AN RSVP MODEL FOR OPNET SIMULATOR WITH AN INTEGRATED QOS ARCHITECTURE

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ABSTRACT

Resource Reservation Protocol (RSVP) allows Internet real-time applications to request a specific end-to-end Quality of service (QoS) for data stream before they start transmitting data. In this paper firstly an overview of RSVP is presented. After that the different quality of services available and the relation between QoS and RSVP have been explained. The fundamentals of RSVP as a protocol is discussed. The performance issues and benchmarking for planned portion architecture at the department of Computer Engineering, Çankaya University has been given next. The experimental results and discussions conclude this paper. In this paper, OPNET network simulation tool has been used. Under given architecture and protocol, performance of quality of service implications has been carried out.

Keywords: RSVP, Quality of Service (QoS), Network flow.

1. INTRODUCTION

Internet allows the transmission of data between end points. In original design, it tries to transmit as quickly as possible but there is no guarantee to the timeliness and assurance of actual delivery. It provides its best effort service at end points. It may give qualitatively better service, but without the quantitative bounds of a guaranteed service it is far from expectations especially in an environment containing various services to be handled in the media. There is a great deal of interest in network applications. Accomplishment of best effort service for one single service is far from present day constraints. Due to demanding changes in end-point requirements, internet is affected to meet the quality of service (QoS) requirements (Tschudin 2001). There are several protocols for real time services (Video Conferencing, Internet TV and Internet Telephony, are rapidly growing and perfected) that support QoS of multimedia applications for IP networks such as Resource Reservation Protocol (RSVP), together with Real-Time Transport Protocol (RTP), Real-Time Control Protocol (RTCP), Real-Time Streaming Protocol (RTSP) (Moon and Aghvami 2001; Bouras 2007; Light et. Al. 2004), provides a working foundation for real-time services. Utilization of RSVP in a network with different perspectives is analyzed and simulations conducted are given in experiments. In this paper, OPNET network simulation tool (OPNET 2000) is used. OPNET is a network simulation tool that outputs the characteristics of a real time network utilizing different services with a priori parameters. Under given architecture and protocol, performance of quality of service implications is carried out.

There is no single technique provides efficient, dependable QoS in an optimum way. Instead a variety of techniques have been developed, with practical solutions often combining multiple techniques. Some of the techniques used to achieve QoS are: Over provisioning, Buffering, Traffic Shaping, the Leaky Bucket Algorithm, Token Bucket Algorithm, and Resource Reservation (Tanenbaum 2003).

RSVP (Resource Reservation Protocol) is a resource reservation setup protocol for the Internet. The RSVP protocol is used by hosts to obtain specific qualities of service from the network for particular application data streams or flows. It is also used by routers to deliver quality-of-service (QoS) requests to all nodes along the path of the flows and to establish and maintain state to provide the requested service (Rfc 2205). RSVP carries the request through the network, visiting each node the network uses to carry the stream. At each node, RSVP attempts to make a resource reservation for the stream. Some applications require reliable delivery of data but do not impose any stringent requirements for the timeliness of delivery. But applications such as video- conferencing, IP telephony, NetRadio require almost exact opposite: Data delivery must be timely but not necessarily reliable. Thus, RSVP was intended to provide IP networks with the capability to support the divergent performance requirements of differing application types (Karsten et. al. 2001).

2. DETAILED BACKGROUND OF RSVP SYSTEM

The RSVP protocol performs a reservation for each flow requiring QoS services; a flow is defined by five tuples (source IP address, destination IP address, transport protocol, source port, and destination port). Each flow needs several RSVP messages, to request, maintain and release the required resources.

With an RSVP based quality of service architecture there are two basic elements: sources and destinations, all of them run RSVP daemons that participate in RSVP protocol and exchange RSVP

messages on behalf of their hosts. They exchange basically two types of messages: PATH and RESV. The RSVP source sends a PATH message which is encapsulated in IP or UDP datagrams (Stallings 2004). The message travels through the network to the destination. When it is received by the destination, if it wants to make a reservation for the particular RSVP flow, it responds with a RESV message and it traverses the reverse path back to the sender. Otherwise, a RESV ERROR message is issued and is sent back to the receiver. An end-to-end reservation is successfully established when the RESV message reaches the sender and is successfully processed by the RSVP daemon on the sender and in all the other nodes in the middle.

