resources: Resource reservation takes place when a request for reservation is received by the routers. The routers take into account the filter specification as described earlier in order to reserve the resources. For multiple reservations with a similar reservation style, a single reservation request with *Resv* message is used. This ensures a flexible and an efficient reservation mechanism.

MATERIALS AND METHODS

In order to evaluate the performance of the RSVP protocol, we used two different logical scenarios in OPNET IT Guru Academic Edition v 9.1, as shown in Fig. 1 and Fig 2. Both the scenarios contain hosts (workstations) together with routers using the Open Shortest Path First (OSPF) (IETF, 1998-b) routing protocol. The two applications considered for experimentation are voice and video conferencing with single application running at a time in a physical scenario. Each physical scenario is further duplicated to represent scenario with and without RSVP based communication. Consequently, we have eight physical scenarios based on the two logical scenarios, each set to run for 600 seconds. Each of the voice application and the video application has four scenarios with the configurations given in Table 1 and Table 2 respectively.

Table 1. Configuration of the scenarios for voice application

Sr. No.	Scenario Name	Application	Total Number of Hosts	No. of hosts with RSVP	No. of hosts without RSVP
1.	Scenario 1	Voice	2	2	0
2.	Scenario 2	Voice	4	2	2
3.	Scenario 3	Voice	2	2	0
4.	Scenario 4	Voice	4	2	2

Table 2. Configuration of the scenarios for video application

Sr. No.	Scenario Name	Application	Total Number of Hosts	No. of hosts with RSVP	No. of hosts without RSVP
1.	Scenario 1	Video	2	2	0
2.	Scenario 2	Video	4	2	2
3.	Scenario 3	Video	2	2	0
4.	Scenario 4	Video	4	2	2

The voice application uses the G.711 transmission b/w peers, whereas the video conferencing application transmits 10 frames per second with each frame containing 128*120 pixels. We use the shared explicit mode of reservation style that allows multiple senders to share the same reservation. The flow specification is set to 5000 bytes, whereas 75% is allowed as the reservable bandwidth at each router and host.

As shown in Fig. 1, the (logical) scenario 1 contains two hosts, both of them are workstations acting as peers since they transmit and receive data simultaneously. The hosts are connected using a core network of routers. These routers are of type *ethernet2_slip8_gtwy_adv* and are inter-connected following the mesh topology. For reservation of resources, the path Host1<->Router1<->Router2<-

>Host2 is used so that the reservation requests travel via the designated path.

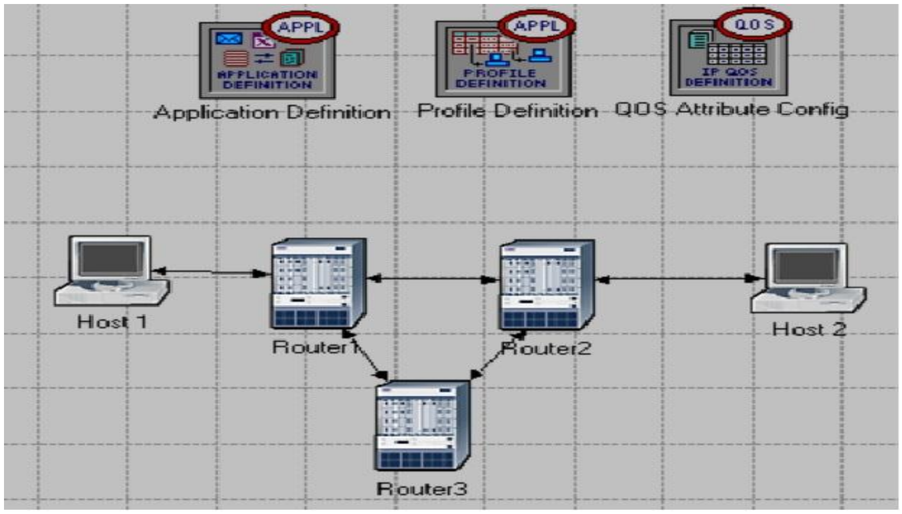

Fig. 1: *Scenario 1 to simulate two peer-to-peer hosts (Host 1 and Host 2) configured to request RSVP based communication.*

