

I. Data Link Layer

Week 4

Provides layer 2 functionality for:

- framing – dividing data into frames
- frame sequencing – maintaining correct order
- flow control
- error detection / correction
- Quality of Service (QoS) issues

Data Link layer typically divided into 2 sub-layers (in IEEE 802 model):

1. LLC – logical link control (802.2)
2. MAC – media access control (Ethernet – 802.3)

II. MAC Layer

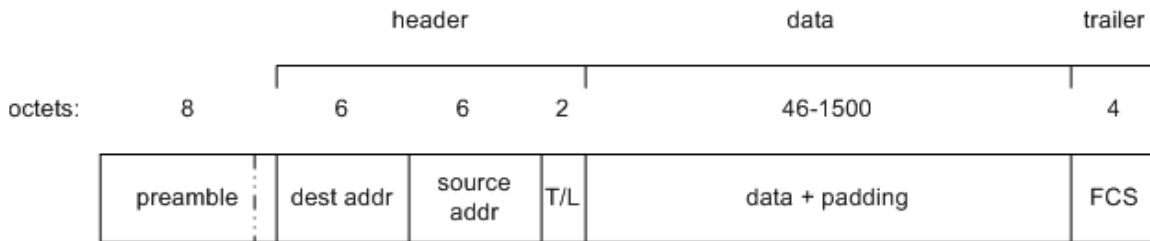
MAC addresses:

- layer 2 addresses, also called hardware addresses, in 802.3, known as Ethernet addresses
- assigned by the manufacturer
- 48 bits, 6 octets, 6 pairs of hex digits

xx:xx:xx:yy:yy:yy where xx pairs indicate vendor, yy pairs indicate serial #

- 3 types of destination addresses
 - a. unicast – sent to a single destination
 - b. multicast – sent to multiple destinations, odd 2nd hex digit in 1st pair – 01:xx
 - c. broadcast – sent to everyone, all 1's, in hex all ?

Ethernet PDU: (see pg 40-47)



- **preamble** (7 + 1 octets) – preamble is used to inform the receiving stations that a frame is coming, and provide a means to synchronize the frame-reception portions of receivers physical layers. The preamble consists of 7 octets of alternating ones & zeros. The last octet of the preamble is called the start of frame delimiter (SOF) and consists of 6 alternating bits ending in two one-bit values.
- **destination address** (6 octets) – the destination address identifies which nodes should receive the frame.
- **source address** (6 octets) – the source address identifies the sending node of the frame.
- **length (L) or type (T) field** (2 octets) – indicates either the length of the data portion of the frame in octets, or the type of the data contained within the data portion of the frame. If the value is ≤ 1500 (x05DC), the value is a length value. If the value is ≥ 1536 (x0600), the value is a type value. Example type values are:
 - x0800: IPv4
 - x0806: ARP
 - x86DD: IPv6
 - x8137: IPX
 - x9000: Loopback

(see <http://standards.ieee.org/regauth/ethertype/type-pub.html> or <http://www.iana.org/assignments/ethernet-numbers>)

- **data** – a sequence of n bytes, where n must be ≤ 1500 . If the length of n is < 46 , padding is added to “pad” the length of the data to 46 bytes
- **frame check sequence (FCS)** (4 octets) – specifically for 802.3, this is a 32-bit Cyclic Redundancy Check (CRC-32)
 - CRC calculated by the sending MAC, then recalculated by the receiving MAC, if equal, no errors
 - FCS is generated over the DA, SA, T/L **and** data fields only (i.e. header and data)
 - for a CRC of length n , the rate of undetected errors is approximately 2^{-n}

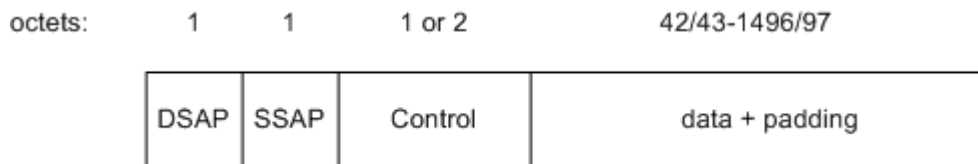
- min frame length: ? octets max frame length: ? octets

III. Invalid Frame Conditions

- **long frames** – length > 1518 with correct CRC
- **runt frames** – length < 64 with correct CRC
- **jabbers** – long frames with incorrect CRC
- **alignment errors** – frames don't end on byte boundary
- **CRC errors** – noise (e.g. crosstalk, NEXT – near end crosstalk, transmit signal picked up on receive pair), bad connections

IV. Logical Link Control (LLC)

- responsible for addressing and flow control
- independent of topology, transmission media & MAC
- 802.2 LLC PDU (pg. 73-74)



DSAP: (upper level) destination service access point

SSAP: (upper level) source service access point

Control: based upon service type

see: <http://www.iana.org/assignments/ieee-802-numbers>

Most common of these is SNAP (SubNet Access Point) – RFC 1042

DSAP: xAA

SSAP: xAA

Control: x03

Flow control types:

1. connection-less
 - no error or flow control
 - no guaranteed delivery
 - reliability assumed at a higher layer
2. acknowledged connection-less
 - received frames are acknowledged (ACK'd), but no connection protocol is set up
3. connection-based
 - logical connection established between nodes