RSVP and other methods of QoS provisioning

Lecture for QoS in the Internet –course S-38.180

9.10.2003 Mika Ilvesmäki

Purpose

- 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 properties

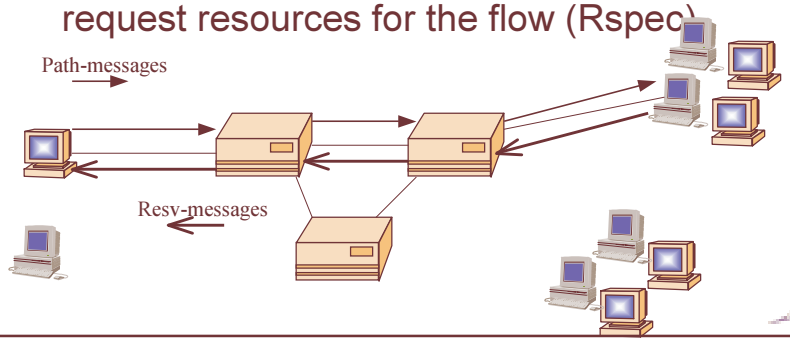
- End-to-end
  - requests from applications
- Per-flow method of signaling
  - fine-granularity
- Originally intended for IP multicast
  - receiver-oriented setup
  - reservations are one-way only

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

Method of establishing flow state

- sender sends a PATH –message to the receiver specifying the traffic characteristics (Tspec) and setting up the path
- receiver responds with RESV-message to request resources for the flow (Rspec)



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

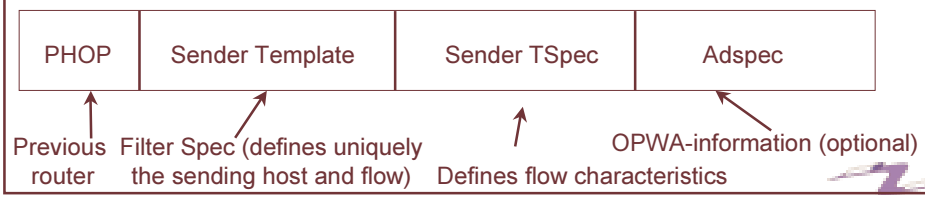
object header

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	

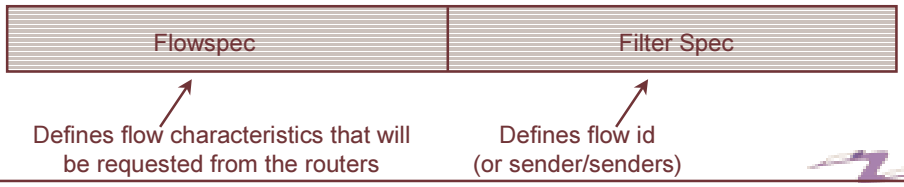
PATH-message

- Sent by the source
- Includes flow identification and flow characterization
- Sets up PATH-state in the router



RESV-message

- Sent by the receiver to reserve resources
- Contains the flow characterization and filter specification
- Sets up RESV-state in the router
- Flowspec may include
  - Tspec (both Guaranteed and Controlled-load)
  - Rspec (only in Guaranteed service)



Reservation types

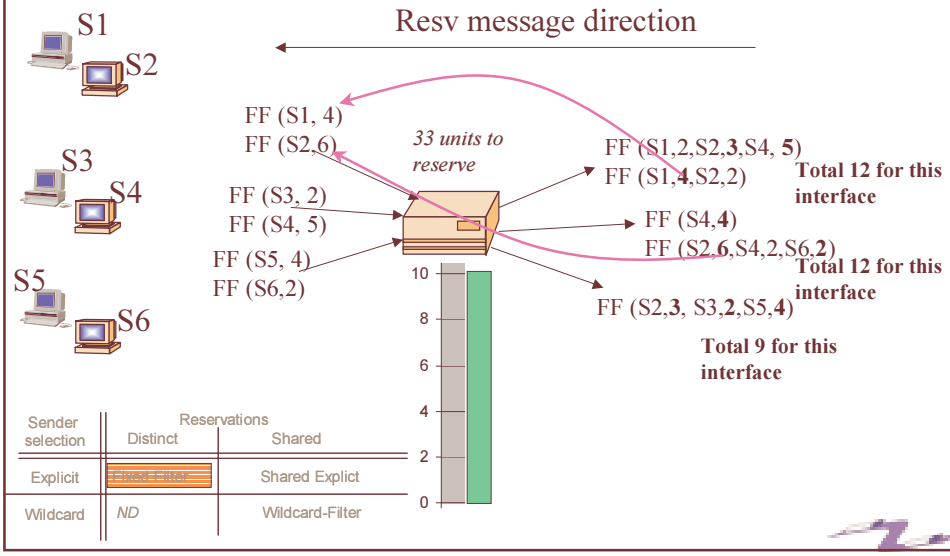
- Three reservation types are defined
  - Wild-card filter
  - Fixed-Filter
  - Shared-explicit
- WF and SE are designed for multicast