A multicast reservation session can also be made. In this case the sender sends the PATH messages to a multicast group address. As in the case of unicast, the path messages travels through the network to all the members of the multicast group. When PATH messages reach the receivers, each receiver independently decides if it wants to request a reservation for the session. Each receiver can potentially request for different reservations for the same session (Barzilai et. al. 1996). Figure1 shows an example, where S1 and S2 are sources, and D1, D2 and D3 are destinations of data. D1, D2 and D3 are members of the same multicast group and S1 and S2 send messages to this multicast group. But we can see in the figure that not all the destinations make the same reservation. D3 sends RESV messages to S1 and S2, so it accepts all the reservations. D2 only accepts one of the reservation requests sending one RESV message to S1. But D1 does not want to make any reservation and does not send any RESV message to S1 and S2.It has to be clear that RSVP is a protocol to negotiate a quality of service for a specific application and it is not a routing protocol. It uses the routing table in routers to determine routes to the appropriate destinations. So it was designed to interoperate with existing unicast and multicast IP routing protocols (3Mallofre 2003).

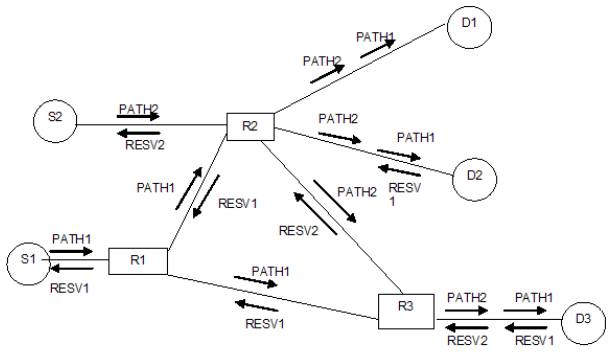

Figure 1: PATH and RESV messages flows in RSVP (Barzilai et. al. 1996)

2.1. Reservation Styles

Reservation style indicates to the network element that an aggregation of reservation request is possible for a multicast group. Resource reservation controls how much bandwidth is reserved, whereas reservation filter determines the packets that can make use of this reservation. RSVP supports three styles of reservation. A description of these styles is provided in the following subsections. If we have different senders for the same RSVP session, then we have two modes:

- Distinct Reservation: creates a different reservation for each upstream sender.
- Shared Reservation: creates a shared reservation for specified senders.
- But we have another option that controls the set of senders. With this option there are also two options:
- Explicit: select a list of the senders.
- Wildcard: selects all the senders for the session. And now if we mix these modes, then as we can see in Figure 2, there exist the Fixed-Filter style (FF), the Shared-Explicit style (SE), and the Wildcard-Filter (WF):

Sender Selection	Reservations: Distinct	Shared
Explicit	Fixed-Filter (FF) style	Shared-Explicit (SE) Style
Wildcard	(None defined)	Wildcard-Filter (WF) Style

Figure 2: Reservation attributes and styles (Rfc 2205)

The Wildcard-Filter (WF) style creates a single reservation shared by all flows from all upstream senders. The Shared-Explicit style (SE) creates a single reservation shared by selected upstream senders, so is the same than the Wildcard-Filter but with not all the senders. And the last style is the Fixed-Filter, which creates a distinct reservation for data packets from a particular sender. This is the last style because there is no defined style for a distinct reservation in a Wildcard sender selection. WF and SE are appropriate for multicast applications in which multiple data sources are unlikely to transmit simultaneously.

2.2. Incorporating RSVP with OPNET

OPNET allows for a very large number of potential statistics. For this reason, collection mechanisms are deactivated by default when a simulation is executed. However, OPNET provides a mechanism to explicitly activate statistics of particular interest, which are recorded in appropriate output files. This is accomplished by specifying a list of probes when running a simulation, which indicate the particular statistic that should be collected.

In order to investigate the RSVP in the network environment, the following statistics have been specified and studied that allowed for the system's behavioral study and validation.

- Link Delays, Throughput and Utilization (for identifying any congested links).
- RSVP Control Traffic sent and received (for verifying the protocol's correctness of functionality).
- Application Traffic sent and received (for verifying the correct traffic flow through the system's components).

2.2.1. The Scenario

Utilization of RSVP in a network with different perspectives is analyzed and simulations conducted are given in experiments for future network topology planned part at the department of Computer Engineering, Cankaya University. In this paper, OPNET network simulation tool is used. OPNET is a network simulation tool that outputs the characteristics of a real time network utilizing different services with a priori parameters. Under given architecture and protocol, performance of quality of service implications is carried out.

