RSVP for QoS provisioning in IntServ

Lecture for QoS in the Internet – course
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RSVP in a nutshell
• In IntServ, applications have to set up a reservation before transmitting traffic
  – RSVP is a signaling protocol for applications to reserve resources by setting up state in hosts and routers
  • but not necessarily only in IntServ
  – RSVP is a state establishment and maintenance protocol

Knowledge gain for this lecture
• After this lecture you will
  – Be able to explain RSVP design goals, actual design, RSVP properties and shortcomings in the design
  – Be able to explain how RSVP functions and what different types of reservations are and how they differ from each other
  – Be able to explain alternative uses for RSVP and RSVP-TE

RSVP design goals
• Heterogeneous receivers
  – Receiver oriented reservation style
• Dynamic membership
  – Data transfer is not controlled by RSVP
• Sharing of resources
  – Reservation styles (WF, FF, SE)
• Adaptation to network dynamics
  – Soft-state approach
• Independence of architectural components
  – Flow specs, admission control, packet classification, scheduling, routing
• Controllable (and modifiable) protocol overhead
  – Refresh period parameter
RSVP design
- Not a routing protocol
  - designed to operate with current and future routing protocols
- Policy independent
  - RSVP is independent of the service architecture
- Soft state
  - times out unless state is refreshed
  - allows for state modification (original and refresh messages identical)
- Transparent operation through Non-RSVP clouds
- Reservations may be shared or not
  - Remember IntServ/RSVP history in multicast sessions

RSVP properties
- End-to-end
  - requests from applications
- Per-flow method of signaling
  - fine-granularity
- Originally intended for IP multicast
  - receiver-oriented setup
  - reservations are one-way only

Method of establishing flow state
- sender first sends a PATH message to the receiver specifying the traffic characteristics (Tspec) and setting up the path (path state)
- receiver then responds with RESV-message to request resources for the flow (Rspec) and sets up flow state.

Soft state
- RSVP sends (by default) PATH and RESV messages periodically
  - If states are not updated regularly they time out.
- PATH refreshes make it possible to adapt to path/(multicast distribution tree) property changes
- RESV refreshes may incorporate changes altered reservations -> adaptive QoS
  - Old reservations die out, no additional state maintenance
RSVP messages
• Sent either as raw IP (protocol 46) or in UDP
• PATH
  – sent downstream along the data path installing path state
• RESV
  – reservation requests sent by the receivers

RSVP message format

PATH-message
• Sent by the source
• Includes flow identification and flow characterization
• Sets up PATH-state in the router
  • Note: RSVP does not restrict a source from transmitting data even without any receiver having made reservation setup

RESV-message
• Sent by the receiver to reserve resources
• Contains the flow characterization and filter specification (reservation type, WF, FF, SE)
• Sets up RESV-state in the router
• Flowspec may include
  – Tspec (both Guaranteed and Controlled-load)
  – Rspec (only in Guaranteed service)
Reservation types

- Three reservation types are defined (and carried in RESV-messages)
  - Wild-card filter
  - Fixed-Filter
  - Shared-explicit

- WF and SE are designed for multicast

<table>
<thead>
<tr>
<th>Sender selection</th>
<th>Reservations</th>
<th>Shared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explicit</td>
<td>Fixed Filter</td>
<td>Shared Explicit</td>
</tr>
<tr>
<td>Wildcard</td>
<td>ND</td>
<td>Wildcard-Filter</td>
</tr>
</tbody>
</table>

Reservation merging

- Reservations may be shared or merged
  - Depending on the reservation type and possible only within same type
  - Router calculates the filterspec and flowspec to be sent to previous hop(s) according to reservation type
  - Reservation messages (RESV) propagate only as far as reservation request meets an existing distribution tree with sufficient resources. (Reservation merged.)

Reservations in action - WF

Reservations in action – FF

Shared reservations with wildcard sender selection. Single reservation for the receiver shared by all flows under all upstream senders.
Adspec – Default general parameters

- General descriptive parameters used to characterize the QoS capabilities of the path of the packet flow (RFC 2215)
- Checked and re-set by every router on the path
  - NUMBER_OF_IS_HOPS
  - Minimum Path Latency
  - Path bandwidth
    - 5 Gbps, 40 Gbps
  - Global break bit
    - the break bit indicating a break in the QoS chain
    - set by the device that is not IntServ compliant or knows such devices to exist in the path
    - cleared when Adspec is created by the sender
  - PathMTU

Adspec – Guaranteed Service fragment

- Ctot, Dtot, Csum and Dsum
- Guaranteed Service break bit
- Guaranteed Service General Parameters
  - overrides the values in default general parameters
Adspec – Controlled load service fragment

- Controlled-load service break bit
- Controlled-load service general parameters
  - overriding those presented in default general parameters

OPWA

- One pass with advertise
  - Sender includes Adspec in the PATH-message
  - with the aid of Ctot and Dtot the receiver is able to determine the path characteristics and form a more accurate RESV-message
  - receiver includes R and S (the slack term) in the RESV-message Rspec
    - Rspec includes also reservation type, filter specification, flow specification with Tspec and Rspec
  - Without Adspec we have OP (One pass) and the RESV-message includes only the Tspec

Slack term

- Indicates the difference between the desired delay and the actual delay obtained with current R (bandwidth reservation)
- Allows the reservations some flexibility
  - balance between queue usage and service rate

Confused?

- PATH(Tspec) describes how the traffic will behave
  - PATH will also establish the route
- The receiver calculates (maybe based on Adspec) what kind of reservations have to be made and puts this reservation request into RESV(Rspec)
  - RESV will make the reservations on the route
Alternative uses of RSVP and future issues

- RSVP-TE
  - RSVP with traffic engineering extensions
- Hierarchical RSVP
  - Reserve large pipes, classify packets to pipes at the edge.
  - Reduction of reservation state, fewer choices for packet scheduling but still looking at the source and destination
- Accounting and billing need to be integrated
- Authentication issues need to be resolved

Using RSVP-TE for label distribution in MPLS

- New functions:
  - Label distribution
  - Explicit routing, rerouting, route tracking
  - Bandwidth/resource reservation
- New objects
  - PATH-message
    - LABEL_REQUEST
    - EXPLICIT_ROUTE
    - RECORD_ROUTE
    - SESSION_ATTRIBUTE
  - RESV-message
    - LABEL
    - RECORD_ROUTE

RSVP-TE in action

- Addition of Label_request-message in RSVP PATH-message
  - Downstream label allocation
- Addition of Label-object to be carried in RSVP RESV-message
  - Labels propagate upstream in the RESV-message
- LSPs are set up with FF-reservation

RSVP summary

- Method for an application to specify desired QoS-level to network hop-by-hop
- RSVP is used to establish/change state in network elements (routers), aka Signaling
- Multicast friendly, receiver-oriented (receiver makes the reservation requests)
- Single direction reservations
- Does not calculate resource requirements (done at the edges).