Data Link Layer, Part 1

Introduction

These slides are created by Dr. Yih Huang of George Mason University. Students registered in Dr. Huang’s courses at GMU can make a single machine-readable copy and print a single copy of each slide for their own reference, so long as each slide contains the copyright statement, and GMU facilities are not used to produce paper copies. Permission for any other use, either in machine-readable or printed form, must be obtained from the author in writing.

---

DLL in OSI Model

- Application
- Presentation
- Session
- Transport
- Network
- Data Link Control
- Physical

(reliable) error-free bit stream

Unreliable bit stream
**Functionalities of DLL**

- framing (when does a transmission unit start and end?)
- error detection (or even error correction)
- flow control
- reliability (optional)

---

**The Reliable-vs-Unreliable Debate**

**Question:** Should DLL provide a reliable bit stream for use by Network Layer?

- Unreliable service
  - appropriate for low-error links and real-time traffic (for example, digitized voice)
  - used in many LANs
  - end-to-end reliability can be enforced at higher layers (for example, transport layer)
• Reliable service
  • suitable for noisy links
  • used in X.25 (an early networking standard produced by the telecommunication industry)

**The Internet Perspective:** In a heterogeneous environment, you have to expect the minimum from the underlying networks anyway. Consequently, end-to-end reliability must be provided, and step-by-step reliability seems redundant.

---

**Framing**

• Why dividing a bit stream into frames?
  • fairness
  • error recovery
  • buffer management
  • or just due to the packetization at higher layers

• Four types of framing:
  1. length count
  2. character-based framing
  3. bit-oriented framing
  4. violations of physical layer encoding
Length Count

- Header contains length of frame
- Problems
  - count may become corrupted
  - receiver has no way to tell where next frame starts
- Rarely used along, often used in conjunction with another framing method, as a double check

Examples

A single transmission error could cause the sender and receiver to lose framing synchronization, maybe indefinitely.
Character-Oriented Framing

- DLE STX — start of frame
- DLE ETX — end of text
- SYN — between frames
- What do we do if DLE appears in the frame?
  - at sending end, insert extra DLE before each DLE in data
  - at receiving end, extra “stuffed” DLEs are extracted
  - this is called character stuffing.

Example

Data: DLE STX A DLE B DLE ETX

Frame: DLE STX DLE DLE STX A DLE DLE B DLE DLE ETX DLE ETX
Bit-Oriented Framing

- Start- and stop-frame pattern: 0 1 1 1 1 1 0
- Bit stuffing
  - sender inserts 0 after every sequence of five 1's
  - when receiver sees five 1's followed by 0, extracts the 0
  - receiver recognizes the end of the frame when seeing six 1's.
- Example:

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

Violations of Physical Layer Encoding

- In some physical layer encoding methods, there unused/illegal states in a bit period.
  - In the manchester encoding, a legal bit period can be either HL or LH, but not HH and LL.
  - In the bipolar encoding, there are three states (Positive, zero, and negative) in a bit period.
- We can use “illegal bits” to represent the beginning and ending of frames.
- This is used in some LANs.