CS551
Reliable Multicast
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http://merlot.usc.edu/cs551-f12
Sender Reliable Error Detection

Wait for ACKs from all receivers, re-send on timeout or selective ACK

- (+) easy resource management
- (-) wait for ACK
- (-) receiver state in sender, not scalable
- (-) ACK implosion
Receiver Reliable Error Detection

- Receivers NACKs lost packets
  - (+) no state at sender - good for multicast
  - (-) does not provide 100% reliability
  - (-) NACK implosion
Implosion
Implosion (Cont...)
Implosion (Cont...)

Diagram of a network with nodes labeled as 'Src' and connections between them.
Implosion (Cont...)
Implosion (Cont...)
Implosion (Cont...)
Implosion (Cont...)
Implosion (Cont...)

```
Src
```

```
-reaching nodes
```

```
-connected nodes
```

```
-thresholds
```
Implosion (Cont...)
Implosion (Cont...)
Implosion (Cont...)
Implosion (Cont...)

![Diagram of network with labeled nodes and arrows indicating data flow.](image-url)
Implosion (Cont...)

Diagram with a source node (Src) and multiple nodes connected in a hierarchical structure.
Implosion (Cont...)
Retransmission

- Re-transmitter
  - sender
  - receiver

- How to retransmit?
  - unicast, multicast, scoped multicast, retransmission group, etc.

- Problem with sender retransmissions
  - exposure
Exposure
Exposure (Cont...)
Exposure (Cont...)

[Diagram of network with nodes and connections]
Exposure (Cont...)

Src
Exposure (Cont...)

![Diagram of network communication with labels and connections]
Exposure (Cont...)

```
Src
```

Diagram:
- Green circles represent nodes or locations.
- Blue triangles indicate connections or paths.
- The diagram shows a hierarchical structure with one central node (Src) connected to multiple other nodes.
Exposure (Cont...)
Exposure (Cont...)

Diagram:

- `Src`
- Connections and symbols indicating data flow or network structure.
Exposure (Cont...)
Exposure (Cont...)
Exposure (Cont...)

[Diagram of a network with nodes labeled 'Src' and other nodes connected in a tree-like structure]
Exposure (Cont...)

Diagram of network with labeled nodes and connections.
Exposure (Cont...)

Diagram showing nodes and connections.
Exposure (Cont...)
Exposure (Cont...)
Exposure (Cont...)

Src

Diagram of communication network with nodes and connections.
Aside - Using the Routers

- Routers do transport level processing
  - buffer packets
  - fuse ACKs
  - send retransmissions
  - this solves implosion and exposure problems, but:
    - not scalable
    - violate end-to-end argument
CS551
Scalable Reliable Multicast
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SRM (Scalable Reliable Multicast)

- Originally designed for \textit{wb}
- Receiver reliable
  - NACK-based
- Every member may multicast NACK or retransmission
- No assistance from routers
SRM Retransmission

- All transmissions go to everyone
- Receivers notice losses
  - how?
    - if there is a missing sequence number from subsequence data
    - use session messages to deal with loss of last packet
- Losses result in repair requests (to everyone)
- Repair requests produce repairs (to everyone)
- Requests and repairs are spaced and avoided
  - via randomization and suppression
SRM Request Suppression
SRM Request Suppression (Cont...)
SRM Request Suppression (Cont...)

![Diagram showing SRM Request Suppression](image)
SRM Request Suppression (Cont...)
When noticing skipped sequence number:
- start a timer whose timeout is proportional to distance from Src
SRM Request Suppression (Cont...)

When noticing skipped sequence number:
- start a timer whose timeout is proportional to distance from Src
When noticing skipped sequence number:
- start a timer whose timeout is proportional to distance from Src
SRM Request Suppression (Cont...)

```
Src
```

Diagram showing a network with nodes and connections.
SRM Request Suppression (Cont...)

[Diagram of SRM Request Suppression]
SRM Request Suppression (Cont...)

Diagram showing network topology with labels and symbols indicating suppression mechanisms.
SRM Request Suppression (Cont...)

![Diagram showing SRM Request Suppression]
SRM Summary

- NACK/Retransmission suppression
  - delay before sending
  - delay based on RTT estimation
  - deterministic and stochastic components

- Periodic session messages
  - discover lost final packets
  - used to estimate OTT from sender to receivers

- Adaptive algorithm to adjust constants
What’s Missing?

- Losses at link (A,C) causes retransmission to the whole group
- Better: only retransmit to those members who lost the packet
  - local recovery
    - router support
  - A to C
  - where have we seen this before?
    - SNOOP