Staged Refresh Timers for RSVP

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Background

- RSVP uses *soft state:*
  - reservations will disappear by themselves if not being refreshed;
  - advantage 1: avoid orphan reservations
  - advantage 2: quick adaptation to route changes
  - explicit tear-down messages to speed up the removal of reservations

… Background

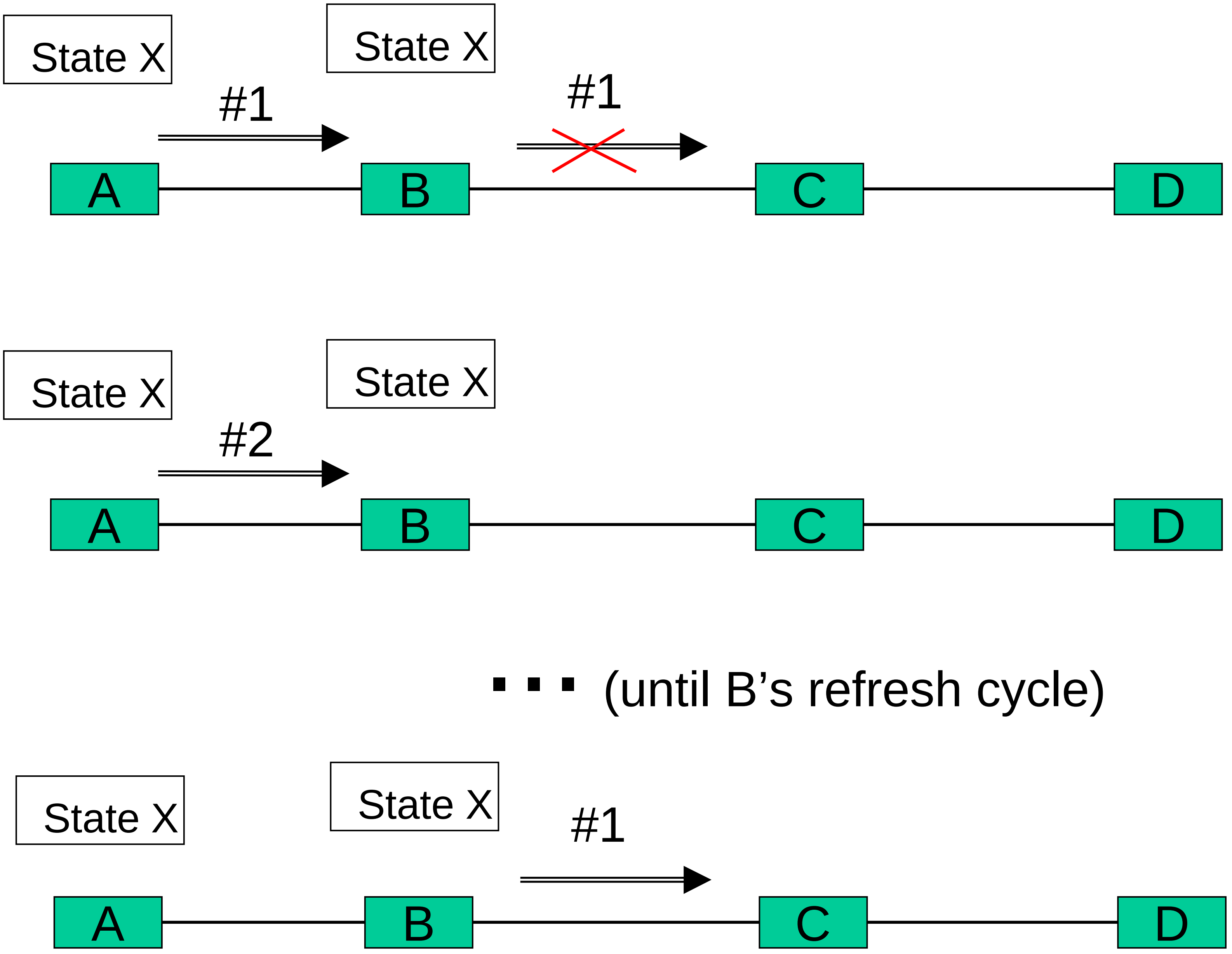
- Unreliable RSVP control message delivery:
  - periodic refresh between hops;
  - cleanup timer: a state is deleted if no refresh messages arrive before the expiration of a cleanup timer interval.