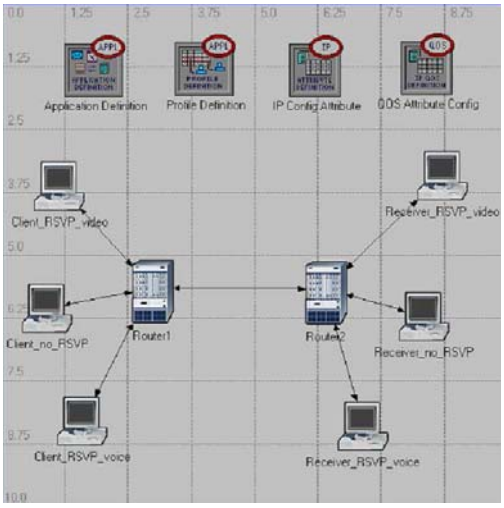

Figure 3: Rsvp enabled network

In order to evaluate the performance of the RSVP model, this network model has been created (see Figure 3).The Ethernet network consists of three clients sending traffic to associated receivers via routers. All the nodes in the network are connected with PPP DS0 links with a 64 Kbps data rate. Client_RSVP_video node and Client_no_RSVP video node are video applications while Client_ RSVP_voice node is voice application. Two video conferencing sessions are competing for the same resources. Traffic between Client RSVP video and Receiver RSVP video uses RSVP to reserve resources also traffic between Client_RSVP_voice and Receiver_RSVP_voice uses RSVP to reserve resources while traffic between Client_no_RSVP and Receiver_no_RSVP uses best effort service. There is one session for each source-destination pair in-place for the duration of the simulation. The reservation will be made for traffic in both directions. The traffic generated by each client is described as having a bandwidth of 5,000 bytes/sec and a buffer size of 5,000 bytes. These parameters will be used for the reservation. Also reservation style is selected Wild Card. OPNET supports five different QoS policies: RSVP Protocol, Committed Access Rate, (CAR), Custom Queuing (CO), Priority Queuing (PQ), and Weighted Fair Queuing (WFQ). In addition OPNET's RSVP model supports Controlled Load service. This service is supported for WFQ and Custom Queuing schemes. This scenario based on WFQ and RSVP.

Configuring Applications Attributes describing RSVP parameters set by the application are defined in two objects: the QoS Attribute Configuration object and the Application Attribute Configuration object. To run an RSVP simulation, both objects must be included in the scenario. Also Profile Definition Attributes and IP Configuration Attributes can be seen for the general network configuration. Figure 4 illustrates the Profile definition Attributes are video reserved, Video unreserved and voice reserved which are defined in Profile Definition. Figure 5 shows the IP Configuration Attributes with default values.

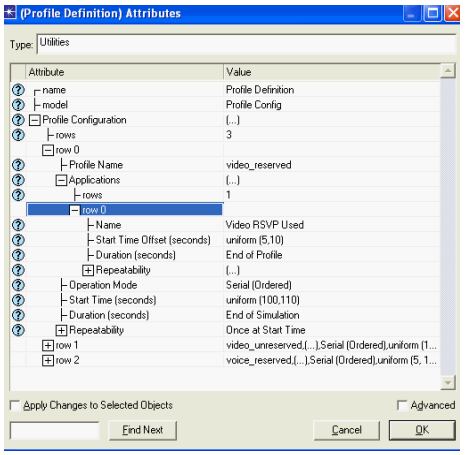

Figure 4: Profile Definition Attributes

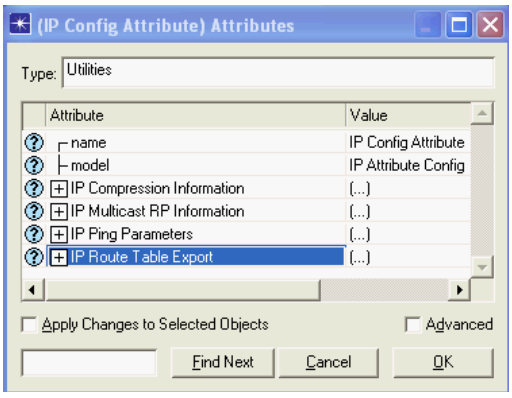

Figure 5: IP config Attribute

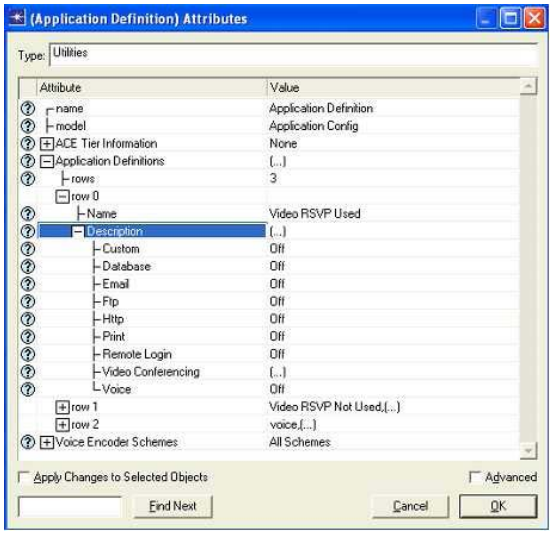

Figure 6: Application definition attributes

Figure 6 shows the Video conferencing and voice applications are defined in Application Definition. For Video Applications, video conferencing status is "On" and other applications are "Off". For voice Application, voice status is "On" and other applications are "Off".

