HELSINKI UNIVERSITY OF TECHNOLOGY

Integrated Services in the Internet – part II: How it works, or RSVP for QoS provisioning

Lecture for QoS in the Internet –course

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Networking laboratory

Knowledge requirements

- Understand the concept of scalabillity.
- Understand the concepts of, and difference between signaling and routing.
- Understand what a protocol is and for what it is meant.
- Understand that a protocol may function outside of the scope it was originally intended for, doing stuff it was not originally designed to do.

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 in a nutshell

- In IntServ, applications have to set up a reservation state in IntServ routers 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 (and a signaling protocol of sorts).

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

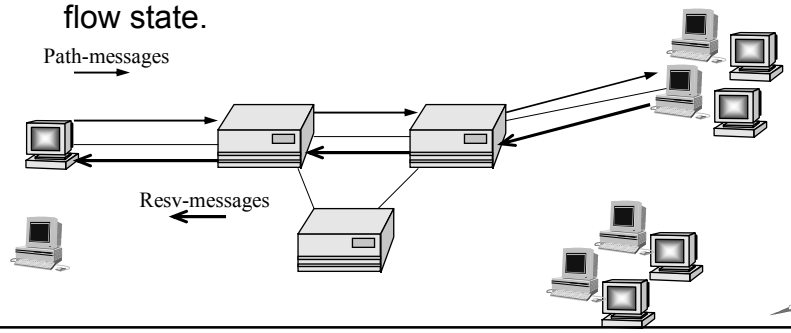
- Not a routing protocol
  - designed to operate with current and future routing protocols
- Policy independent
  - RSVP is independent of the service architecture
- Soft state
  - times out unless state is refreshed
  - allows for state modification (original and refresh messages identical)
- Transparent operation through Non-RSVP clouds
- Reservations may be shared or not
  - Remember IntServ/RSVP history in multicast sessions

RSVP properties

- End-to-end
  - Traffic specs and resource requests from end host applications
- Per-flow method of signaling
  - fine-granularity state set-up in the routers
- 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.



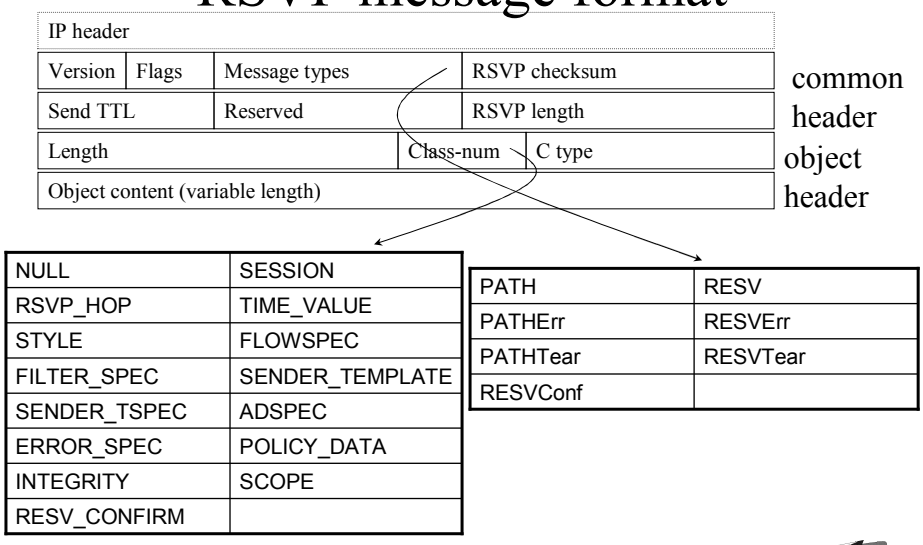
Soft state

- 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 as raw IP (protocol 46)
  - specified to function also with UDP
- PATH
  - sent downstream along the data path installing path state
- RESV
  - reservation requests sent by the receivers

