Reliable and Application Layer Multicast

Wang Lin
Agenda

- Reliable Multicast
  - introduction
  - categories

- Application Layer Multicast
  - introduction
  - how to build

- Conclusion
Introduction to Reliable Multicast

- Reliable multicast protocol on top of IP multicast
- The reliable is guaranteed by acknowledgements and segments retransmission analogous to TCP
- Solve the problems that the best effort multicast can not overcome, such as multipoint software distribution and multiplayer internet games.

Problems:
- feedback imposition
  - the feedback from the receivers flood the source and the network, make them overloaded
- "crying baby"
  - the high packet loss of few receivers may result in the whole multicast session slow down
Categories

- SCE
- Nak-based loss reporting
- Distributed loss recovery
- Router-assisted loss recovery
- FEC-based recovery
SCE

- Single-connection emulation
- The source sends packets by IP multicast and the receivers send ACKs by IP unicast
- The repairs are sent out only by the resource
- ACK-based and centralized reliable multicast
- Not scale well, only work well within small group
- ACK implosion and crying baby
NAK-Based Recovery

- Negative acknowledgement based recovery
- Opposed to ACK-based loss reporting
- The receivers detect the loss and send the negative acknowledgement back to request retransmission
- Less traffic, better than ACK-based
- Problem: NAK implosion
Distributed Loss Recovery (1)

- Opposed to centralized global loss recovery
- Multiple retransmitters repair the loss of the nearby group members
- Speeds up the loss recovery process and avoids source overloaded
Distributed Loss Recovery (2)

- Two techniques:
  - global recovery with duplicate avoidance (no explicitly retransmitter)
    - any receiver may retransmit the repair
    - RTT (round trip time) to avoid duplicate retransmission and prevent feedback implosion
  - tree based local recovery (explicitly retransmitter defined)
    - only DRs (designated receivers) retransmit the repair
    - three recover ways:
      1. multicast: with duplicate avoidance multicast NAKs and multicast repairs
      2. cascaded: unicast unicast NAKs and unicast repairs
      3. hybrid: unicast NAKs and multicast repairs
Router-Assisted Loss Recovery

- Adds router support for fast and efficient loss recovery
- Maintains session state and transport-layer functionality in the network layer
- LMS (light-weight multicast)
  - each router selects a replier
  - the router steers all the requests to the replier
  - the replier multicasts repairs to loss nodes
- PGM (pragmaic general multicast)
  - the NAKs are forwarded and confirmed hop by hop
  - the router makes sure the retransmission is sent to the network that needs it
- AIM (addressable internet multicast)
  - label all the branch points uniquely
  - packets could be delivered to any subtree
FEC-Based Recovery

- Forward error correction-based recovery
- Encode method for error correction
- Little or no feedback
- No feedback implosion and crying baby problem
- Combine with general purpose RM recovery techniques to reduce repair traffic, but increase latency
Introduction to Application Layer Multicast

- Add overlay network to the current IP network
- The processes of the intelligent node receives one packet and forwards it to multiple receivers are both via reliable TCP unicast
Introduction to Application Layer Multicast (1)

- IP multicast

- Application layer multicast

![Diagram showing IP multicast and Application layer multicast]
Introduction to Application Layer Multicast (2)

- **Effective transport**
  - built on top of unicast
  - one to many problem changed into one to one problem, effectively solved by TCP

- **Easy deployment**
  - not all the network support IP multicast, but all support IP unicast
  - application layer multicast is bundled with application
  - the router does not need to keep the routing state

- **Asynchronous delivery**
  - overlay node can store the file and deliver to the receivers when they are ready
  - on-demand video

- **Application layer routing**
  - end-to-end application metrics

- **Versatility**
  - content adaption from sender to receiver
How To Build?

- Overlay setup
  - mesh implementation
    - the overlay talks to the nodes that have virtual links with it
  - non-mesh implementation
    - the overlay talks to any other overlays
- Tree organization
  - distribution tree
  - Ongoing maintenance
- Content distribution
- End-user subscription
Conclusion (1)

**Reliable multicast**
- Based on IP multicast
- Limited multicast address (class D)
- Need routers to maintain group state
- Difficult to solve congestion control, reliability and heterogeneities problems
- Used in network based game and data conference
- More efficient, less bandwidth consumption for large number of receivers
- Most of the reliable multicast protocols are in research progress
- Commercial usage in the future.
Conclusion (2)

Application layer multicast
- Based on unicast
- Infinite multicast address
- Do not need routers support
- Solve the problems in multicast by the unicast solutions
- Used in network that does not support IP multicast, on demand video
- Less efficient for, high deliver latency, high deploy cost for large scale group
- Has not been widely adopted yet
- Get a scalable overlay network by applying ad-hoc multicast protocol in the future
Reference

- Sudhir Dixit, Tao Wu. Content Networking In The Mobile Internet, pp.93-117
- C.Kenneth Miller, StatBurst Communications. Reliable Multicast Protocols and Applications. 
- RFC 2357-IETF Criteria for Evaluating Reliable Multicast Transport and Application Protocol
- Jun-Hong Cui, Li Lao, Orange Dialameh. A Viable Solution for Large Scale Multicast Support. 
- Kim Ho Dong, Shin Hyun Moon. Considerations on applying ad-hoc multicast protocol to overlay multicast. 
Thank You!