CSE/EE 461 – Lecture 2
Coding & Framing
(and a little about layering)

Janet Davis
jlnd@cs.washington.edu
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Administrative Stuff

• Introduction sheets
• Drops/Adds
• Fishnet 4.1 is up!
  – Commands in Intro to Fishnet don’t work
    (sorry)
  – See mailing list archives for correct
    commands
Your Feedback

• Interested in
  – organizing problems
  – Ruby, iPAQs, Fishnet
  – Internet history
• Questions
  – Too many to answer here! See email.
  – Workload
  – Learning Ruby
  – Layering

Detour:
Protocols and Layering

• A protocol is an agreement dictating the form and function of data exchanged between parties to effect communication.
• Two parts:
  – Syntax:
  – Semantics:
• Examples:
Layering and Protocol Stacks

- Layering is how we combine protocols
  - Higher layers
  - Peer layers

Layer N+1
  e.g., HTTP

Layer N
  e.g., TCP

Home PC  www.cnn.com

Example – Layering at work
Layering Mechanics

Messages passed between layers

Layer N+1 PDU becomes Layer N ADU

A Packet on the Wire

Start of packet

End of packet
Internet Protocol Framework

<table>
<thead>
<tr>
<th>Model</th>
<th>Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link</td>
<td>Many (Ethernet, …)</td>
</tr>
<tr>
<td>Network</td>
<td>IP</td>
</tr>
<tr>
<td>Transport</td>
<td>TCP / UDP</td>
</tr>
<tr>
<td>Application</td>
<td>Many (HTTP, SMTP)</td>
</tr>
</tbody>
</table>

Problem 1: Reliability

- How can we communicate reliably and efficiently on a small network?
- Sources of unreliability
  - Corrupted data
  - Lost packets
  - Link & router failures
- State of the Internet as of 1985
This Lecture

How can we send a packet across a wire?
– Assume we have D to A, A to D converters

1. Coding:
2. Framing:

What are our goals for coding & framing?
Non-Return to Zero (NRZ)

0 = 0 0 0 0 1 1 0 1
1 = 1

Issues?

Manchester encoding

0 = 0 0 0 0 1 1 0 1
1 = 1

Alternative approach

• Use NRZI
  \[0 = \ldots, \quad 1 = \ldots\]

• And avoid
  \[0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 1 \quad 0 \quad 1\]

4B/5B encoding

• Encode 4 bits with 5 bits
• Find 16 5 bit codes such that there are no
XOR

• XOR data with a fixed, long, pseudo random bit string, e.g.
  10011011101000110100

Real systems

• Ethernet

• FDDI

• SONET
Framing

- Need to send a message, not just bits
- How can we signal where messages start & end?

Bit stuffing

- Example: PPP (Point-to-Point Protocol)

<table>
<thead>
<tr>
<th>Flag</th>
<th>(header)</th>
<th>Payload (variable)</th>
<th>(trailer)</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x7E</td>
<td></td>
<td></td>
<td></td>
<td>0x7E</td>
</tr>
</tbody>
</table>

- Occurrences of flag inside payload must be “stuffed”
  - Replace 0x7E with
  - Replace 0x7D with
Alternatives that avoid bit stuffing

• “Invalid” signal from physical layer
  – e.g. Manchester, 4B/5B

• Explicit byte count

• Fixed-size frames

Tradeoffs

• Efficiency (in terms of bandwidth)
• Robustness (with respect to errors)

• Example: frame size
How does this relate to layering?

Next time

• Coping with corruption: Error Detection & Correction
What was the muddiest point today? (tear off & return)