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

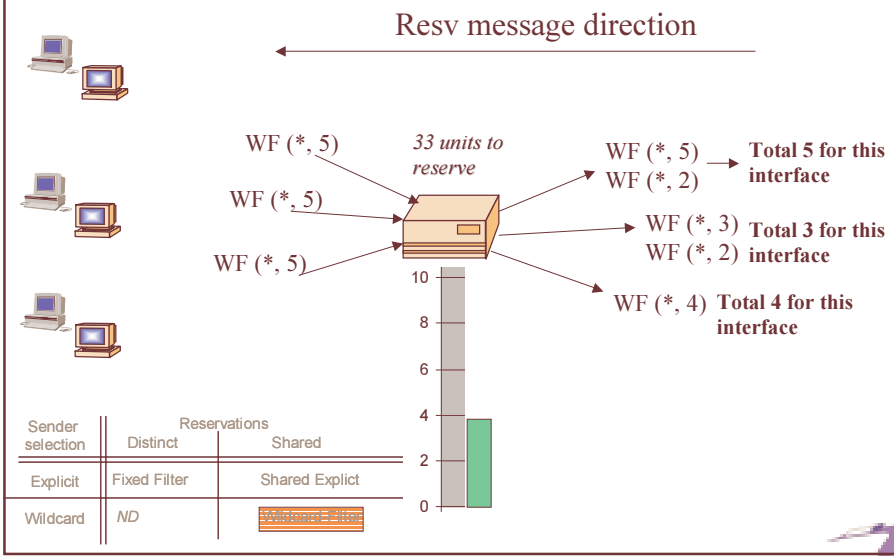
Reservation merging

- 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

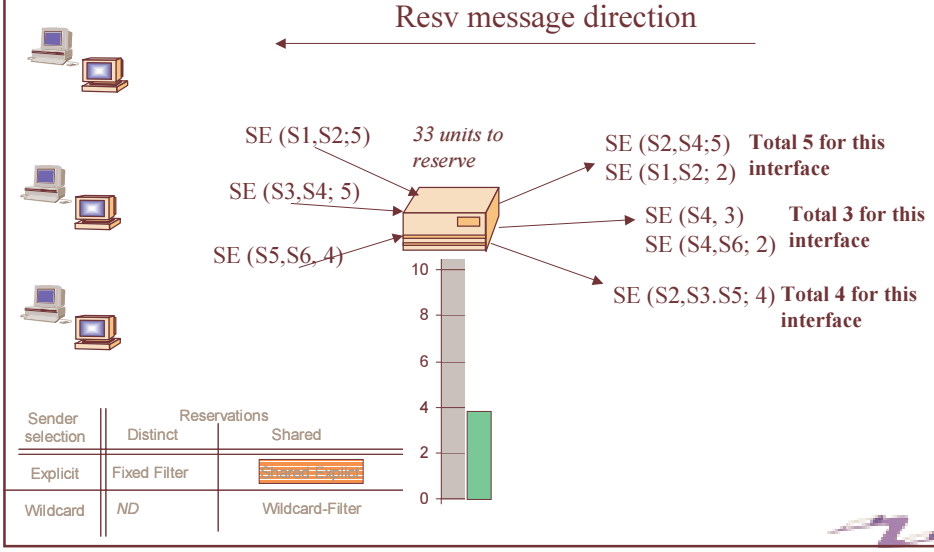
Reservations in action - FF



Reservations in action – WF



Reservations in action - SE



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**

HELSINKI UNIVERSITY OF TECHNOLOGY Mika Ilvesmäki, Lic.Sc. (Tech.)