Motivation

- Packet loss problem in the Mbone:
  - 1-2% on average;
  - 20% or more occasionally.
- **If** the *first* RSVP message is lost due to congestion:
  - no PATH or RESV re-transmitting until the next refresh cycle (30 seconds by default).
  - no retransmission for tear-down messages; the default timeout is 90 seconds.

… Motivation

- Why not increase the refresh rate?
- A problem with hop-by-hop refresh:
  - do not propagate unchanged refresh messages.
  - for example ...



▪ ▪ ▪ (until B’s refresh cycle)

… Motivation

- Why do we need reliable and fast RSVP message delivery?
  - End system multimedia application requirement: the first few seconds may be critical.
  - Service policy requirement: The delay of RSVP delivery may cause billing and accounting problems.

Terminology

- Sending and Receiving nodes
- Trigger and Refresh Messages:
  - trigger messages: generated due to state changes. Need to be delivered immediately after state changes are detected.
  - refresh messages: replicated messages to maintain states. Could be sent very infrequently.

Operation Overview

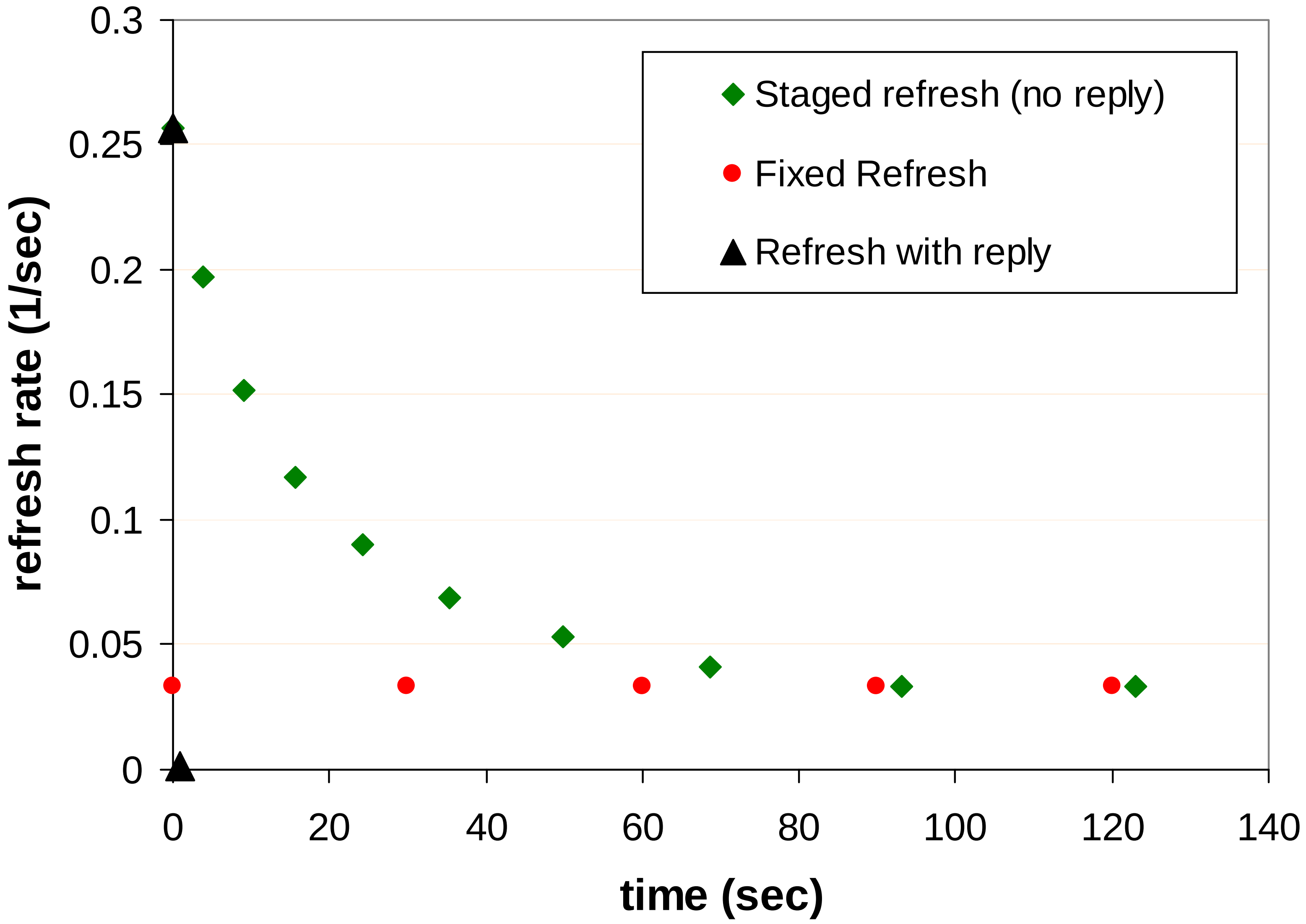
- Send trigger messages with echo-request.
- Retransmit the message until the echo-reply is received.
- The retransmission interval is governed by a *staged refresh timer*.
- Scale back the refresh rate if the echo-reply is received.

