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RSVP protocol in Multimedia Networks

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***Abstract*- Contrary to the high bandwidth, real-time and bursty traffic of multimedia data, in real life, networks are shared by thousands and millions of users, and have limited bandwidth, unpredictable delay and availability. The *Resource Reservation Protocol (RSVP)* is a network-control protocol that enables Internet applications to obtain differing qualities of service (QoS) for their data flows. Such a capability recognizes that different applications have different network performance requirements. In this paper the detailed description of RSVP is given with a simulation of multicast session which compares time delays of ARRP and RSVP.**

I. INTRODUCTION

Computer networks were designed to connect computers on different locations so that they can share data and communicate. In the old days, most of the data carried on networks was textual data. Today, with the rise of multimedia and network technologies, multimedia has become an indispensable feature on the Internet. Animation, voice and video clips become more and more popular on the Internet.

Multimedia networking products like Internet telephony, Internet TV, video conferencing have appeared on the market. In the future, people would enjoy other multimedia products in distance learning, distributed simulation, distributed work groups and other areas [5]. For networkers, multimedia networking is to build the hardware and software infrastructure and application tools to support multimedia transport on networks so that users can communicate in multimedia. Multimedia networking will greatly boost the use of the computer as a communication tool.

A) The real-time challenges

However, multimedia networking there are three difficulties. QoS requirements are communicated through a network via a flow specification, which is a data structure used by internetwork hosts to request special services from the internetwork. A flow specification describes the level of service required for that data flow. This description takes the form of one of three traffic types. **1. Best-effort**

2. Rate-sensitive

3. Delay-sensitive.

Best-effort traffic is traditional IP traffic. Applications include file transfer (such as mail transmissions), disk mounts, interactive logins, and transaction traffic. These types of applications require reliable delivery of data regardless of the amount of time needed to achieve that delivery.

Rate-sensitive traffic requires a guaranteed transmission rate from its source to its destination. An example of such an application is H.323 videoconferencing.

Delay-sensitive traffic is traffic that requires timeliness of delivery and that varies its rate accordingly. MPEG-II video, for example, averages about 3 to 7 Mbps, depending on the amount of change in the picture.

II. PROBLEM DOMAIN-MULTIMEDIA OVER INTERNET

To run multimedia over Internet, several issues must be solved.

First, multimedia means extremely dense data and heavy traffic. The hardware has to provide enough bandwidth.

Second, multimedia applications are usually related to multicast, i.e., the same data stream, not multiple copies, is sent a group of receivers. For example, in video conference, the video data need to be sent to all participants at the same time.

Third, the price tag attached shared network resources is unpredictable availability. But real-time applications require guaranteed bandwidth when the transmission takes place. So there must be some mechanisms for real-time applications to reserve resources along the transmission path.

Fourth, Internet is a packet-switching datagram network where packets are routed independently across shared networks.

Fifth, there should be some standard operations for applications to manage the delivery and present the multimedia data.

III. PROPOSED SOLUTION

The solution for multimedia over IP is to classify all traffic, allocate priority for different applications and make reservations. The Integrated Services working group in the IETF (Internet Engineering Task Force) developed an enhanced Internet service model called Integrated Services that includes best-effort service and real-time service [1]. The real-time service will enable IP networks to provide quality of service to multimedia applications. Resource Reservation Protocol (RSVP) provides a working foundation for real-time services. Integrated Services allows applications to configure and manage a single infrastructure for multimedia applications and traditional applications. It is a comprehensive approach to provide applications with the type of service they need and in the quality they choose. This paper, which takes many materials from corresponding Internet Drafts and RFCs, is a detailed review of RSVP protocol.

It is important to note that RSVP is not a routing protocol. RSVP works in conjunction with routing protocols and installs the equivalent of dynamic access lists along the routes that routing protocols calculate. Thus, implementing RSVP in an existing network does not require migration to a new routing protocol.

A) *RSVP Features*

- RSVP flows are simplex.
- RSVP supports both multicast and unicast, and adapts to changing memberships and routes.
- RSVP is receiver-oriented and handles heterogeneous receivers.
- RSVP has good compatibility.

