Error Detection on Ethernet

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Presentation Outline

- Medium Access Control
- IEEE 802.3 CSMA/CD
- Collision detection
- Frame format
- Bit error detection & CRC
- Summary for Ethernet
Medium Access Control (MAC)

- Uses in broadcast networks: e.g. LANs
- Key issue: How to determine who gets to use the channel

If only one channel is available for multiple users, channel allocation protocol must be carefully studied.
- Referred to as Multiaccess channels, random access channels
FRAME COLLISION

\[ t_0 + t + t_0 + 2t + t_0 + 3t \]

Vulnerable period

collision
CSMA/CD

- Carrier Sense Multiple Access with Collision Detection
- No predictable or scheduled time for any station to transmit
  ⇒ station transmissions are ordered randomly
- Early techniques for random access: ALOHA, slotted ALOHA
- CSMA
  1. If the medium is idle, transmit (immediately).
  2. If the medium is busy, continue to listen until the channel is sensed idle.
     If two or more stations are waiting to transmit, a collision is unavoidable.
- CD
  3. If a collision is detecting during TX, transmit a brief jamming signal and then cease transmission.
  4. After sending jamming signal, wait a random amount of time (repeat from step 1).
- Advantage with CD
  Shorten the damaged frames’ transmission time.
CSMA/CD Operation

station
IEEE 802.3 & Ethernet

- Xerox PARC built a 2.94 Mbps CSMA/CD system (1976).
- Xerox, DEC, and Intel drew up a standard for a 10 Mbps Ethernet.
- This standard formed the basis for 802.3.
- Minor differences exist between Ethernet and 802.3:
  - e.g: 10 Mbps fixed speed vs. 1-10 Mbps, frame header indication
Binary Exponential Backoff Algorithm

- How to decide random amount of waiting time after collision.
- After collision, slot time is applied.
  
  e.g: 2.5 km network span has 51.2 µsec
- The $i$th collided station picks random slot between 0 and $2^i - 1$

0 1

0 1 2 3

0 1 2 3 4 5 6 7

0 1 2 3 ... ... 1022 1023

GIVE UP
Frame Format

To allow the receiver’s clock to synchronize with sender’s: 10101010...

Maximum frame size: 1518 bytes \((6 + 6 + 2 + 1500 + 4)\)

* excluding preamble and SOF
Bit Error Detection (1)

- Uses CRC (Cyclic Redundancy Code)

Polynomial Code: K bit frame is represented to polynomial with k terms.
\[ x^{k-1} \text{ to } x^0 \Rightarrow \text{can be said to be of degree } k - 1. \]
\[ \text{e.g: } 110001 \Rightarrow x^5 + x^4 + x^0 \]

Generator polynomial \( G(x) \): code agreed between TX and RX.
Both high and low order bits must be 1.

Message polynomial \( M(x) \): frame poly + \( r \) zero bits
\[ r = 1 \text{ bit less than } G(x) \]

Transmitted frame = frame bit + \( \{M(x) \oplus G(x)\} \) : Remainder
Bit Error Detection (2)

Frame: 110101

Generator: 1001

M(x): 110101000

1 0 0 1
1 1 0 1 0 1 0 0 0
1 0 0 1
1 0 0 0
1 0 0 1
0 0 1 1
0 0 0 0
0 1 1 0
0 0 0 0
1 1 0 0
1 0 0 1
1 0 1 0
1 0 0 1
0 1 1

Remainder

Transmitted frame: 110101000011
Ethernet is currently the most popular LAN systems.

It has MAC sublayer and CSMA/CD protocol.

It listens medium status and detects idle or busy status.

When the channel is idle, data ready stations immediately transmit data.

If a collision is detected, stations stop transmission and waits a random amount of time with binary backoff.

LLC layer manages bit errors with CRC and the receiver requests retransmission to the sender for error frame.