Data Link Layer : Elementary Data Link Protocols

OVERVIEW

Layers
Application Layer
Presentation Layer
Session Layer
Transport Layer
Network Layer
Data Link Layer
Physical Layer

- Design Issues
- Error Detection and Correction
- **Elementary Data Link Protocols**
- Sliding Window Protocols
- A Simplex STOP & WAIT Protocol
- High Level Data Link Control (HDLC)
- Point-to-Point Protocol (PPP)
- Protocol Verification

Data-link Control & Protocols

► Data-link layer is responsible for implementation of point-to-point flow and error control mechanism.

► **Flow Control** :

► When a data frame (Layer-2 data) is sent from one host to another over a single medium, it is required that the sender and receiver should work at the same speed.

► That is, sender sends at a speed on which the receiver can process and accept the data.

► What if the speed (hardware/software) of the sender or receiver differs? If sender is sending too fast the receiver may be overloaded, (swamped) and data may be lost.

Data-link Control & Protocols

▶ Two types of mechanisms can be deployed to control the flow:

o **Stop and Wait**

o **Sliding Window**

▶ **Stop and Wait**

▶ This flow control mechanism forces the sender after transmitting a data frame to stop and wait until the acknowledgement of the data-frame sent is received.

Stop and Wait
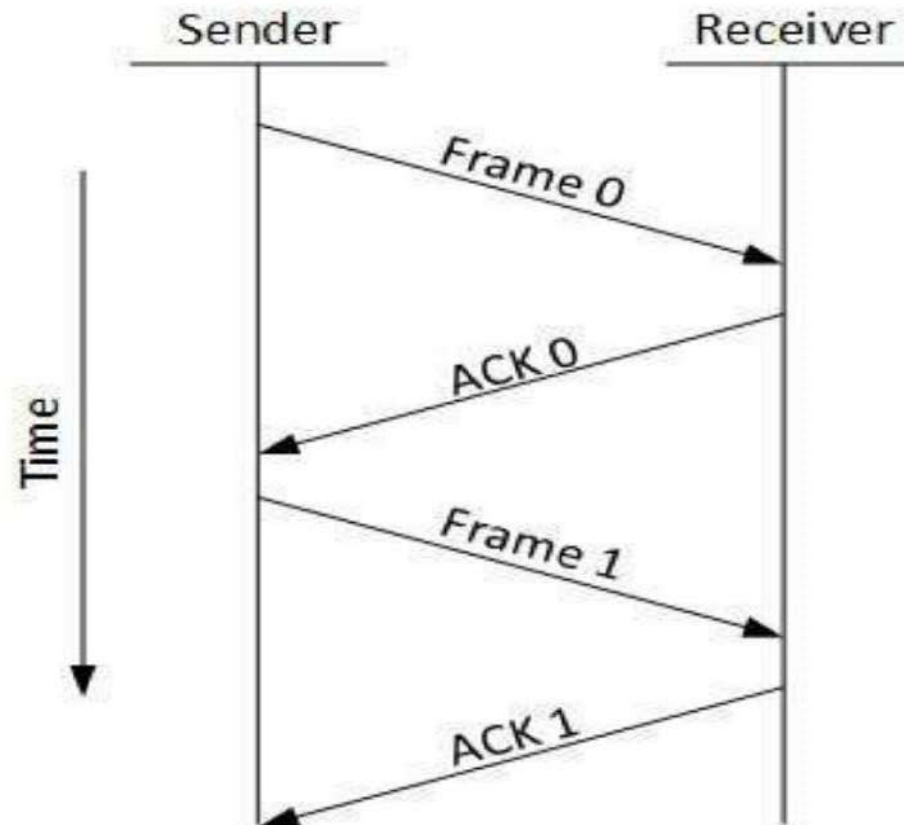
Sliding Window

► In sliding window method, multiple frames are sent by sender at a time before needing an acknowledgment.

► Multiple frames sent by source are acknowledged by receiver using a single ACK frame.

► Sliding window refers to an imaginary boxes that hold the frames on both sender and receiver side.

► It provides the upper limit on the number of frames that can be transmitted before requiring an acknowledgment.

► Frames may be acknowledged by receiver at any point even when window is not full on receiver side.

Sliding Window Cont..

▶ Frames may be transmitted by source even when window is not yet full on sender side.

▶ The windows have a specific size in which the frames are numbered modulo- n, which means they are numbered from 0 to n-l.

▶ For e.g. if n = 8, the frames are numbered 0, 1,2,3,4,5,6, 7, 0, 1,2,3,4,5,6, 7, 0, 1, ...

▶ The size of window is n-1.