B) *RSVP Soft State Implementation*

In the context of an RSVP-enabled network, a *soft state* refers to a state in routers and end nodes that can be updated by certain RSVP messages. The soft state characteristic permits an RSVP network to support dynamic group membership changes and adapt to changes in routing. To maintain a reservation state, RSVP tracks a soft state in router and host nodes. The RSVP soft state is created and must be periodically refreshed by path and reservation-request messages [4]. If no matching refresh messages arrive before the expiration of a cleanup timeout interval, the state is deleted. The soft state also can be deleted as the result of an explicit teardown message. RSVP periodically scans the soft state to build and forward path and reservation-request refresh messages to succeeding hops. When a route changes, the next path message initializes the path state on the new route. Future reservation-request messages establish a reservation state. The state on the now-unused segment is timed out. (The RSVP specification requires initiation of new reservations through the network 2 seconds after a topology change.) When state changes occur, RSVP propagates those changes from end to end within an RSVP network without delay. If the received state differs from the stored state, the stored state is updated. If the result modifies the refresh messages to be generated, refresh messages are generated and forwarded immediately.

C) *RSVP Data Flows Process-Multicasting*

Unlike routing protocols, RSVP is designed to manage flows of data rather than make decisions for each individual datagram. Data flows consist of discrete sessions between specific source and destination machines. A session is more specifically defined as a simplex flow of datagrams to a particular destination and transport layer protocol. Thus, sessions are identified by the following data: destination address, protocol ID, and destination port. RSVP supports both unicast and multicast simplex sessions. A multicast session sends a copy of each datagram transmitted by a single sender to multiple destinations. A unicast session features a single source and destination machine. An RSVP source and destination address can correspond to a unique Internet host. A single host, however, can contain multiple logical senders and receivers distinguished by port numbers, with each port number corresponding to a different application.

The reservation requests are initiated by the receivers. They do not need to travel all the way to the source of the sender. Instead, it travels upstream until it meets another reservation request for the same source stream, then merges with that reservation. Figure1 shows how the reservation requests merge as they progress up the multicast tree.

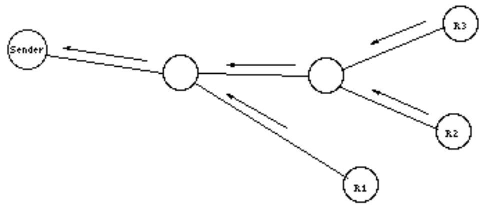

Figure 1: reservation merging.

This reservation merging leads to the primary advantage of RSVP: scalability---a large number of users can be added to a multicast group without increasing the data traffic significantly. So RSVP can scale to large multicast groups and the average protocol overhead decreases as the number of participants increases.

The reservation process does not actually transmit the data and provide the requested quality of service. But through reservation, RSVP guarantees the network resources are available when the transmission actually takes place. The delivery of reservation parameters is different from the determination of these parameters. How to set the connection parameters to achieve the requested QoS is the task of QoS control devices, the role of RSVP is just a general facility to distribute these parameters.

D) *RSVP Operational Model*

The RSVP resource-reservation process initiation begins when an RSVP daemon consults the local routing protocol(s) to obtain routes. A host sends IGMP messages to join a multicast group and RSVP messages to reserve resources along the delivery path(s) from that group.

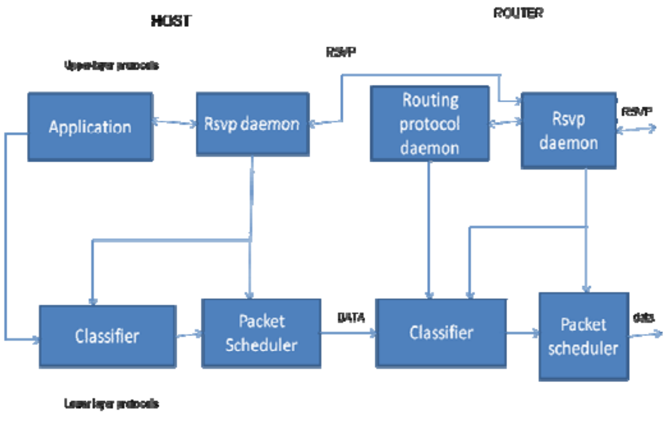

Figure:The RSVP Operational Environment Reserves Resources for Unidirectional Data Flows

Each router that is capable of participating in resource reservation passes incoming data packets to a packet classifier and then queues them as necessary in a packet scheduler. The RSVP packet classifier determines the route and QoS class for each packet. The RSVP scheduler allocates resources for transmission on the particular data link layer medium used by each interface. If the data link layer medium has its own QoS management capability, the packet scheduler is responsible for negotiation with the data link layer to obtain the QoS requested by RSVP. The scheduler itself allocates packet-transmission capacity on a QoS-passive medium, such as a leased line, and also can allocate other system resources, such as CPU time or buffers. A QoS request, typically originating in a receiver host application, is passed to the local RSVP implementation as an RSVP daemon [2].