Staged Refresh Timer

- Each sending node has the following tunable parameters:
  - R_f: the initial fast refresh interval. Default value is 3 seconds.
  - R_s: the slow refresh interval (after echo-reply). Default is 15 minutes.
  - R: fixed refresh interval. 30 sec by default.
  - Δ: an incremental value. 0.3 by default.

Staged Refresh Timer (2)

- After sending a trigger message:
  - unless the echo-reply is received, schedule retransmission after R_f, $(1+\Delta)\ R_f$, $(1+\Delta)^2\ R_f$, …
  - if the echo-reply is received, switch the refresh rate to R_s.
  - When $(1+\Delta)^l\ R_f$ reaches to R, refresh PATH/RESV with R, and stop sending tear-down messages.


0.3
0.25
0.2
0.15
0.1
0.05
0
refresh rate (1/sec)
0
20
40
60
80
100
120
140
time (sec)
◆ Staged refresh (no reply)
● Fixed Refresh
▲ Refresh with reply

Staged Refresh Timer (3)

A new RSVP timer algorithm:

```
If ($R_k < R$)
        $R_k \rightarrow R_k (1+\Delta)$
        send out a refresh message
        wake up in state k after $R_k$ seconds;
        exit
else
        $R_k \rightarrow R$
        if (the state k is a tear-down message)
                clean up state k;
                exit;
        else
                send out state k after $R_k$ seconds;
                exit
```

Basic Properties

- hop-by-hop;
- minor addition to the RSVP protocol;
- backward compatible;
  - does not require the proposed scheme to be implemented on the receiving nodes.
- small operating overhead.