As shown in Fig. 2, the (logical) scenario 2 contains four hosts, all of them are workstations acting as peers. In contrast to scenario 1, only Host 1 and Host 2 are allowed to request RSVP based communication and are peers for communication which implies that Host 1 can only communicate to Host 2 and vice-versa. Similarly, Host 3 and Host 4 are peers so that Host 3 can only communicate to Host 4 and vice-versa. The core network has the same topology and routers as those in scenario 1. For reservation of resources, the path Host1<->Router1<->Router2<->Host2 is used so that the reservation requests travel via the designated path, whereas Host 3 and Host 4 are not allowed to request the reservation of resources.

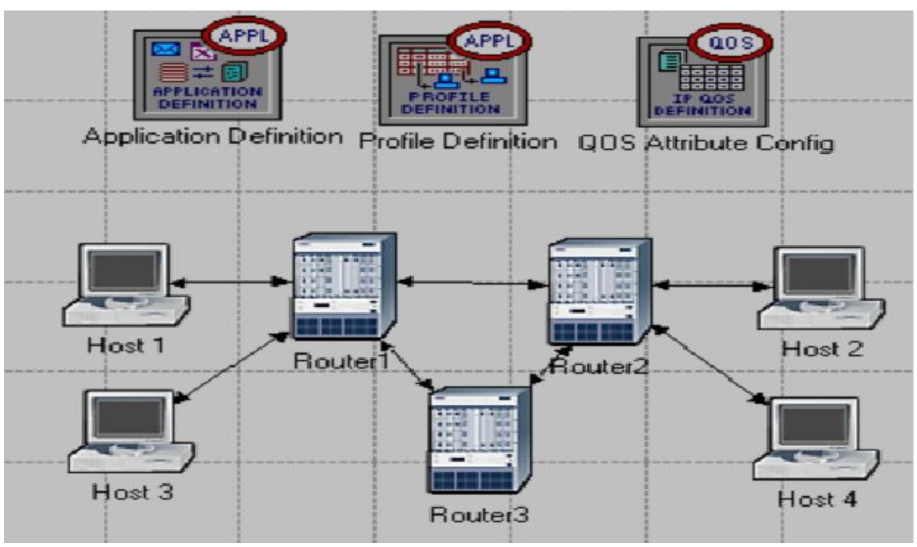

Fig. 2: *Scenario 2 to simulate two sets of peer-to-peer hosts with first set comprising Host 1 & Host 2 configured to request RSVP based communication, and second set Host 3 & Host 4 configured to communicate without RSVP.*

RESULTS AND DISCUSSION

With voice application using scenario 1, the results corresponding to the RSVP control traffic sent and the packet end-to-end delay are shown in Fig. 3 and Fig. 4 respectively.

For scenario 1 of the voice application, the average RSVP control traffic sent is 12.93 packets/second. However, for scenario 2 of the voice application, the average RSVP control traffic sent is 0.049 packets/second. It implies that for scenario 1, a large traffic fulfills the required criteria of RSVP flow specification as there are only two hosts communicating via the reservation path. In contrast, for scenario 2, there are four hosts communicating via the reservation path thereby producing large data traffic not conforming to the required specification of RSVP.