RSVP message format

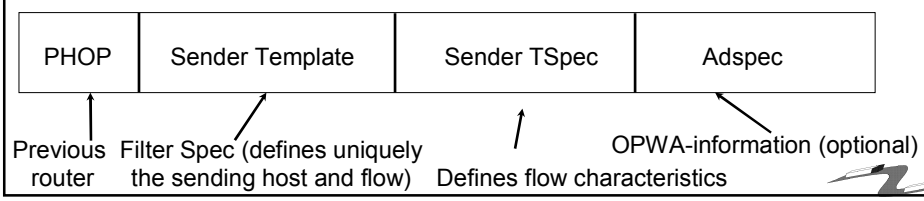


NULL	SESSION
RSVP_HOP	TIME_VALUE
STYLE	FLOWSPEC
FILTER_SPEC	SENDER_TEMPLATE
SENDER_TSPEC	ADSPEC
ERROR_SPEC	POLICY_DATA
INTEGRITY	SCOPE
RESV_CONFIRM	

PATH	RESV
PATHErr	RESVErr
PATHTear	RESVTear
RESVConf	

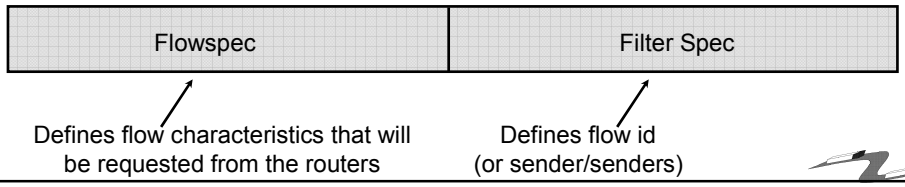
PATH-message

- 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



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

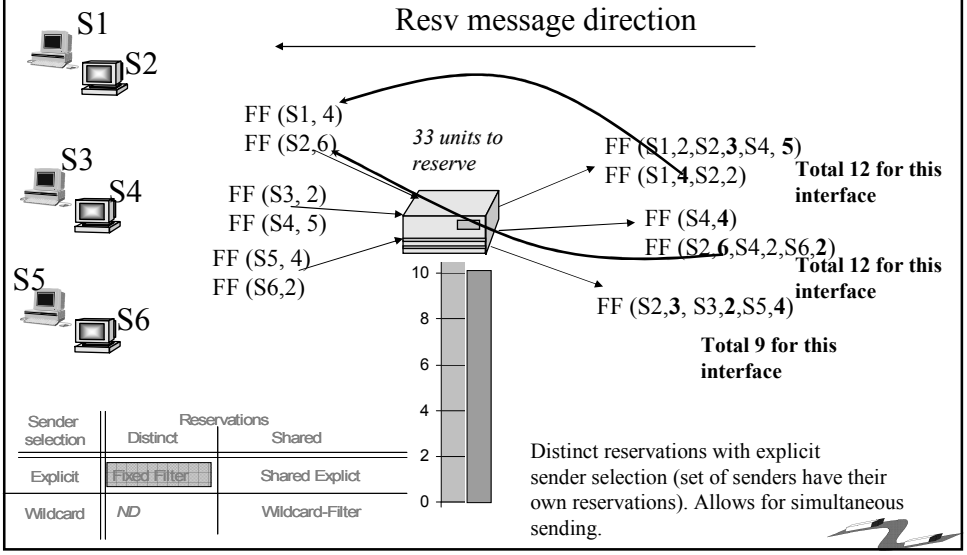
- Three reservation types are defined (and carried in RESV-messages)
  - Wild-card filter
  - Fixed-Filter
  - Shared-explicit
- WF and SE are designed for multicast

