Preventing Reorder and Duplication Using Topology Sequence Numbers

Michael Takefman

The Key Ideas

- Duplication
  - Make sure a packet only ever circulates once
  - Limit bi-directional flood distance such that the scope does not overlap
    - Only accept bi-directionally flooded packets on a single ring attachment in case the scope does overlap due to failure
- Insure reorder does not occur
  - Use TSN to insure delivery in proper order
- Two possible frame formats
  - Differ in implementation requirements and support of passthru
- TTL decremented on launch ringlet only

A Key Definition

- For a ring using bi-directional flooding the ***flooding scope*** of a node is a tuple which indicates the distance that a packet should travel on each ring under normal conditions
- For an N node ring, there are N flooding scopes $FS_n(I_n,J_n)$; where $I_n+J_n = N-1$ for $n = 1 .. N$
- Whenever a protection event occurs, the FS for all but one of the nodes change. When the ring is healed it is likely that the FS return to the pre-fault values.

A Key Observation

- For bi-directionally flooded rings, the MAC replicates the packet for both attachments.
- Due to internal buffering within the MAC, it is critical that the FS of the packet is set when the Client gives the MAC the packet
- Setting the FS just prior to attach could have the same packet get two different flooding scopes that overlap

A Key Question

- Do we want to support Passthru mode (and strict operation)
- What fault model do we want to support
  - Single faults
  - Sequential Faults
  - Concurrent Faults
- ISO 15802-1 states reorder and duplication should be negligible
  - What does that really mean?

Topology Sequence Numbers

- A simple method of insuring no misorder and duplication and allowing steering to occur in minimal time without the need to flush
- Each node maintains a local sequence number for its current Flooding Scope
- Anytime the scope changes such that a destination would switch ringlet acceptance the TSN is incremented
- The TSN and FS is advertised by the node when its flooding behavior is changing, the node should increment the sequence number
- All data packets carry the TSN of the source node and are flooded in accordance with the corresponding FS

Topology Sequence Numbers

- Destination nodes receive TSN and FS from all nodes.
- Destination nodes determines which ringlet is used to receive bi-directional packets for the given TSN
- A database associating SA and TSN is stored for each ringlet attachment
- Incoming packets are checked against the destination node's current TSN database and are deleted if the TSN does not match
  - This operation does not have to be performed on the transit path. It can be performed on the client receive path.

Data Frame Header for RAM Implementation

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WS	TTL							RI	FE	PT		SC		WE	E/P
DA[48:32]															
DA[48:32]															
DA[48:32]															
SA[48:32]															
SA[48:32]															
SA[48:32]															
Rsv	TSN							FT		TB					
HEC[15:0]															

