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

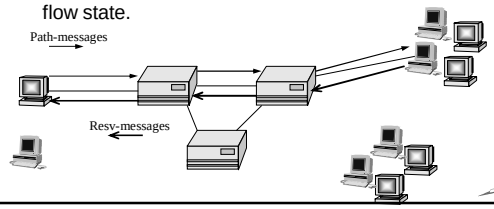
- Not a routing protocol
  - designed to operate with current and future routing protocols
- Policy independent
  - RSVP is independent of the service architecture
- Soft state
  - times out unless state is refreshed
  - allows for state modification (original and refresh messages identical)
- Transparent 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

IP header			
Version	Flags	Message types	RSVP checksum
Send TTL		Reserved	RSVP length
Length		Class-num	C type
Object content (variable length)			

common header

object header

NULL	SESSION
RSVP_HOP	TIME_VALUE
STYLE	FLOWSPEC
FILTER_SPEC	SENDER_TEMPLATE
SENDER_TSPEC	ADSPEC
ERROR_SPEC	POLICY_DATA
INTEGRITY	SCOPE
RESV_CONFIRM	

PATH	RESV
PATHErr	RESVErr
PATHTear	RESVTear
RESVConf	

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

PHOP	Sender Template	Sender TSpec	Adspec

Previous router

Filter Spec (defines uniquely the sending host and flow)

Defines flow characteristics

OPWA-information (optional)

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)

Flowspec	Filter Spec

Defines flow characteristics that will be requested from the routers

Defines flow id (or sender/senders)

Reservation types

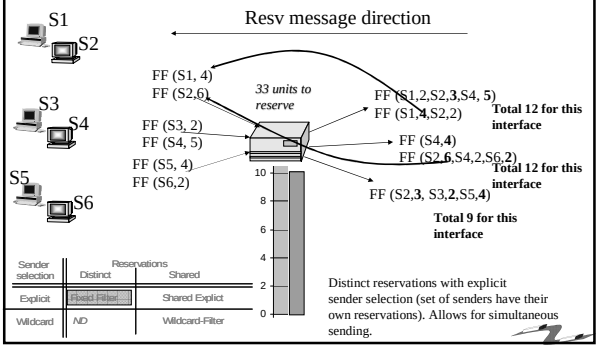
- Three reservation types are defined (and carried in RESV-messages)
  - Wild-card filter
  - Fixed-Filter
  - Shared-explicit
- WF and SE are designed for multicast

Sender selection	Reservations: Distinct	Reservations: Shared
Explicit	Fixed Filter	Shared Explict
Wildcard	*ND*	Wildcard-Filter

Reservation merging

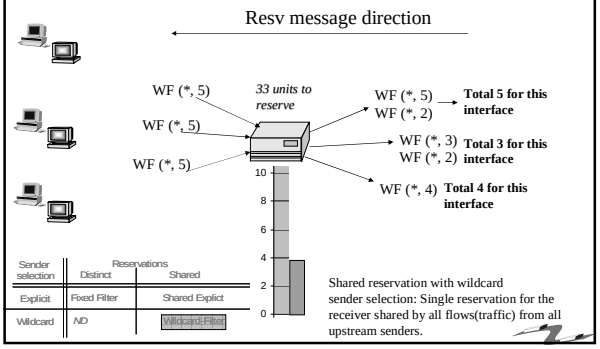
- Reservations may be shared or merged
  - Depending on the reservation type and possible only within same type
  - router calculates the filterspec and flowspec to be sent to previous hop(s) according to reservation type
  - Reservation messages (RESV) propagate only as far as reservation request meets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

Reservations in action - FF



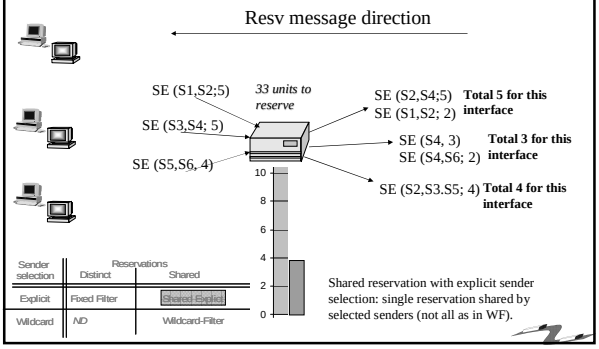
Distinct reservations with explicit sender selection (set of senders have their own reservations). Allows for simultaneous sending.

Reservations in action – WF



Shared reservation with wildcard sender selection: Single reservation for the receiver shared by all flows(traffic) from all upstream senders.

Reservations in action - SE



Shared reservation with explicit sender selection: single reservation shared by selected senders (not all as in WF).

Adspec

- optional object in the PATH-message
- Consists of
  - Default General parameters
  - Guaranteed Service fragment
  - Controlled Load Service fragment
- advertise receivers the characteristics of the end-to-end **path**

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
    - IntServ Hop Count
  - Minimum Path Latency
    - speed-of-light + packet processing limitations
  - Path bandwidth
    - 1 byte/s ... 40 Terabytes/s
  - 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

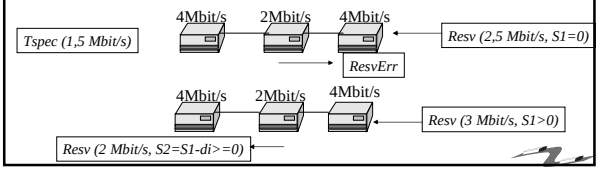
- Controlled-load service break bit
- Controlled-load service general parameters
  - overriding those presented in default general parameters

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).