

Limitations of IP

- IP provides only best effort service
- IP does not participate in resource management
 - Cannot provide service guarantees on a per flow basis Cannot provide service guarantees on a per flow ba
 Cannot provide service differentiation among traffic aggregates

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- Early efforts
 - Tenet group at Berkeley
 ATM
- IETF efforts
 - Integrated services initiative
 - Differentiated services initiative

So, what is required?

- Flow differentiation
- Simple FIFO scheduling will not work!
- Admission control
- Resource reservation
- Flow specification

Integrated Services Internet

Enhance IP's service model

- Old model: single best-effort service class
 New model: multiple service classes, including best-effort and QoS classes
- Create protocols and algorithms to support new
- service models
- Old model: no resource management at IP level
- New model: explicit resource management at IP level
- Key architecture difference
 - Old model: stateless
 - New model: per flow state maintained at routers

- used for admission control and scheduling
- set up by signaling protocol



















Service Classes

- Service can be viewed as a contract between network and communication client
 - end-to-end service
 - other service scopes possible
- Three common services
 - best-effort ("elastic" applications)
 - hard real-time ("real-time" applications)
 - soft real-time ("tolerant" applications)

Hard Real Time: Guaranteed Services

- Service contract
- network to client: guarantee a deterministic upper bound on delay for each packet in a session
- client to network: the session does not send more than it specifies
- Algorithm support

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- admission control based on worst-case analysis
- per flow classification/scheduling at routers

Soft Real Time: Controlled Load Service

Service contract:

- network to client: similar performance as an unloaded best-effort network
- client to network: the session does not send more than
- it specifies

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- Algorithm Support
 - admission control based on measurement of aggregates
 - scheduling for aggregate possible

Role of RSVP in the Architecture

- Signaling protocol for establishing per flow state
- Carry resource requests from hosts to routers
- Collect needed information from routers to hosts
- At each hop
 - consults admission control and policy module
 - sets up admission state or informs the requester of the failure

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RSVP Design Features

- IP Multicast centric design
 Why multicast and not unicast?
- Receiver initiated reservation
- Different reservation styles
- Soft state inside network
- Why soft state?
- Decouple routing from reservation

IP Multicast

- Best-effort MxN delivery of IP datagrams
- Basic abstraction: IP multicast group
 - identified by Class D address: 224.0.0.0 239.255.255.255
 sender needs only to know the group address, but not the membership
 - receiver joins/leaves group dynamically
- Routing and group membership managed distributedly
 - no single node knows the membership
 - tough problem
 - various solutions: DVMRP, CBT, PIM



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RSVP Basic Operations

- Sender sends PATH message via the data delivery path
- set up the path state each router including the address of previous hop
- Receiver sends RESV message on the reverse path
 - specifies the reservation style, QoS desired
 - set up the reservation state at each router
- Things to notice
 - receiver initiated reservation
 - decouple the routing from reservation
 - two types of state: path and reservation













Reservation Styles and Filter Spec

- Reservation style
 - use filter to specify which sender can use the
- reservation
- Three styles
 - wildcard filter: does not specify any sender; all packets associated to a destination shares same resources
 - Group in which there are a small number of simultaneously active senders
 - fixed filter: no sharing among senders, sender explicitly identified for the reservation

- Sources cannot be modified over time
 dynamic filter: resource shared by senders that are
 (explicitly) specified
 - Sources can be modified over time





















Recap of RSVP

- PATH message
 - sender template and traffic spec
 - advertisement
 - mark route for RESV message
 - follow data path
- RESV message
 - reservation request, including flow and filter spec

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- reservation style and merging rules
- follow reverse data path
- Other messages
 - PathTear, ResvTear, PathErr, ResvErr

What is still Missing?

- Classification algorithm
- Scheduling algorithm
- Admission control algorithm
- QoS Routing algorithm

Why did IntServ fail?

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Economic factors

- Deployment cost vs Benefit
- Is reservation, the right approach?
 Multicast centric view
- Is per-flow state maintenance an issue?
- What about QoS in general?