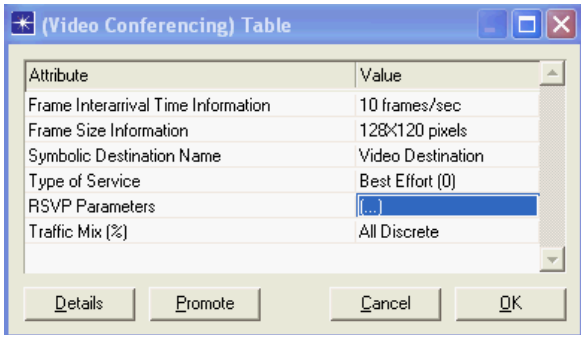

Figure 7: Video conferencing table

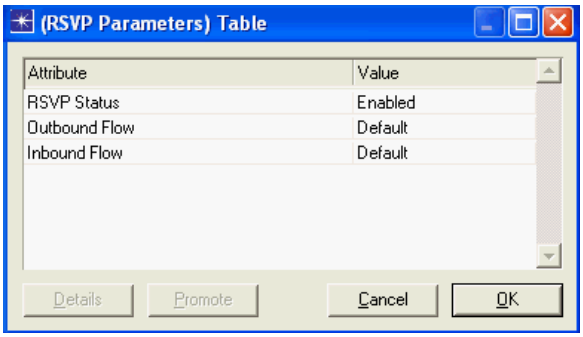

Figure 8: RSVP parameters table

The following Figures 7 and 8 show the RSVP parameters on Video conferencing application and RSVP status of this application.

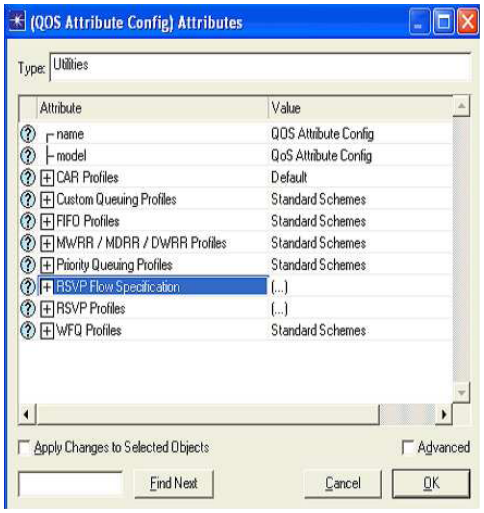

Figure 9: QoS attribute config attributes

Figure 9, Figure 10, and Figure 11 illustrate the RSVP flow specification and RSVP profiles. The traffic generated by each client is described as having a bandwidth of 5,000 bytes/sec and a buffer size of 5,000 bytes. These parameters will be used for the reservation. Also reservation style is selected Wild Card.