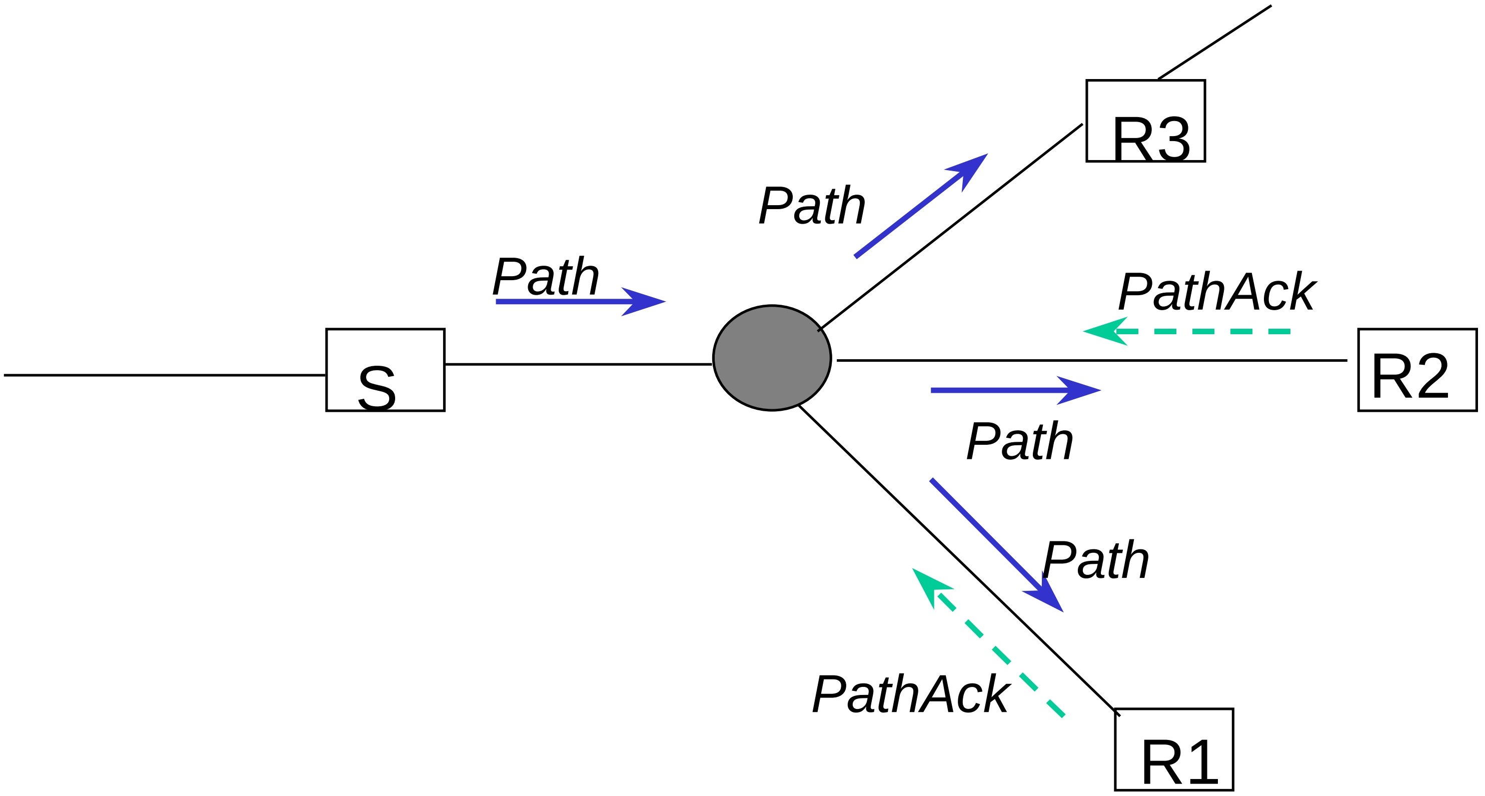
Special Considerations (1):
tear-down messages

- Release the resource, and mark the state as *closing*.
- Use the state info for retransmission;
- Remove the state *only* after
  - the echo-reply is received,
  - or the refresh interval has changed to the fixed interval R.

Special Considerations (2): operation in NBMA

- Problem: for a multicast session, a sending node *does not* know the total number of receiving nodes for PATH or PATHTEAR at an egress interface.
- Therefore, cannot switch to a longer refresh timer Rs based on having received echo-replies.

