Data Link Layer, Part 1
Introduction

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DLL in OSI Model
Functionalities of DLL

- Framing
  - how does a transmission unit start and end?
- Error detection/correction
- Flow control
- Reliability
  - actions in the presence of transmission errors
Not all these features are present in all DLL protocols

Framing

- character-based framing
- bit-oriented framing
- violations of physical layer encoding
## 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” DLE’s are extracted
  - this is called **character stuffing**

<table>
<thead>
<tr>
<th>DATA</th>
<th>DLE</th>
<th>STX</th>
<th>A</th>
<th>DLE</th>
<th>B</th>
<th>DLE</th>
<th>ETX</th>
</tr>
</thead>
</table>

| 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 the 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 0

011111101111101010111110001110001111110

CS 455
Violations of Physical Layer Encoding

- In some physical layer encoding methods, there are unused/illegal states in a bit period.
  - In the Manchester encoding, a legal bit period can be either HL or LH, but never HH and LL

- We can use “illegal bits” to represent the beginning and/or ending of frames.
  - Ethernet uses HH to mark the end of frames.