Sliding Window Protocols

- Frames are numbered.
- Lost frames can be retransmitted.
- Duplicate frames can be deleted.
- Out of order frames can be reordered.

The sender maintains two variables:

- S_L = the number of the "oldest" frame sent, but not ACK'ed.
- S_U = the number of the next frame to send that has not ever been sent.
- $S_U - S_L$ = the size of the sender's window (the number of sending buffers needed)

The receiver maintains two variables:

- R_L = lowest numbered frame the receiver is willing to accept
- R_U = one more than the highest numbered frame the receiver is willing to accept.
- $R_U - R_L$ = size of receiver's window.

Algorithm

Rough algorithm of the sliding window protocols:

1. Transmit all frames in the sender's window (no more than from S_L to S_{U-1})
2. Whenever the receiver gets a frame in its window:
   (a) it generates an ACK for the highest frame correctly received (same as the frame for protocol 5).
   (b) if the frame R_L has been received it passes R_L to the host and bumps R_L and R_U (advances the window).
3. Whenever the receiver gets a damaged frame or a frame not within its window it generates a NAK for one less than the frame expected ($R_L - 1$) (only for protocol 6).

4. Whenever the sender receives an ACK for a frame within its window, it marks that frame as having been correctly sent and received. If S_L is ACKed then increment S_L and S_U (advance the sender's window) and transmit S_{U-1} (last previously unsent frame).

5. Whenever a timer goes off, retransmit the corresponding frame.

Relationships

Sequence numbers: $0..(2^n - 1)$

$S_L < S_U$, $R_L < R_U$

Steady state condition: $R_L \leq S_U$

Interval of *active* frames: $[S_L, R_U)$

So $R_U - S_L \leq 2^n$ and $(R_U - R_L) + (S_U - S_L) \leq 2^n$

where n is the number of bits in the sequence number Two cases:

1. Receiver window size of one (protocol 5):

   $R_U - R_L = 1$
   $(S_U - S_L) + 1 \leq 2^n$
   $(S_U - S_L) \leq 2^n - 1$

2. Receiver and sender have equal window sizes (protocol 6):

   $R_U - R_L = S_U - S_L = W$
   $2W \leq 2^n$
   $W \leq 2^{n-1}$

Protocol 6 Example

Situation:

1. Sender sends sequence numbers 0-3.

2. Receiver has ACKed 0-3 (advancing window), but sender has not received the ACKs.