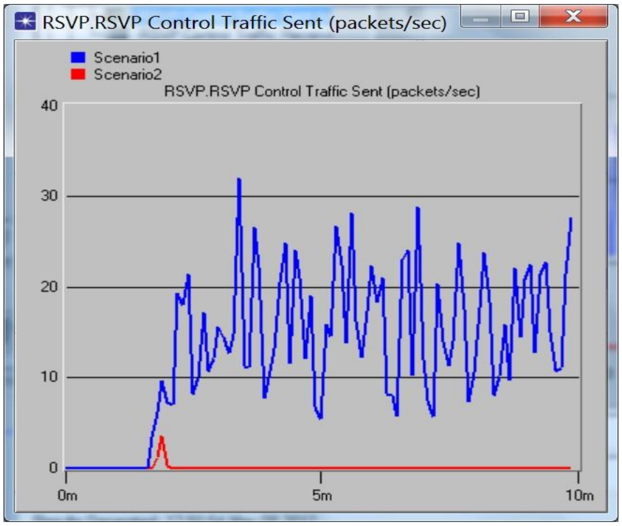

Fig. 3: RSVP control traffic sent for the voice application (simulation time on x-axis and packets/second on y-axis).

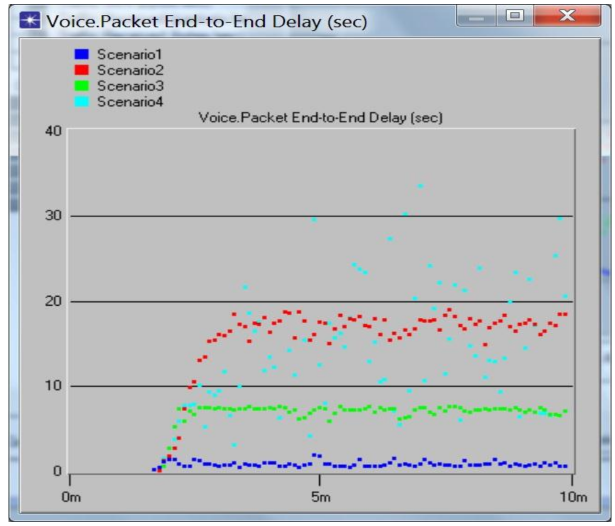

Fig. 4: Packet end-to-end delay for the voice application (simulation time on x-axis and delay in seconds on y-axis).

As shown in Fig. 4, the packet end-to-end delay for scenario 1, 2, 3 & 4 is 0.84, 15.83, 6.99 & 14.19 seconds respectively. The scenario 1 is more efficient, as its equivalent scenario 3 using no RSVP at all is almost 8 times slower. This is mainly due to the fact that most of the communication in scenario 1 is taking place using the RSVP protocol. With reserved bandwidth and low communication data in scenario 1, the overall performance of the network communication improves and the packet end-to-end delay decreases. In contrast to previous scenarios (1 & 3), the scenario 4 performs better than scenario 2. It implies that due to large amount of traffic, RSVP is unable to send reservation requests efficiently. Furthermore, the overhead of RSVP mechanism deteriorates the performance of the network in scenario 2.

With video application using scenario 1, the results corresponding to the RSVP control traffic sent and the packet end-to-end delay are shown in Fig. 5 and Fig. 6 respectively.

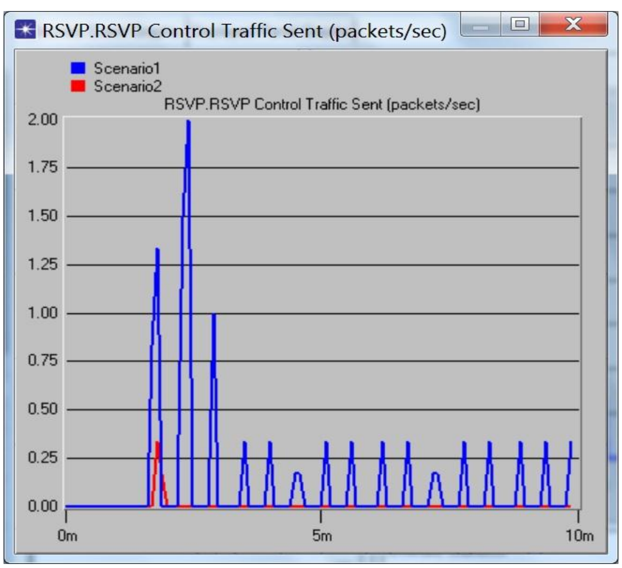

***Fig. 5:** RSVP control traffic sent for the video application (simulation time on x-axis and packets/second on y-axis).*