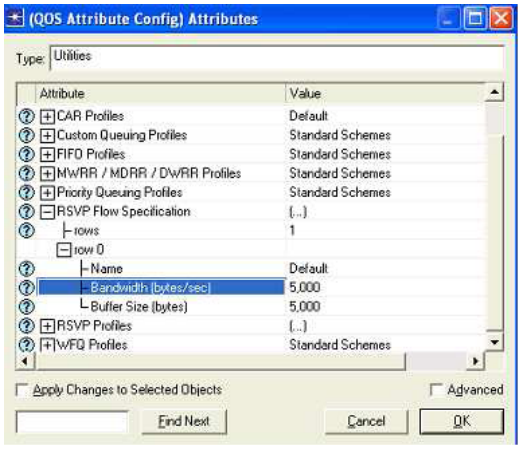

Figure 10: QoS flow spec atribute

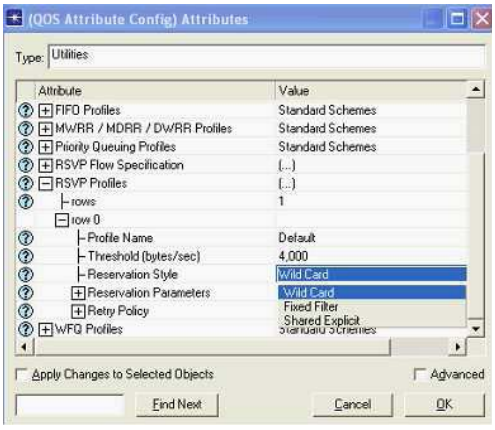

Figure 11: QoS RSVP reservation style

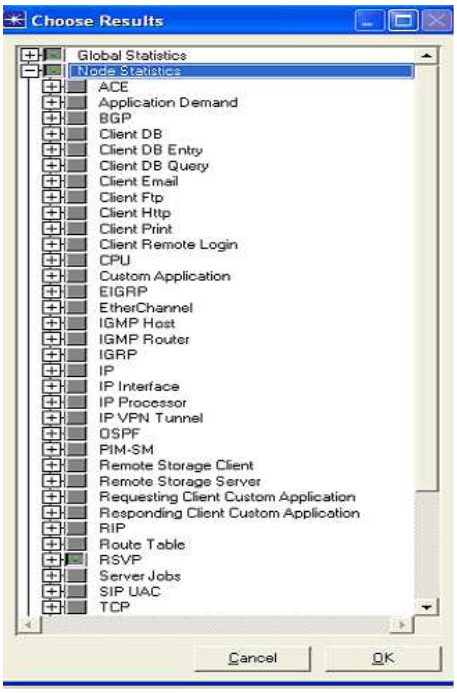

Figure 12: Statistics collection

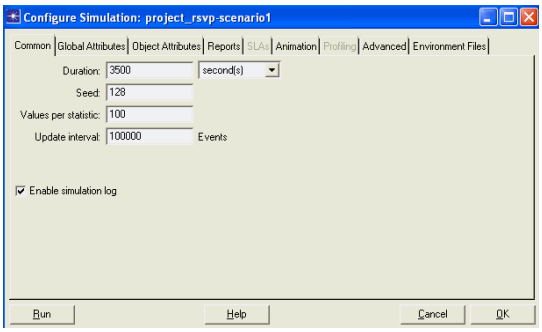

Figure 13: Simulation runtime settings

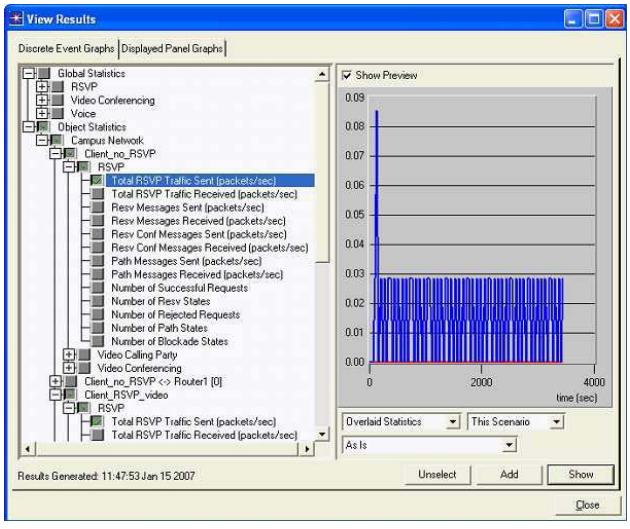

Figure 14: Selected simulation results

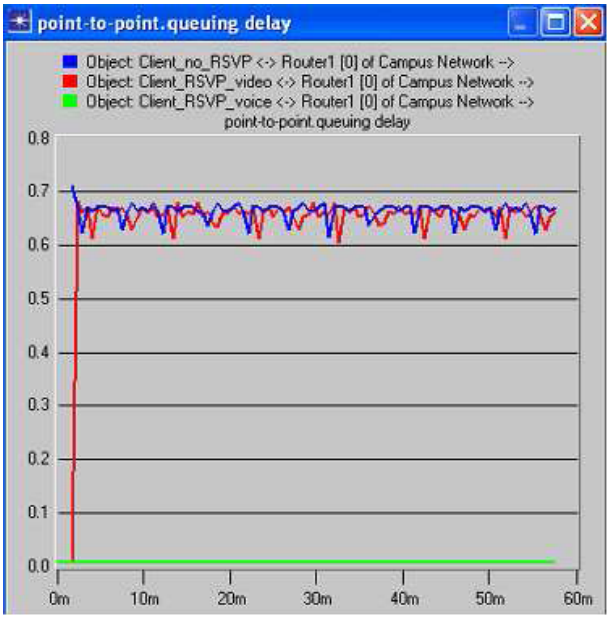

Figure 15: P2P queuing delay

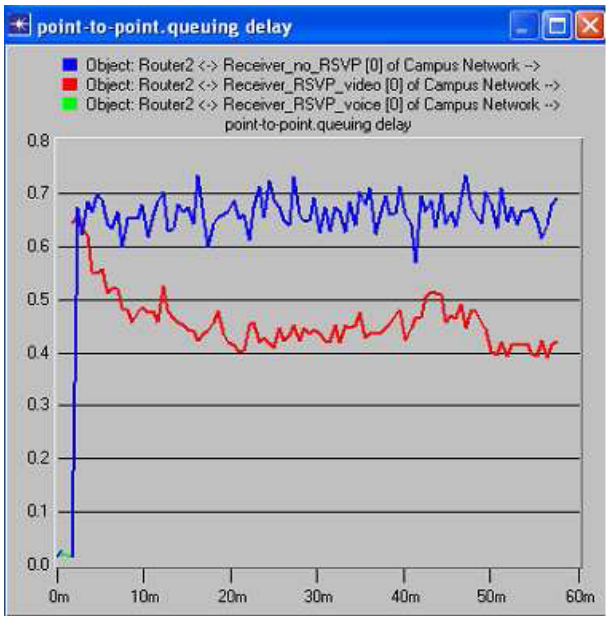

Figure 16: P2P queuing delay