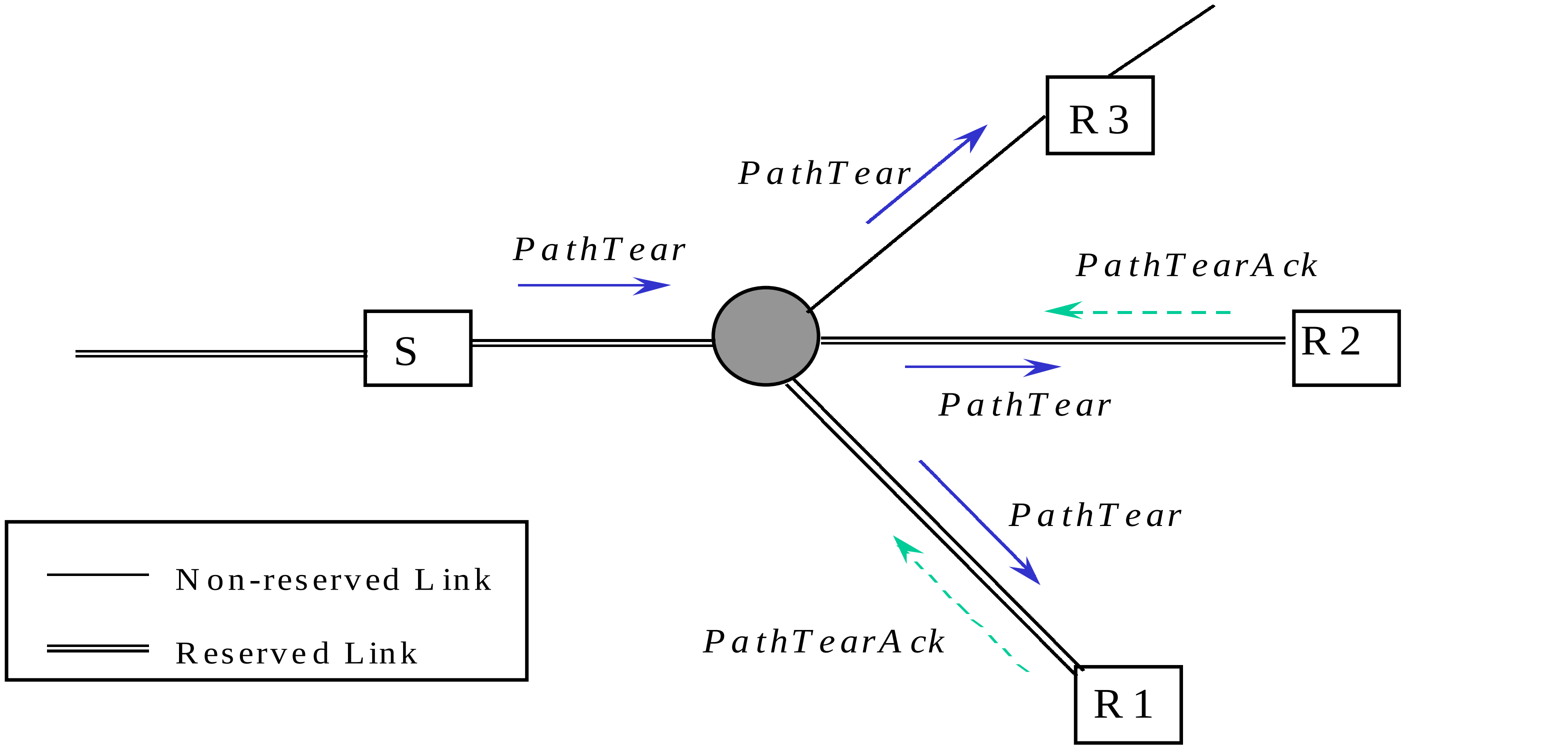
Operation in NBMA:
PATH message



Operation in NBMA: PATH

- Solution 1: Query ARP or MARS server to find out the exact number of receiving nodes. Switch to Rs after receiving replies from all receiving nodes.
- Solution 2: PATH is used for traffic advertisement. So don’t apply staged refresh timer for PATH messages.