The RSVP protocol then is used to pass the request to all the nodes (routers and hosts) along the reverse data path(s) to the data source(s). At each node, the RSVP program applies a local decision procedure called admission control to determine whether it can supply the requested QoS. If admission control succeeds, the RSVP program sets the parameters of the packet classifier and scheduler to obtain the desired QoS. If admission control fails at any node, the RSVP program returns an error indication to the application that originated the request.

E) RSVP Messages

RSVP supports four basic message types: reservation-request messages, path messages, error and confirmation messages, and teardown messages. Each of these is described briefly in the sections that follow.

Reservation-Request Messages: A *reservation-request message* is sent by each receiver host toward the senders. This message follows in reverse the routes that the data packets use, all the way to the sender hosts.

Path Messages: An *RSVP path message* is sent by each sender along the unicast or multicast routes provided by the routing protocol(s). A path message is used to store the path state in each node. The path state is used to route reservation-request messages in the reverse direction.

Error and Confirmation Messages: Three error and confirmation message forms exist: path-error messages, reservation-request error messages, and reservation-request acknowledgment messages.

Path-error messages result from path messages and travel toward senders. Path-error messages are routed hop by hop using the path state. At each hop, the IP destination address is the unicast address of the previous hop.

Reservation-request error messages result from reservation-request messages and travel toward the receiver. Reservation-request error messages are routed hop by hop using the reservation state. At each hop, the IP destination address is the unicast address of the next-hop node. Information carried in error messages can include the following:

- Admission failure
- Bandwidth unavailable
- Service not supported
- Bad flow specification
- Ambiguous path

Reservation-request acknowledgment messages are sent as the result of the appearance of a reservation-confirmation object in a reservation-request message. This acknowledgment message contains a copy of the reservation confirmation. An acknowledgment message is sent to the unicast address of a receiver host, and the address is obtained from the reservation-confirmation object. A reservation-request acknowledgment message is forwarded to the receiver hop by hop (to accommodate the hop-by-hop integrity-check mechanism).

Teardown Messages: *RSVP teardown messages* remove the path and reservation state without waiting for the cleanup timeout period. Teardown messages can be initiated by an application in an end system (sender or receiver) or a router as the result of state timeout. RSVP supports two types of teardown messages: path-teardown and reservation-request teardown. *Path-teardown messages* delete the path state (which deletes the reservation state), travel toward all receivers downstream from the point of initiation, and are routed like path messages. *Reservation-request teardown messages* delete the reservation state, travel toward all matching senders upstream from the point of teardown initiation, and are routed like corresponding reservation-request messages.

F) RSVP Reservation Style

Reservation style refers to a set of control options that specify a number of supported parameters. RSVP supports two major classes of reservation: *distinct reservations* and *shared reservations*. Distinct reservations install a flow for each relevant sender in each session. A shared reservation is used by a set of senders that are known not to interfere with each other. Each supported reservation style/scope combination is described following the illustration [4].

Wildcard-Filter Style: The *wildcard-filter (WF) style* specifies a shared reservation with a wildcard scope. With a WF-style reservation, a single reservation is created into which flows from all upstream senders are mixed. Reservations can be thought of as a shared pipe whose size is the largest of the resource requests for that link from all receivers, independent of the number of senders. The reservation is propagated upstream toward all sender hosts and is automatically extended to new senders as they appear.

Fixed-Filter Style: The *fixed-filter (FF) style* specifies a distinct reservation with an explicit scope. With an FF-style reservation, a distinct reservation request is created for data packets from a particular sender. The reservation scope is determined by an explicit list of senders. The total reservation on a link for a given session is the total of the FF reservations for all requested senders. FF reservations that are requested by different receivers but that select the same sender must be merged to share a single reservation in a given node.

Shared-Explicit Style: The *shared-explicit (SE) style* reservation specifies a shared reservation environment with an explicit reservation scope. The SE style creates a single reservation into which flows from all upstream senders are mixed. As in the case of an FF reservation, the set of senders (and, therefore, the scope) is specified explicitly by the receiver making the reservation.