▶ For e.g. In this case it is 7. Therefore, a maximum of n-l frames may be sent before an acknowledgment.
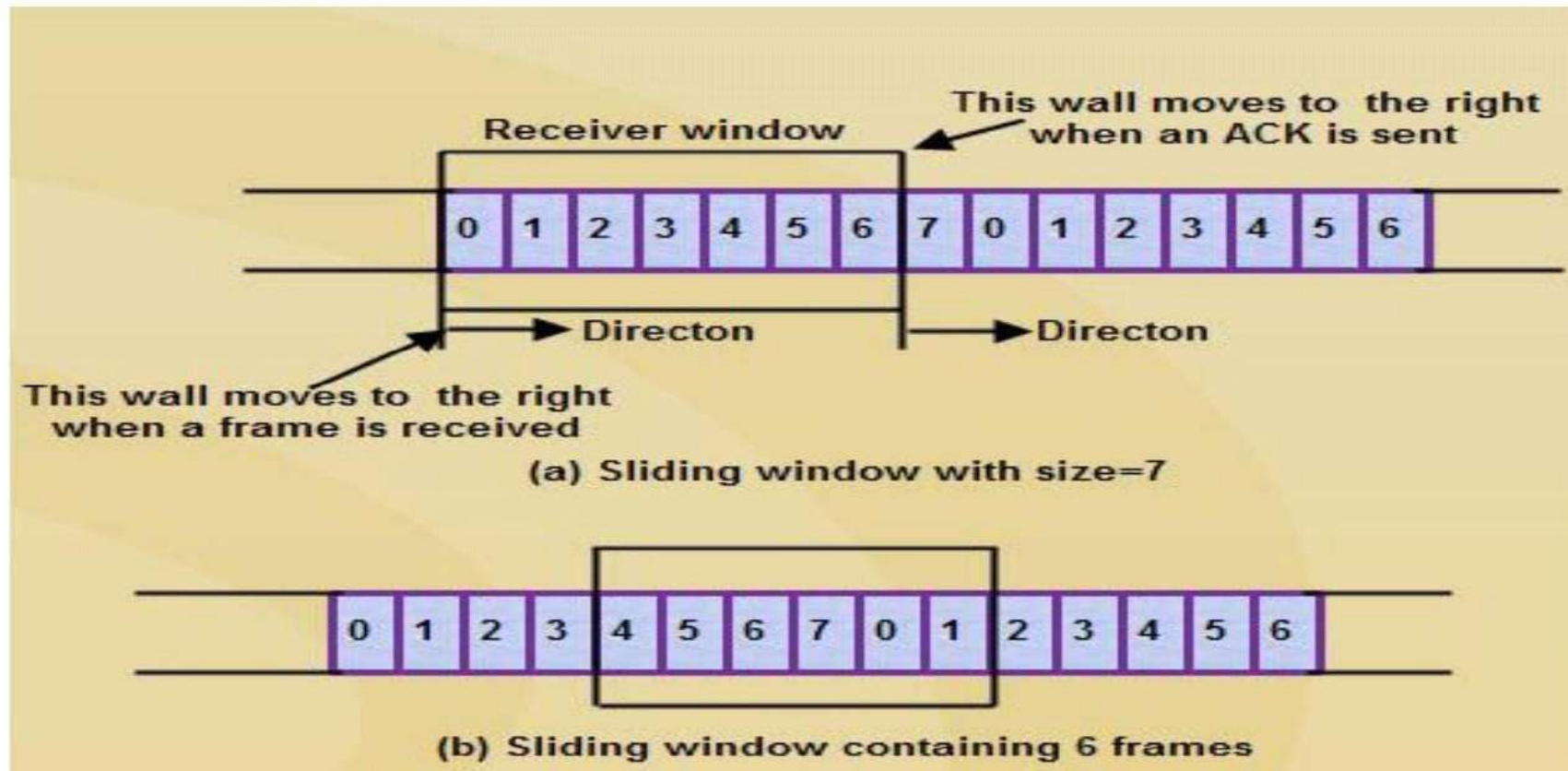
Sliding Window Cont..

► When the receiver sends an ACK, it includes the number of next frame it expects to receive.

► For example in order to acknowledge the group of frames ending in frame 4, the receiver sends an ACK containing the number 5. When sender sees an ACK with number 5, it comes to know that all the frames up to number 4 have been r...

6	7	0	1	2	3	4	5	6	7	0	1	2	3	4

Window

Sliding window

Sliding Window on Sender Side

▶ At the beginning of a transmission, the sender's window contains n-l frames.

▶ As the frames are sent by source, the left boundary of the window moves inward, shrinking the size of window.

▶ This means if window size is w, if four frames are sent by source after the last acknowledgment, then the number of frames left in window is w-4.

▶ When the receiver sends an ACK, the source's window expand

▶ i.e. (right boundary moves outward) to allow in a number of new frames equal to the number of frames acknowledged by that ACK.

Sliding Window on Sender Side

(a) Sliding window with size=7

(b) Sliding window containing 6 frames

Sliding Window on Sender Side Cont..

► For example, Let the window size is 7, if frames 0 through 3 have been sent and no acknowledgment has been received, then the sender's window contains three frames - 4,5,6.

► Now, if an ACK numbered 3 is received by source, it means three frames (0, 1, 2) have been received by receiver and are undamaged.

► The sender's window will now expand to include the next three frames in its buffer.

► At this point the sender's window will contain six frames (4, 5, 6, 7, 0, 1).

Sliding Window on Receiver Side

▶ At the beginning of transmission, the receiver's window contains n-1 spaces for frame but not the frames.