Operation in NBMA: PATHTEAR



Operation in NBMA: PATHTEAR

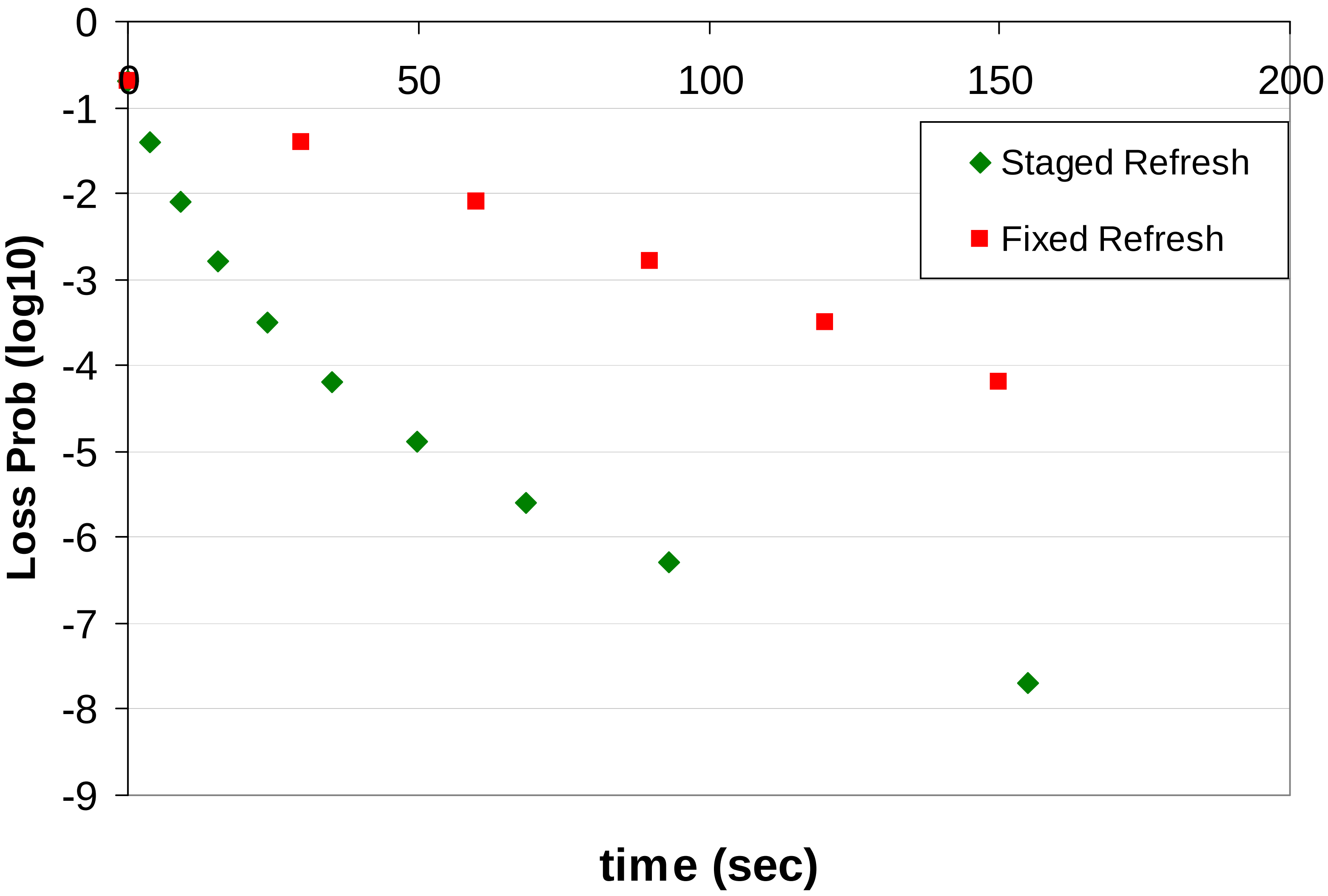
- A sending node knows all the receiving nodes that have made reservations.
- Generate PATHTEAR with staged refresh timer until replies are received from all known nhop nodes.

Evaluation

Reduced Message Loss Probability

– Assume the message loss probability for a single message is 20%. The *accumulative* probability that no reservation is established after half minute is reduced to 3×10^{-4} compared with 4×10^{-2} with the current fixed timer.

– For loss rate of 2%, the failure probabilities become 3×10^{-9} and 4×10^{-4}, respectively.


0
-1
-2
-3
-4
-5
-6
-7
-8
-9
Loss Prob (log10)
0
50
100
150
200
time (sec)
◆ Staged Refresh
■ Fixed Refresh

Evaluation

Reduced Protocol Overhead

(150 bytes per message)

	60 s	**60 min**
Fixed Refresh	300	18,000
Slewed Refresh **(slew.rate = 0.3)**	300	1,950
Staged Refresh (no reply)	900	18,600
Staged Refresh (with reply)	300	900

Conclusion

- Simple
- Backward Compatible