Figure 15 and Figure 16 compare the point-to-point queuing delay experienced using RSVP with the queuing delay experienced not using RSVP between the Clients to Router1 and Router2 to Receivers. As expected, traffic using RSVP reservation experienced less queuing delay.

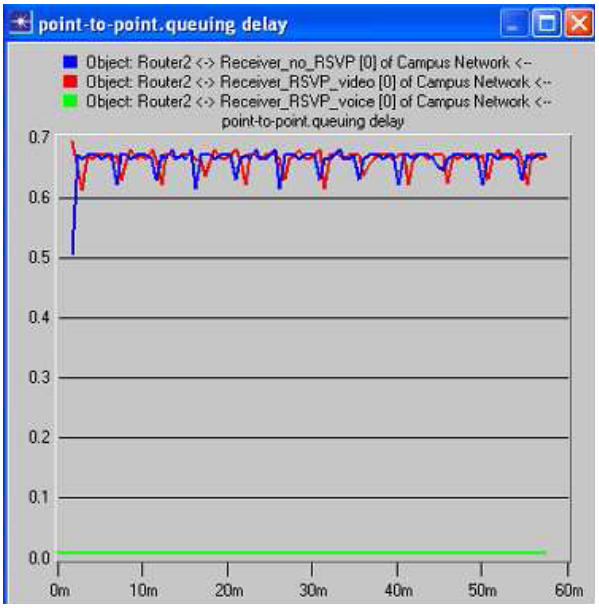

Figure 17: P2P queuing delay

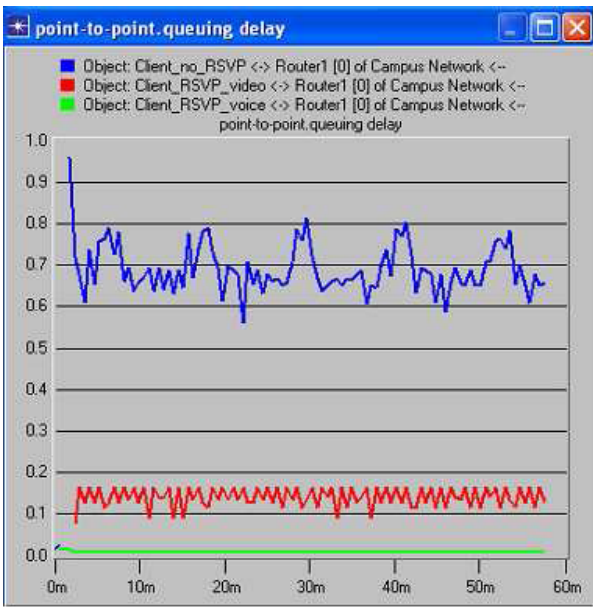

Figure 18: P2P queuing delay

Figure 17 and Figure 18 compare the point-to-point queuing delay experienced using RSVP with the queuing delay experienced not using RSVP between the Receivers to Router2 and Router1 to Clients. As expected, traffic using RSVP reservation experienced less queuing delay.