▶ As the new frames come in, the size of window shrinks.

▶ Therefore the receiver window represents not the number of frames received but the number of frames that may still be received without an acknowledgment ACK must be sent.

▶ Given a window of size w, if three frames are received without an ACK being returned, the number of spaces in a window is w-3.

Sliding Window on Receiver Side Cont..

▶ As soon as acknowledgment is sent, window expands to include the number of frames equal to the number of frames acknowledged.

▶ For example, let the size of receiver's window is 7 as shown in diagram. It means window contains spaces for 7 frames.

▶ With the arrival of the first frame, the receiving window shrinks, moving the boundary from space 0 to 1.

▶ Now, window has shrunk by one, so the receiver may accept six more frame before it is required to send an ACK.
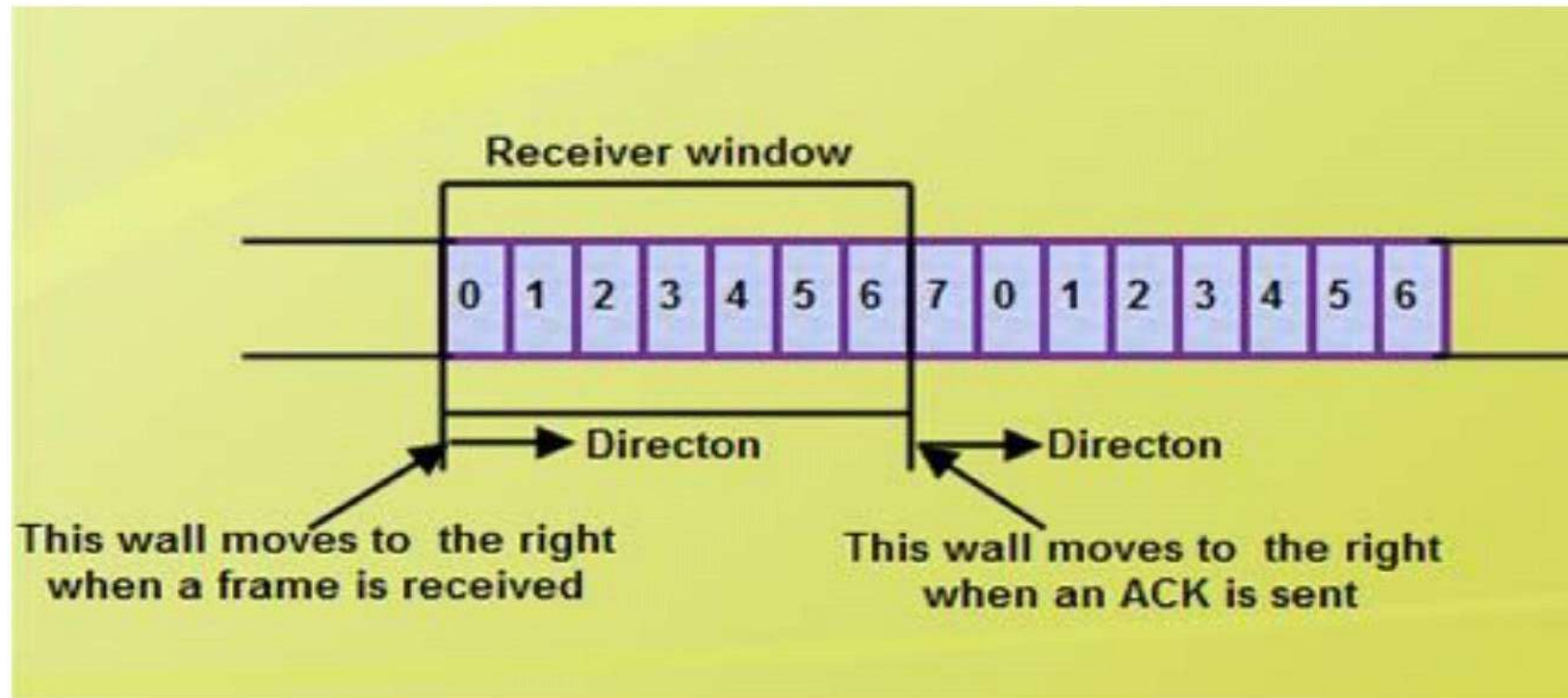
Sliding Window on Receiver Side Cont..

▶ If frames 0 through 3 have arrived but have DOC been acknowledged, the window will contain three frame spaces.

▶ As receiver sends an ACK, the window of the receiver expands to include as many new placeholders as newly acknowledged frames.

▶ The window expands to include a number of new frame spaces equal to the number of the most recently acknowledged frame minus the number of previously acknowledged frame.

▶ For *e.g.,* If window size is 7 and if prior ACK was for frame 2 & the current ACK is for frame 5 the window expands by three (5-2).

Sliding Window on Receiver Side Cont..

▶ Therefore, the sliding window of sender shrinks from left when frames of data are sending.

▶ The sliding window of the sender expands to right when acknowledgments are received.

▶ The sliding window of the receiver shrinks from left when frames of data are received.

▶ The sliding window of the receiver expands to the right when acknowledgement is sent.