Data Link Layer

End to End
Communication between the initial source to the final destination

Node to Node
Communication between any two nodes
Nodes may be routers or hosts.

The data link layer governs data transfer between two adjacent nodes on the network. Thus, it is node-to-node and does not worry about end-to-end communication. The data chunks that are transmitted are referred to as **frames**.

Services provided by the Data Link Layer

Framing
Taking data from the layer above it and converting it to frames. This includes encapsulating the data in a header and trailer. This information depends on the protocol being used.

Header information includes physical addresses (also referred to as flat addresses). These identify the particular device. Ex: MAC addresses.

If this were a LAN using Ethernet, the size of the frame would be 1500 bytes. If it were going over a WAN, the size of the frame could be different.

Error Detection (and possibly correction)
Example: CRC (Cyclic redundancy check)
CRC can detect a wide range of errors

Flow Control
Makes sure the receiver isn't overwhelmed by the rate at which data is transmitted. This will include some sort of handshaking.

Allows reliable data transfer. This is done via acknowledgements and re-transmit.

Types of Frames

- **Data Frame**
- **Acknowledgement Frame** – small, short, used by receiver to acknowledge that it received a frame without errors.

STOP-AND-WAIT Protocol

(Automatic Repeat Request – ARQ)

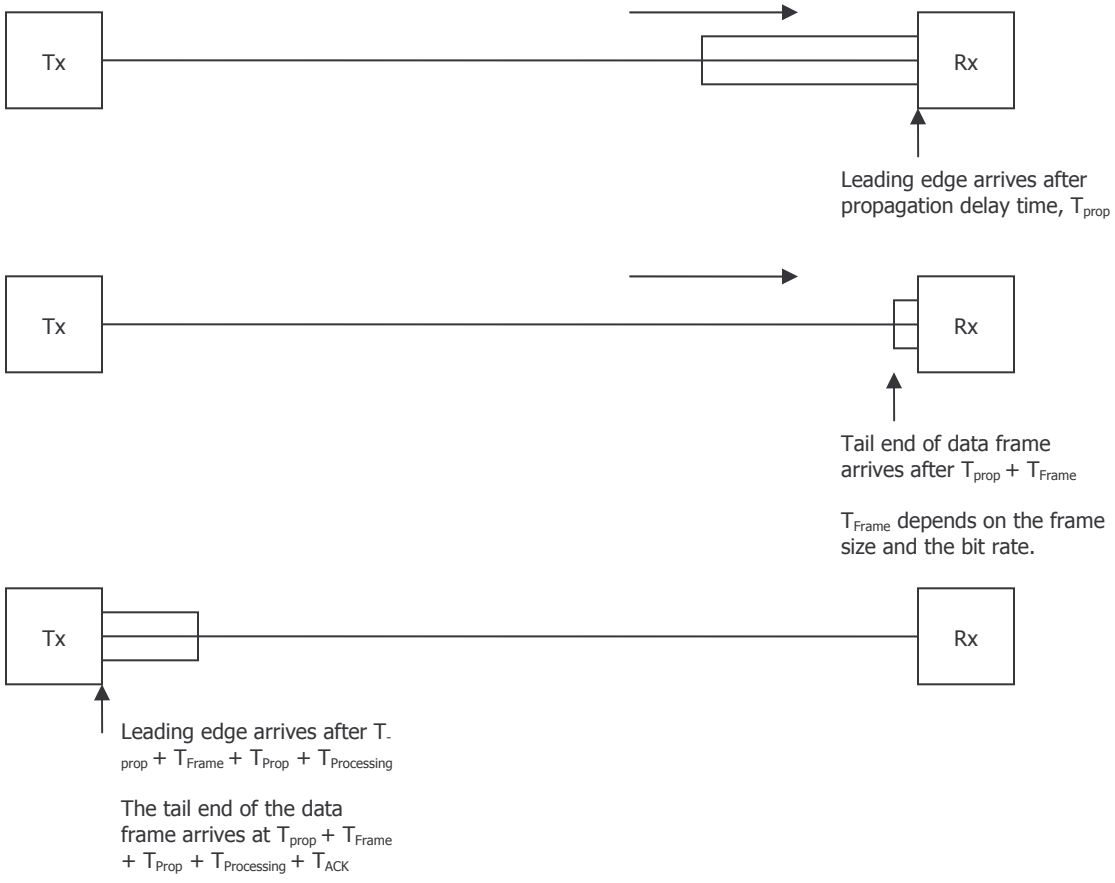
Sender Protocol
Transmits a frame and saves a copy of it.

Starts up a timer. Wait for ACK frame from receiver.
If timer times out without receiving ACK, re-transmit the frame.

The frame number alternates between 0 and 1. The receiver sends an ACK1 to acknowledge Data frame 0. The receiver sends an ACK0 to acknowledge Data Frame 1.

Receiver Protocol
If it receives a frame with an error of any kind, it discards it and no ACK is sent.
Error could be from a CRC, a frame with the wrong sequence number, etc.
This forces the transmitter's timer to timeout. The data will get resent.

For a guided medium, $V = \frac{2}{3}C = 2\times10^8 m/s$



$$T_{Timer} = T_{Frame} + 2T_{Prop}$$