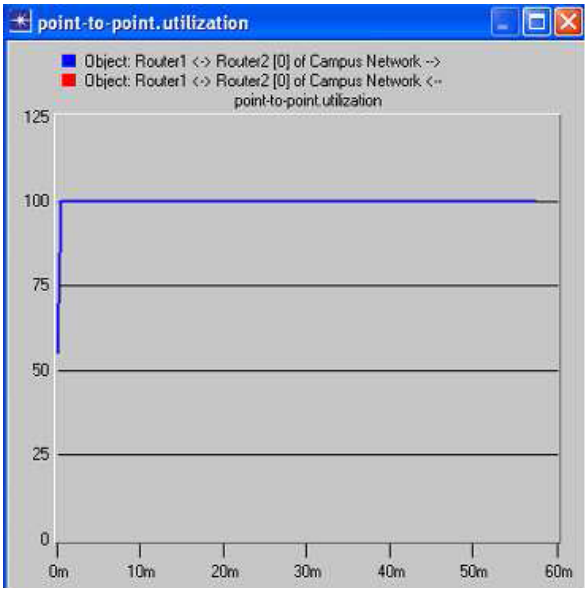

Figure 19: Link utilization

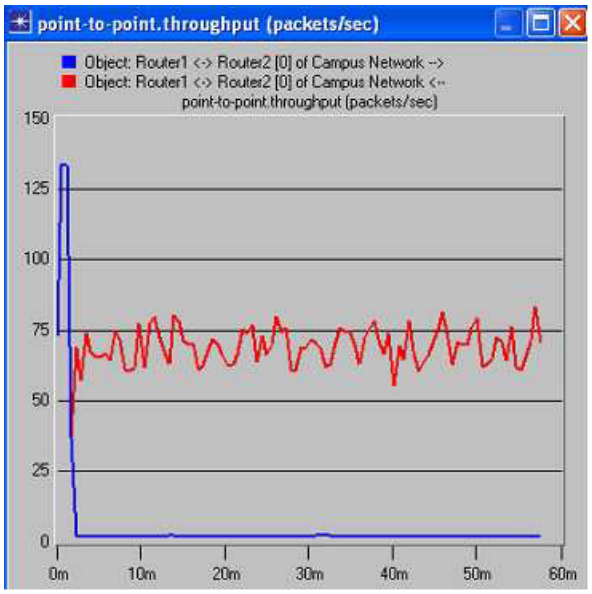

Figure 20: Link utilization

In Figure 19, utilization of the link between Router1 and Router2 is shown. RSVP is used between Router1 and Router2. Maximum Reservable Bandwidth is a percentage of the link bandwidth that RSVP can use. Maximum Reservable Bandwidth is configured to 100%. As expected, traffic using RSVP reservation experienced using full bandwidth. In Figure 20, throughput of the link between Router1 and Router2 is shown. It clearly shows how sufficient the link between Router 1 and Router 2 is for this load.

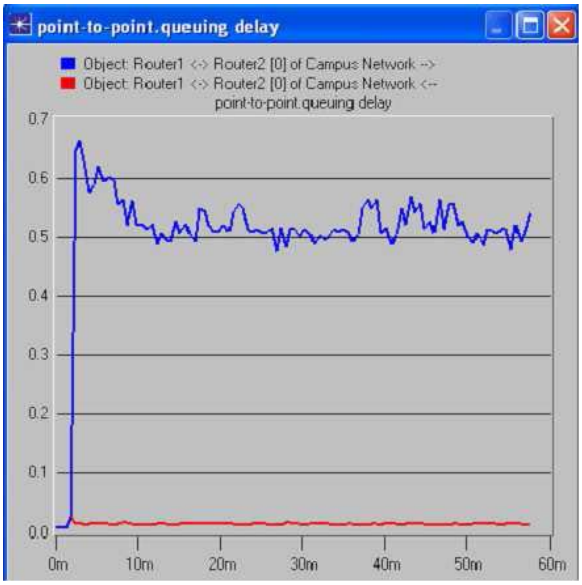

Figure 21: Link Queuing Delay

In Figure 21 queuing delay of the link between Router1 and Router2 is shown. RSVP is used between Router1 and Router2. In our scenario all clients are connected to Router1. Therefore Router1 sends more confirmation messages. As expected, the outgoing link between Router1 and Router2 experienced higher queuing delay.

Figure 22 and Figure 23 show the Total RSVP Traffic Sent and Received on Router1 and Router2 experienced using RSVP. As expected, the network is used by Router2 all the time so there is no too much change. The Router1 uses the network some times. Therefore fast change can be seen.

These two figures (Figure 24 and 25) show the Total RSVP Resv Messages Sent and Received on Router1 and Router2 experienced using RSVP. As expected, the network is used by Router2 all the time so there is no too much change. The Router1 uses the network some times. Therefore fast change can be seen.

