Overview

• Integrated Services in the Internet (IntServ):
  – motivation
  – service classes
• Resource Reservation Protocol (RSVP):
  – description of the RSVP standard
  – functionality
  – limitations
• (+ admission and policy control after DiffServ presentation)

IntServ Fundamentals

• Fulfill the needs of the Internet applications that need QoS guarantees
  – (often multicast, real-time applications in mind)
• Service classes:
  – guaranteed service – throughput and delay guarantees (needs admission control, policing, reshaping and scheduling)
  – controlled-load service – throughput guarantees (needs admission control and policy control)
  – best-effort (trivial)
Leaky Bucket

- Reshaping a data stream based on traffic properties

Bursty traffic

The bucket can be overflowed (data loss)

Shaped traffic

The bucket Buffered data

Token Bucket

- Obtaining a “token” is a prerequisite to forward a packet
- the tokens are generated according to the flow description

Bursty traffic

Token bank

Under stable conditions, tokens and data flow would match
- token bucket is needed for detailed flow description

Token generator

IntServ Architecture

RSVP process

Host

RSVP process

Router

Application

Policy control

Routing process

Admission control

RSVP

Packet scheduler

Classifier

RSVP

Packet scheduler

Classifier

RSVP
IntServ & RSVP

• RSVP is an IntServ implementation
• Tight relationship: other implementations possible but nonexistent

Main RSVP attributes

• Used to request a specific QoS from the network
• simplex (unidirectional) connections
• routing performed by an underlying protocol (IP), no other assumptions
• receiver initiated reservation
• soft state
• designed with multicast group communication in mind

Resource reservation process

• Data source sends periodic PATH messages to the receiver(s)
• receiver initiated reservation: receivers choose the level of resources reserved and send RECV messages to the source
• soft state is created and maintained using these messages
PATH message

- A PATH message contains:
  - address of the last RSVP-capable node
  - sender template: sender address and port or flow label
  - “Tspec”, the traffic specification. For example, the guaranteed service could contain mean throughput, maximal burst size and per-hop delay

RECV message

- A RECV message includes:
  - reservation style (FF, SE or WF)
  - filter specification
  - flow specification, including the sender’s Tspec and the reservation specification Rspec
- reservation styles:
  - wildcard filter (“No-filter”): WF*(Q)
  - fixed filter: FF(S(Q))
  - shared explicit (“Dynamic-filter”): SE(S1, S2, …Sn) (Q))

Why different reservation styles?

- Merging of flows in multicast:
  - wildcard filter: all senders
  - fixed filter: single sender
  - shared explicit: chosen senders
- tradeoff between the state amount and functionality
Soft state

- Path and reservation state is maintained by routers
- The state is refreshed by periodic messages
- The state is cleared if the messages are absent for $K \cdot (message \ period)$; $K$ is typically 3.5
- Members join/leave, routes may change
- Message merging

Topology change
Scalability

+ Several novel design principals (receiver initiated reservation, different reservation styles)
+ Message aggregation in multicast
  - Size of memory needed to maintain the RSVP state in steady state is linearly proportional to the number of flows
  - Control traffic in steady state is proportional to the number of flows
  - Overload of classifier
  - Scheduler
  - RSVP signaling daemon (soft state?)

Scalability examples

- $m$ small groups using wildcard-filter reservation style:
  - $m \cdot \text{MSG}_\text{LEN}$ per refresh period
- $m$ larger groups, $n$ members on average, using dynamic-filters:
  - $m \cdot n \cdot \text{MSG}_\text{LEN}$ per refresh period
  - Much more state processing in routers, but less real time traffic compared to the first case
RSVP and IPv6

- RSVP can use both IPv4 and IPv6
- careful implementation of RSVP and packet scheduler processes on a router should have better performance using IPv6 than IPv4.
- flow label field may be used to mark data streams with guaranteed QoS?

Implementation and deployment status

- Router implementation on CISCO IOS 11.2 and above, many alpha & beta test versions
- host implementations: many test versions and prototypes
- QoS support for VoIP
- local area network deployment, no WAN