Adspec – Default general parameters

- Minimum Path Latency
- Path bandwidth
- Global break bit
  - cleared when Adspec is created by the sender
- IntServ Hop Count
- 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

HELSINKI UNIVERSITY OF TECHNOLOGY Mika Ilvesmäki, Lic.Sc. (Tech.)

Adspec – Controlled load service fragment

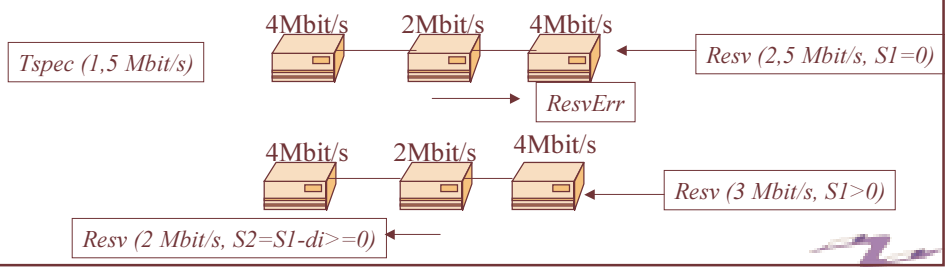
- Controlled-load service break bit
- Controlled-load service general parameters
  - overriding those presented in default general parameters

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

HELSINKI UNIVERSITY OF TECHNOLOGY Mika Ilvesmäki, Lic.Sc. (Tech.)

RSVP problems

- Implementation
  - RSVP is somewhat vague in its definitions and therefore difficult to implement consistently
    - RSVP API found in latest MS Windows APIs
    - compatibility between operating systems
  - For IntServ to function every node on the path must implement the IntServ functionality
    - especially true for the Guaranteed service

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

Domain wide QoS

- a.k.a Constraint based routing (CR) or QoS routing (QoSR)
- Calculate the route so that multiple constraints are met and that the route is optimal for every constraint
  - Constraints: delay, bandwidth, etc. and/or administrative
- Problems: route oscillation, path capacity
- Could be used together with a signalling protocol (RSVP or CR-LDP) that has knowledge on the constraint values

CR-LDP

- LDP (label distribution protocol) is defined for distribution of labels in MPLS-networks.
  - Constraint-based Routing LDP (CR-LDP) uses information not available for routing protocols when setting up the paths.
    - Explicitly routed LSPs
- CR-LDP is simple, scalable (TLV), open and non-proprietary signalling protocol

CR-LDP and QoS

- Strict and loose explicit routing
  - Route pinning
- Specification of traffic parameters (peak rate, delay variation…)
- Use of resource classes (instead of traffic parameters)
- LSP pre-emption
  - Set-up priority better than holding priority may preempt an existing LSP

Comparing RSVP_TE and CR-LDP

- Both can be used to establish LSPs
- CR-LDP works over TCP, RSVP works over IP (or UDP)
- Direction of resource reservations is different

Property	CR-LDP	RSVP_TE
Transport mechanism	Transport on TCP (reliable)	Raw IP packets (unreliable)
State management	Hard state	Soft state; needs per-flow refresh management
Msgs required for LSP set-up and maintenance	Request, mapping	Path, Resv, Resv_Conf
Base architecture	Based on LDP for MPLS	Based on RSVP, may require major changes
Signalling of QoS and traffic parameters	Can signal DiffServ and ATM traffic classes	Extendable, currently based on IntServ
Types of LSPs	Strict, loose, and loose pinned	Strict and loose, no pinning
Models of label distribution and LSP set-up	All modes	Only downstream on demand
Failure notification	Reliable procedure	Unreliable procedure
Loop detection/prevention	Employs path vector TLV to prevent Label Request –loops. Hop Count TLV used to find looping LSPs	May be done using Record_Route -object