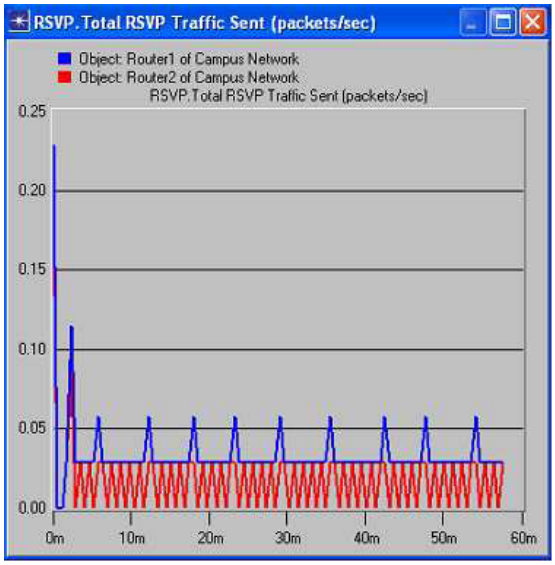

Figure 22: RSVP traffic sent

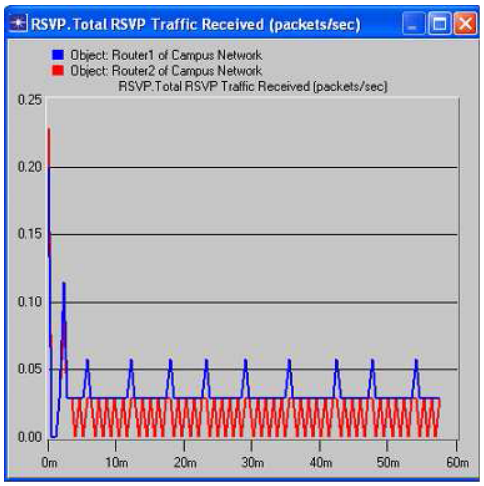

Figure 23: RSVP traffic received

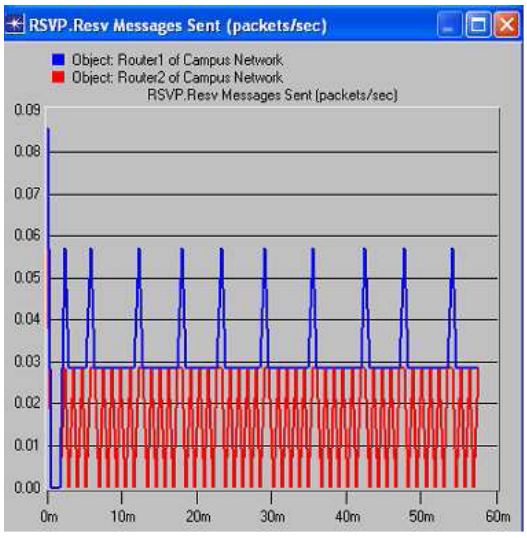

Figure 24: RSVP traffic sent

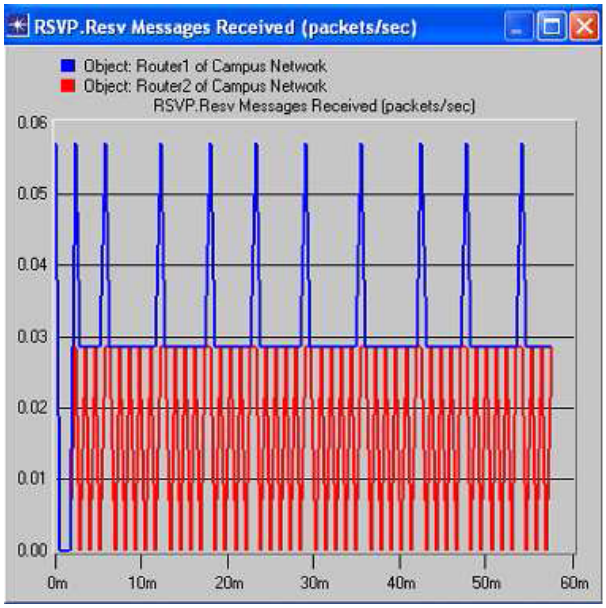

Figure 25: RSVP traffic received

3. CONCLUSIONS

We conducted some experiments by using OPNET IT Guru Academic Edition 9.1. A scenario is established. Clients and receivers with/without RSVP are used in our simulation. Some results are obtained link utilization, throughput, point to point delay, queuing delay, IP traffic are measured. RSVP protocol does allocation of bandwidth before transmission. If allocation is not done, data transmission does not occur.

In summary RSVP has the following attributes (Rfc 2205):

- RSVP makes resource reservations for unicast and multicast applications.
- RSVP sessions are simplex. Thus, a bidirectional exchange of data between a pair of machines actually constitutes two separate RSVP simplex sessions.
- RSVP is receiver-oriented. The receiver of a data flow initiates and maintains the resource reservation used for that flow.
- RSVP maintains soft state in routers and hosts, providing graceful support for dynamic membership changes and automatic adaptation to routing changes.
- RSVP is not a routing protocol but depends upon present and future routing protocols. RSVP transports and maintains traffic control and policy control parameters that are opaque to RSVP.
- RSVP provides several reservation models or styles to fit a variety of applications.
- RSVP provides transparent operation through routers that do not support it.
- RSVP supports both IPv4 and IPv6.

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