Data Link Layer

Only interested in the communication between two nodes.

Example

Using the stop-and-wait protocol
200m long link made of optical fiber
Data rate of 1 Gbps
Frame Size: 8000 bits

$$\frac{8000 bits / frame}{10^9 bits / \sec} = 8\mu s = T_{Frame}$$

$$\frac{200m}{2\times 10^8 m/s} = 1\mu s = T_{prop}$$

$$T_{Timer} = 8\mu s + 2(1\mu s)$$

$$T_{Timer} = 10\mu s$$

Determining Frame Size

How many bits fit on a link?

$$B = \frac{R \times D}{V}$$

B is the number of bits
R is the data rate, in bits per second
D is the distance, in meters
V is the velocity, in meters per second

Using the previous example:

$$B = \frac{10^9 bps \times 200m}{2\times 10^8 m/s} = 1000 bits$$

Link Utilization

Percent of time that the link contains data

$$U = \frac{Time\ data\ is\ present\ on\ the\ link}{total\ transaction\ time} = \frac{T_{Frame}}{T_{Frame} + 2T_{Prop}} = \frac{1}{1 + 2\frac{T_{Prop}}{T_{Frame}}}$$

The frame size might need to be adjusted to accommodate the link length.

Example

1 Mbps link

$$T_{Prop} = \frac{72,000,000m}{3\times10^8 m/s} = 240ms$$

Frame size = 8000 bits

$$T_{Frame} = \frac{8000bits}{10^6 bps} = 8ms$$

The stop and wait protocol is okay if you have high speed links with fairly noiseless environments. When transmitting over long distances, though, it is slow and inefficient

Sliding Window Protocol

This is used by "real" protocols such as HDLC.

It allows more frames to be sent without receiving an acknowledgement

The sending device has a window

Frames have additional information. For example, the frame number specified in the header is not a 1 or a 0, but a number from 0 to 7.

$$w = 2^m - 1$$

The receiver's acknowledgement is a cumulative acknowledgement. It does not have to acknowledge every single frame that it receives. To acknowledge receipt of frames 0 and 1, it would send an ACK packet with a sequence number of 2.

The goal is to prevent the window from shrinking to 0.