G) RSVP Tunneling

It is impossible to deploy RSVP or any new protocol at the same moment throughout the entire Internet. Indeed, RSVP might never be deployed everywhere. Therefore, RSVP must provide correct protocol operation even when two RSVP-capable routers are interconnected via an arbitrary cloud of non-RSVP routers. An intermediate cloud that does not support RSVP is incapable of performing resource reservation, so service guarantees cannot be made. However, if such a cloud has sufficient excess capacity, it can provide acceptable and useful real-time service.

To support connection of RSVP networks through non-RSVP networks, RSVP supports tunneling, which occurs automatically through non-RSVP clouds. Tunneling requires RSVP and non-RSVP routers to forward path messages toward the destination address by using a local routing table. When a path message traverses a non-RSVP cloud, the path message copies carry the IP address of the last RSVP-capable router. Reservation-request messages are forwarded to the next upstream RSVP-capable router.

Two arguments have been offered in defense of implementing tunneling in an RSVP environment. First, RSVP will be deployed sporadically rather than universally. Second, by implementing congestion control in situations in which congestion is a known problem, tunneling can be made more effective. Sporadic, or piecemeal, deployment means that some parts of the network will actively implement RSVP before other parts. If RSVP is required end to end, no benefit is achievable without nearly universal deployment, which is unlikely unless early deployment shows substantial benefits.

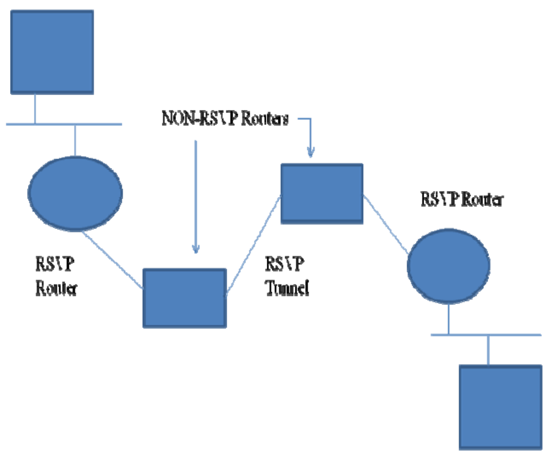

Figure: An RSVP Environment Can Feature a Tunnel Between RSVP-Based Networks

IV.RSVP SIMULATION RESULTS

A multicast session sends a copy of each datagram transmitted by a single sender to multiple destinations.

A single host, however, can contain multiple logical senders and receivers distinguished by port numbers, with each port number corresponding to a different application. Here in simulation we compare the results of ARRP [3] with RSVP in which the time to transmit the packet is reduced

Figure: Data Transmission Using ARRP

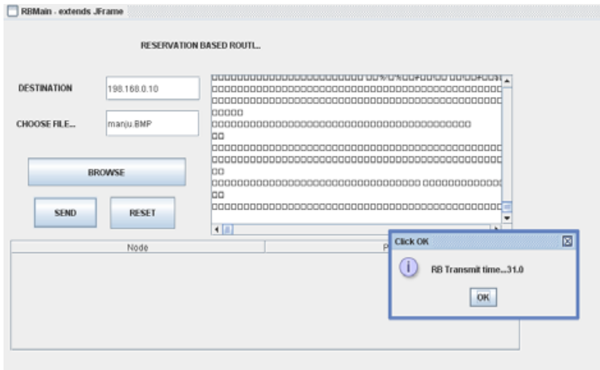

Figure: Data Transmission Using RSVP

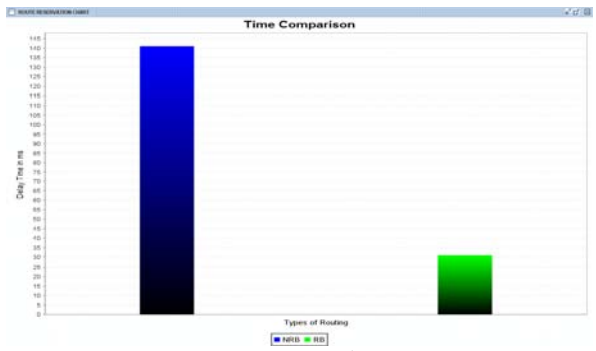

Figure: Time comparison chart for ARRP and RSVP

V. CONCLUSION

RSVP detects the levels of performance required by different applications and modifies network behaviors to accommodate those required levels. We verified the correctness by simulation results.

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