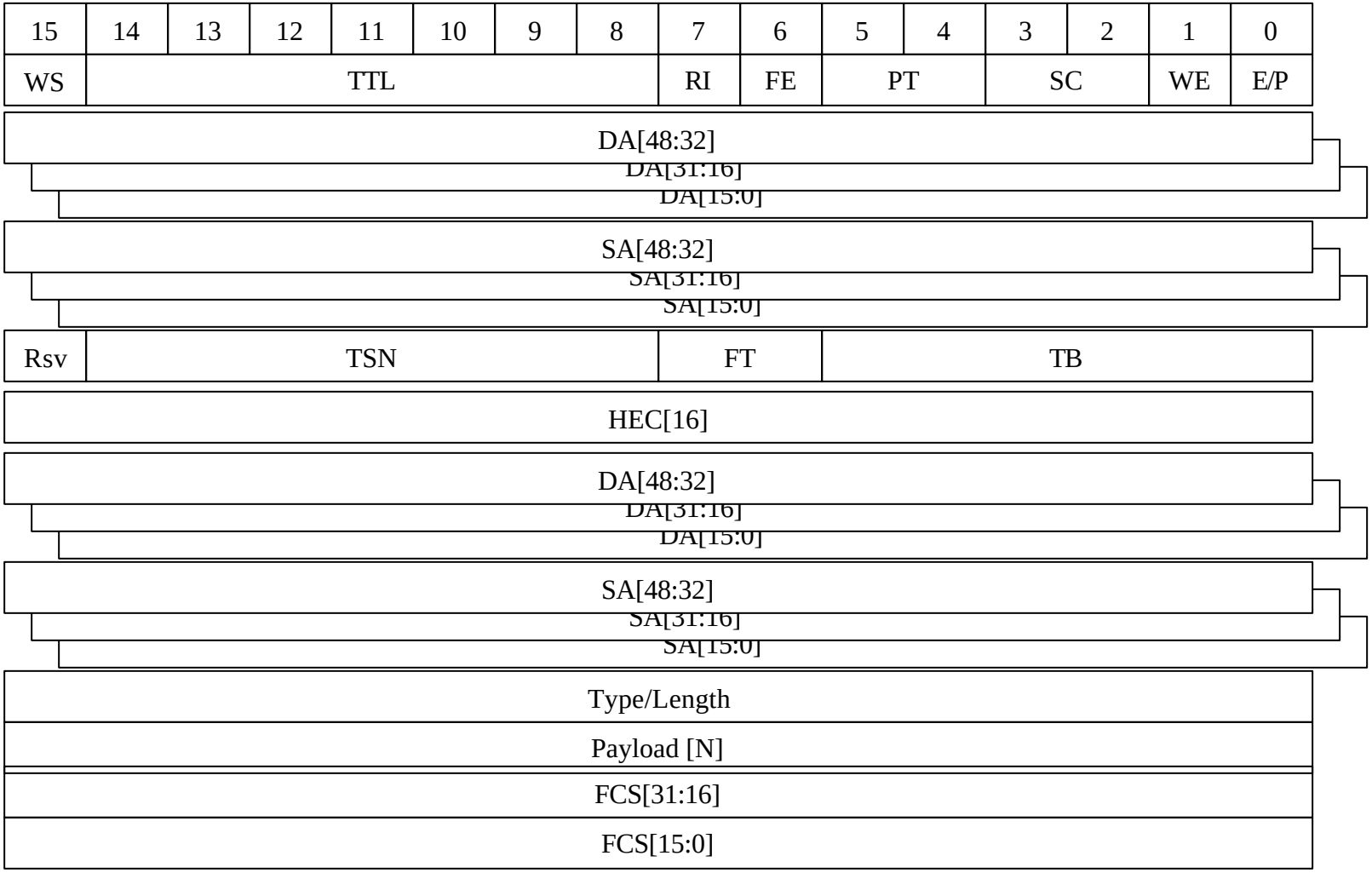
Data Frame Header for CAM Implementation

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
TTL								RI	FE	PT		SC		WE	E/P
DA[48:32]															
DA[48:32]															
DA[48:32]															
SA[48:32]															
SA[48:32]															
SA[48:32]															
TSN												FT		WS	Rsvd
HEC[15:0]															

Short Data Frame Format

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WS	TTL							RI	FE	PT		SC		WE	E/P
DA[48:32]															
DA[31:16]															
DA[15:0]															
SA[48:32]															
SA[31:16]															
SA[15:0]															
Rsv	TSN							FT	TB						
HEC[16]															
Type/Length															
Payload [N]															
FCS[31:16]															
FCS[15:0]															

Bridge Frame Format



Determining Flooding Changes

- Source has both the previous topology and the new topology (due to a protection event)
- The TSN must be incremented if the flooding scope has changed such that a destination switches which ringlet it listens to for bi-directional flooding
- Source will broadcast a new TSN and flooding scope.
- All destinations receive and update their TSN acceptance table

TSN Message / Database

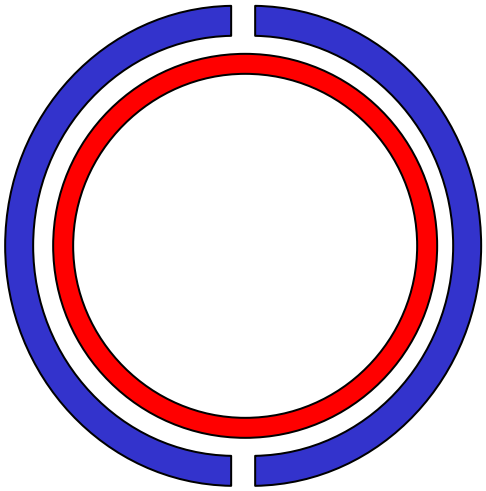
This 32 bit field can be added to topology messages and broadcast whenever the source has updated the TSN

