Overview of IEEE 802.3 and Ethernet

• Electrical functions
  – The SQE test is used on IEEE 802.3 transceivers.
    » Enables the controller to learn the status of an external transceiver.
  – Jabber control used on IEEE 802.3 transceivers.
    » Disables a transceiver that talks for longer than it should.
  – Ethernet transceivers were only made with Ethernet V1.0.
    » Virtually nonexistent today and not compatible with IEEE 802.3 transceivers.

• Packet format
  – Ethernet and IEEE 802.3 use different packet formats, as shown on the next few pages.

• Link control services
  – Ethernet has only unacknowledged connectionless service.
  – IEEE 802.3 can implement either connectionless or connection-oriented protocols when used with IEEE 802.2.
<table>
<thead>
<tr>
<th>Preamble</th>
<th>MAC layer header</th>
<th>OSI layer 3 - 7 headers and data</th>
<th>MAC trailer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Destination address</td>
<td>Source address</td>
<td>Type field</td>
</tr>
</tbody>
</table>

**The Preamble, Ethernet**
Bit Order and Transmission for Ethernet

Bits within bytes are transmitted left to right.

Transmission sequence:
- Destination address: 6 bytes
- Source address: 6 bytes
- Type field: 2 bytes
- Data field: 46 - 1500 bytes
- Frame Check Sequence: 4 bytes
## The Ethernet Packet

<table>
<thead>
<tr>
<th>Preamble</th>
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## IEEE 802.3 Packet Format

<table>
<thead>
<tr>
<th>7 bytes</th>
<th>1 byte</th>
<th>6 bytes</th>
<th>6 bytes</th>
<th>2 bytes</th>
<th>1 byte</th>
<th>1 byte</th>
<th>1 or 2 bytes</th>
<th>&lt; 1496 bytes</th>
<th>4 bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preamble</td>
<td>Start of</td>
<td>Destination</td>
<td>Source</td>
<td>Length</td>
<td>Destination</td>
<td>Source</td>
<td>Control</td>
<td>Data</td>
<td>Pad</td>
</tr>
<tr>
<td></td>
<td>Frame</td>
<td>address</td>
<td>address</td>
<td>field</td>
<td>Service</td>
<td>Access</td>
<td>fields</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delimiter</td>
<td></td>
<td></td>
<td></td>
<td>Point</td>
<td>Point</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(DSAP)</td>
<td>(SSAP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optional</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Destination Address

- **Byte 0**
  - Bit 7
  - Bit 0
  - Transmitted first

### Source Address

- **Byte 0**
  - Bit 7
  - Bit 0
  - Transmitted first
**Detail Comparison of the Two Formats**

### IEEE 802.3 CSMA/CD packet

<table>
<thead>
<tr>
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<th>6 bytes</th>
<th>2 bytes</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Preamble</td>
<td>Start of Frame Delimiter</td>
<td>Destination address</td>
<td>Source address</td>
<td>Length field</td>
<td>Destination Service Access Point (DSAP)</td>
<td>Source Service Access Point (SSAP)</td>
<td>Control Fields</td>
<td>Data</td>
<td>Pad</td>
</tr>
</tbody>
</table>

Optional IEEE 802.2 fields

---

### Destination Address

- **Byte 0**: U L 1 G
- **Byte 1**: 
- **Byte 5**: 

Transmitted first

### Source Address

- **Byte 0**: U L U
- **Byte 1**: 
- **Byte 5**: 

Transmitted first
**Ethernet and IEEE 802.3 Packets**

- **IEEE 802.3 with IEEE 802.2**
  - **Preamble**: 7 bytes
  - **Start of Frame Delimiter**: 1 byte
  - **Destination address**: 2 or 6 bytes
  - **Source address**: 2 or 6 bytes
  - **Length**: 2 bytes
  - **DSAP**: 1 byte
  - **SSAP**: 1 byte
  - **Control**:
  - **Data**:
  - **PAD**:
  - **CRC**: 4 bytes

- **Ethernet V2.0**
  - **Preamble**: 8 bytes
  - **Destination Address**: 6 bytes
  - **Source Address**: 6 bytes
  - **Type Field**: 2 bytes
  - **Data Field**: 46 to 1500 bytes
  - **CRC**: 4 bytes
• Many different types of packets may traverse an Ethernet network.
  – All will use either the IEEE 802.3 or Ethernet packet format.
  – Packets differ based on network software protocols.
    » AppleTalk and Novell NetWare generally use the IEEE 802.3 packet format.
    » DECnet and TCP/IP generally use the Ethernet packet format.