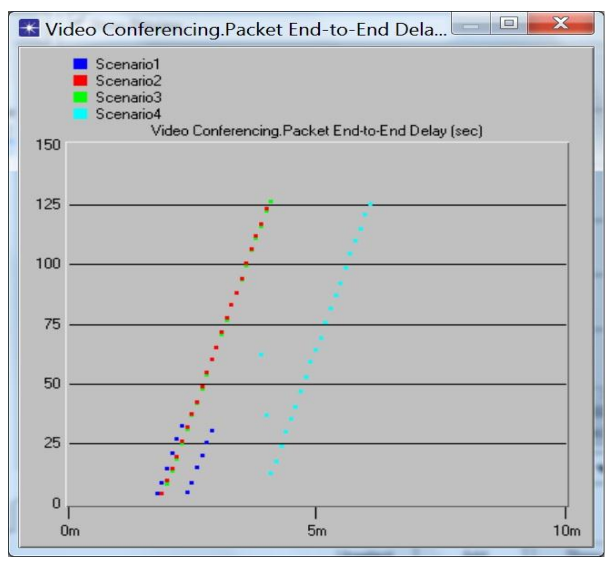

***Fig. 6:** Packet end-to-end delay for the video application (simulation time on x-axis and delay in seconds on y-axis).*

For scenario 1 of the video application, the average RSVP control traffic sent is 0.11 packets/second. However, for scenario 2 of the video application, the average RSVP control traffic sent is 0.005 packets/second. Similar to the voice application, a large traffic in scenario 1 fulfills the required criteria of RSVP flow specification, and in scenario 2, a large number of hosts produces huge amount of data not conforming to the required specification of RSVP.

As shown in Fig. 6, the packet end-to-end delay for scenario 1, 2, 3, & 4 is 17.74, 63.18, 65.27 & 67.95 seconds respectively. The scenario 1 is more efficient, as its equivalent scenario 3 using no RSVP at all is almost 4 times slower. This is mainly due to the fact that most of the communication in scenario 1 is taking place using the RSVP protocol. With reserved bandwidth and low communication data in scenario 1, the overall performance of the network communication improves and the packet end-to-end delay decreases. In contrast, the scenario 2 and scenario 4 are very close and scenario 2 is marginally better than scenario 4. It implies that due to large amount of traffic, RSVP is able to send only a small number of reservation requests and consequently, there is a slight improvement in the packet end-to-end delay achieved by scenario 2.

Conclusion: This paper presents a performance analysis of the RSVP protocol. We simulate two logical scenarios while incorporating the voice and the video applications. The scenarios differ in the number of hosts among which the communication takes place. We use the peer-to-peer model for network communication. The RSVP protocol is evaluated in terms of the metrics of the control traffic sent and the packet end-to-end delay.

Both for the voice application and video application, a large number of RSVP control traffic is sent only if the amount of data being transmitted conforms to the flow specification given for RSVP. For scenarios with small number of hosts, a large amount of data meets the requirement, thereby generating a large amount of RSVP control traffic. RSVP therefore reserves the resources and allows dedicated communication. Consequently, the communication performance improves as the packet end-to-end delay decreases. In contrast, for scenarios with large amount of data, the RSVP protocol is unable to perform well and the delay increases for voice application, however, there is a slight improvement in the case of video conferencing application.

As future work, we intend to analyze the impact of RSVP protocol with regards to the routing protocols, in conjunction with various topologies and the queuing mechanism being used in the network.

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