Multicast Issues

- Reliable multicast
- Multicast congestion control
- Assigned reading
  - [F+97] A Reliable Multicast Framework for Light-Weight Sessions and Application Level Framing

Overview

- Scalable Reliable Multicast
- Congestion Control

SRM

- Originally designed for \( wb \)
- Receiver-reliable
  - NACK-based
- Every member may multicast NACK or retransmission
SRM Request Suppression
Packet 1 is lost; R1 requests resend to Source and Receivers
Packet 1 is resent; R2 and R3 no longer have to request a resend

SRM Star Topology
Packet 1 is lost; All Receivers request resends
Packet 1 is resent to all Receivers

Deterministic Suppression
Delay = $C_1 \times d_{S,R}$

SRM: Stochastic Suppression
Delay = $U[0, D_2] \times d_{S,R}$
SRM (Summary)

- NACK/Retransmission suppression
  - Delay before sending
  - Delay based on RTT estimation
  - Deterministic + Stochastic components
- Periodic session messages
  - Full reliability
  - Estimation of distance matrix among members

What's Missing?

- Losses at link (A,C) causes retransmission to the whole group
- Only retransmit to those members who lost the packet
  - [Only request from the nearest responder]

Local Recovery

- Different techniques in various systems
- Application-level hierarchy
  - Fixed v.s. dynamic
  - TTL scoped multicast
  - Router supported

Overview

- Scalable Reliable Multicast
- Congestion Control
Multicast Congestion Control
• What if receivers have very different bandwidths?
  • Send at max?
  • Send at min?
  • Send at avg?

Video Adaptation: RLM
• Receiver-driven Layered Multicast
• Layered video encoding
• Each layer uses its own mcast group
• On spare capacity, receivers add a layer
• On congestion, receivers drop a layer
• Join experiments used for shared learning

Layered Media Streams
R1 joins layer 1, joins layer 2, joins layer 3
R2 join layer 1, join layer 2, fails at layer 3
R3 joins layer 1, fails at layer 2

Drop Policies for Layered Multicast
• Priority
  • Packets for low bandwidth layers are kept, drop queued packets for higher layers
  • Requires router support
• Uniform (e.g., drop tail, RED)
  • Packets arriving at congested router are dropped regardless of their layer
• Which is better?
  • Intuition vs. reality!
RLM Intuition

- Uniform
  - Better incentives to well-behaved users
  - If oversend, performance rapidly degrades
  - Clearer congestion signal
  - Allows shared learning
- Priority
  - Can waste upstream resources
  - Hard to deploy
  - RLM approaches optimal operating point
  - Uniform is already deployed
  - Assume no special router support

RLM Join Experiment

- Receivers periodically try subscribing to higher layer
  - If enough capacity, no congestion, no drops
    ⇒ Keep layer (& try next layer)
  - If not enough capacity, congestion, drops
    ⇒ Drop layer (& increase time to next retry)
- What about impact on other receivers?

Join Experiments
RLM Scalability?

- What happens with more receivers?
- Increased frequency of experiments?
  - More likely to conflict (false signals)
  - Network spends more time congested
- Reduce # of experiments per host?
  - Takes longer to converge
- Receivers coordinate to improve behavior

Next Lecture: Security

- Denial of service
- IPSec
- Firewalls
- Assigned reading
  - [SWKA00] Practical Network Support for IP Traceback
  - [B89] Security Problems in the TCP/IP Protocol Suite