• All protocols are slowly switching to the IEEE 802.3 packet format.
• An access method based on the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) algorithm.

• Work started back in 1973 by Bob Metcalfe and David Boggs from Xerox Palo Alto Research Center (PARC).
  – He studied the Aloha network and "fixed" the mathematics.

• Experimental Ethernet implemented in 1975.

• Cooperative effort between Digital, Intel, and Xerox produced Ethernet Version 1.0 in 1980.
  – This also became known as the Blue Book specification or DIX standard.

• Ethernet V2.0 adopted in 1982.

• Ethernet was adopted with modifications by the standards committees IEEE 802.3 and ANSI 8802/3.

• Ethernet conforms only to the bottom two layers of the OSI model.

• Transmits information to other stations on the network through the use of packets.

• Ethernet allows for only connectionless communication.
Normal Ethernet Operation

- **A** sends data to node **D**
- **B** receives the data and discards it due to address mismatch
- **C** receives the data and discards it due to address mismatch
- **D** processes the data because the address matches

Transmitted packet seen by all stations on the LAN (broadcast medium)
Ethernet Collisions

Data transmission for A

Collision

Data transmission for C
CSMA/CD - A Simple Definition

- Ethernet uses the Carrier Sense Multiple Access with Collision Detection algorithm.

  - A network station wishing to transmit will first check the cable plant to ensure that no other station is currently transmitting (CARRIER SENSE).

  - The communications medium is one cable, therefore, it does allow multiple stations access to it with all being able to transmit and receive on the same cable (MULTIPLE ACCESS).

  - Error detection is implemented throughout the use of a station "listening" while it is transmitting its data.

    » Many ways to detect when another station has erroneously started to transmit.

      ✷ Two or more stations transmitting causes a collision (COLLISION DETECTION)

      ✷ A jam signal is transmitted to network by the transmitting stations that detected the collision, to ensure that all stations know of the collision. All stations will "backoff" for a random time.

      ✷ Detection and retransmission is accomplished in microseconds.
Ethernet Transmission Flowchart

1. transmit packet
2. assemble packet
3. deferring on?
   - yes
   - no
4. start transmission
5. collision detect?
   - yes
   - no
6. transmission done?
   - yes
   - no
7. done excessive collision errors
8. done
9. increment attempts
10. compute and wait backoff time
11. send jam signal
Ethernet Reception Flowchart

1. **receive packet**
2. **start receiving**
3. **done receiving?**
   - yes
     - packet too small?
       - yes
         - done error length
       - no
         - yes
           - disassemble packet
         - no
           - no
             - extra bits?
               - yes
                 - done packet_check error
               - no
                 - done receive ok
4. **valid CRC?**
   - yes
     - recognize address?
       - yes
         - done receive ok
       - no
         - no
         - no
           - done alignment error
     - no
       - valid length?
         - yes
           - done receive ok
         - no
           - done error length
Final Ethernet Issues

- Ethernet is an access method that strictly adheres to the CSMA/CD algorithm.
- Ethernet is a multiprotocol solution.
- Ethernet is hardware, not software.
- Ethernet is a broadcast oriented network.
  - All data packets are seen by all stations on the network.
  - This should not be confused with a broadcast packet.
- Ethernet does not guarantee delivery of a data packet.
  - It will detect an error in the packet via the CRC but Ethernet provides only connectionless service.
  - The upper layer protocols (layers 3 - 7) usually have some type of reliable protocol built to take care of this issue.
- An Ethernet controller is allowed to "miss" packets when the controller is busy.
Ethernet Misconceptions

• Ethernet is not necessarily less efficient than any other access method.
  – Depends on the application that is using Ethernet.

• Collisions are important in Ethernet but it is inherent in the design.

• Not all upper layer networking software was designed to run over Ethernet.

• Smaller packets are not more efficient on Ethernet.

• The size of the cable does not affect the speed of Ethernet.

• Ethernet may transmit and receive at 10 Megabits per second but the actual data throughput is much less.

• The design of the cabling system will affect performance.

• There are minimum or maximum packet size requirements.