RSVD[N]	TSN[M]	IHOPS[8]	OHOPS[8]

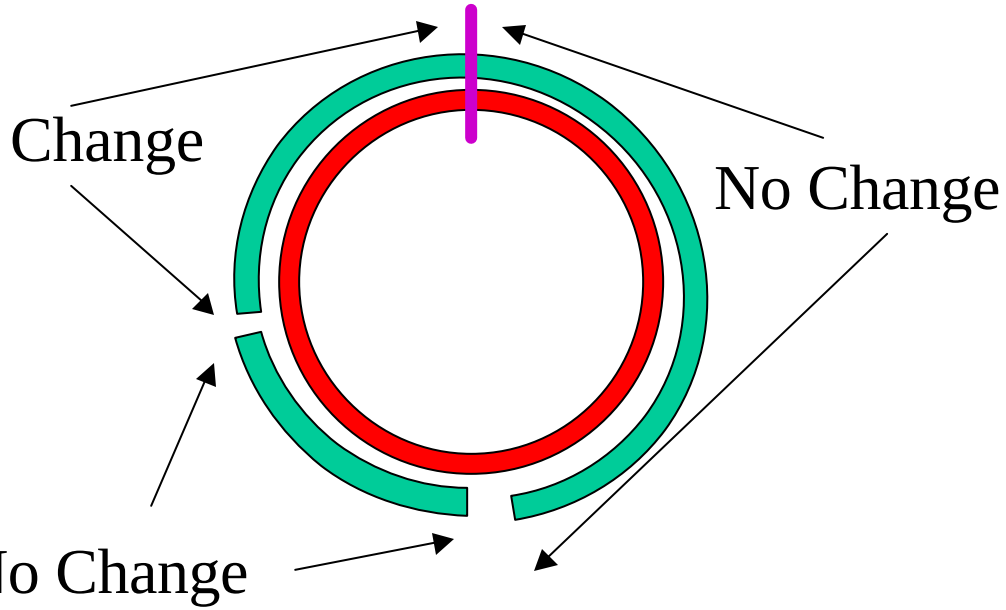
1	SA [47:0]	BiDi	Chk[4]	TSN[7]
	SA[47:0]	BiDi	Chk[4]	TSN[7]
	SA[47:0]	BiDi	Chk[4]	TSN[7]
64	SA[47:0]	BiDi	Chk[4]	TSN[7]

Limiting Loss

- There is an opportunity to limit the loss of packets from an old TSN during the switch to the new TSN
- The observation is that if the flooding reception has not changed for a destination, then reorder will not occur



Normal



Protection

Limiting Loss (cont)

- If the flooding scope has not changed, it is safe to continue to accept the old TSN and wait for the new TSN to arrive
  - Therefore no need to check TSN until the new TSN has arrived re-enabling strict checking of TSN
- If the flooding scope has changed, checking against the new TSN checking is required

Acceptance Rules

- ```
  if ( (SAIndex = CheckDB(pkt.sa)) == MISS)  // SA not in the database so don't accept
          delete_packet();
  else if ( DB[SAIndex].Chk[(RI<<1) | pkt.sc[1]] && pkt.tsn != DB[SAIndex].tsn) )
          delete_packet();                          // TSN does not match
  else if ( pkt.ft == BiDi && DB[SAIndex].bidi != RI)
          delete_packet();                          // Bi directional packet not on proper ringlet
  else
          accept_packet();                          //the packet is good;
  ```

- ```
  if ( pkt.tsn == DB[SAIndex].tsn)                  // need to insure checking is now on
          if ( pkt.sc[1] )
                  DB[SAIndex].Chk[(RI <<1) | 1] = 1;
          else
                  {                                 // Set both checks since a LP has arrived;
                  DB[SAIndex].Chk[(RI << 1) | 1] = 1;
                  DB[SAIndex].Chk[(RI << 1) ] = 1;
                  }
  ```

Advantages

- Lowest level of packet loss of all proposals
- Receive checks can be placed in either the transit or receive path
- Two rings can be joined without a need for a new TSN or any damage to existing ring traffic
- Small amount of change to existing Draft and limited to a single area
  - *Proposal P requires TTL changes to change more than one area*
- Supports flexible scoping mechanism