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

Reservation merging

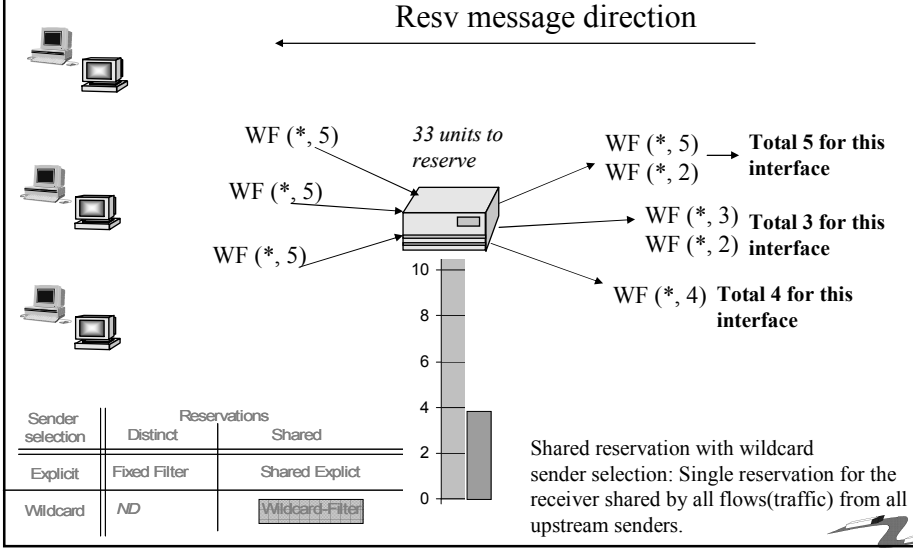
- Reservations may be shared or merged
  - Depending on the reservation type and possible only within same type
  - router calculates the filterspec and flowspec to be sent to previous hop(s) according to reservation type
  - Reservation messages (RESV) propagate only as far as reservation request meets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

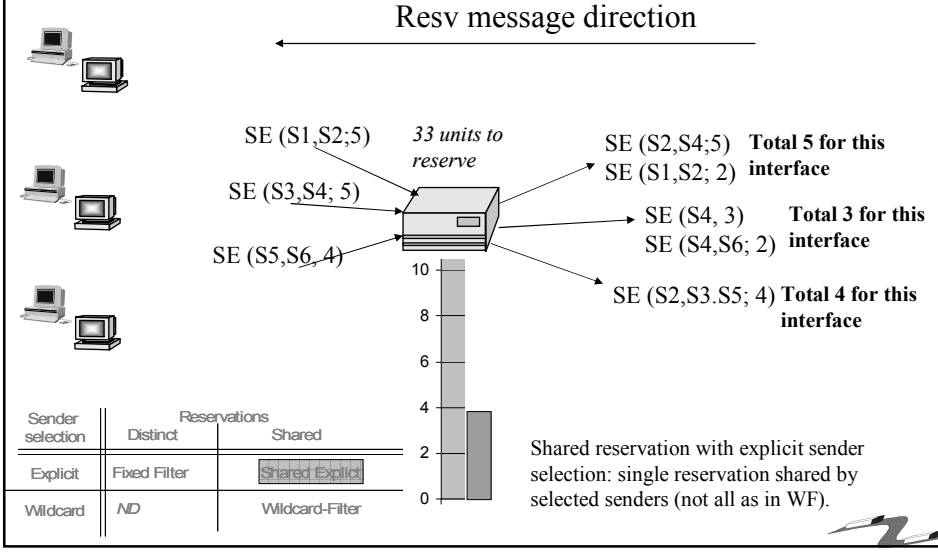
Reservations in action – WF



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

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

Reservations in action - SE



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

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

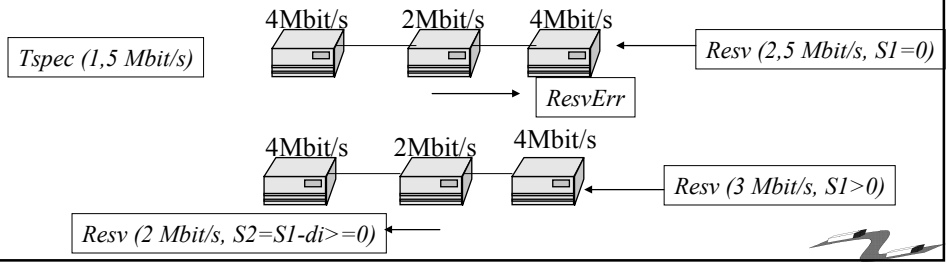
- Controlled-load service break bit
- Controlled-load service general parameters
  - overriding those presented in default general parameters

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

- Label identifies (explicitly) a route, not just the destination (and is independent of the source and the destination).
- 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).