ECE 697J – Advanced Topics in Computer Networks

Packet Processing Algorithms and Data Structures
9/16/03
Packet Processing

- Software processing of packets
- Issues:
  - System goals
  - Buffer management
  - Network byte order
  - Bridge algorithm
  - Table lookups and hashing
  - IP fragmentation and reassembly
  - IP forwarding
  - TCP connection recognition
  - TCP splicing
System Goals

• “To allow it to run arbitrarily long, a network system must be designed with limits on all resources and the limits must be fixed independent of arriving traffic; designs that violate this principle will not be considered”

• Examples?

• Related statement: “Network systems should be designed to handle worst case traffic.”

• How is this different from a general workstation?
Packet Buffers

- How many packet buffers should be available?
  - Many to avoid loss
  - Few to avoid delay
- Variable-size buffer allocation can lead to fragmentation
  - Example?
- Buffer copying is expensive
  - Why?
  - What can be done to reduce buffer copies?
- What size should buffers be?
  - Max IP packet size is 64kB
Packet Sizes

- From caida.org:
Packet Sizes

- From caida.org:
Buffer Sizes

- Many packets are very small
- Almost no packets larger than 1500 bytes
- Buffer allocation schemes:
  - Large buffer
  - Linked list
- What are the pros and cons?
- Example implementation of buffer mechanism:
  - “mbufs” in BSD Unix operating system
mbufs

- Unix BSD packet mbufs:

- Also allows for large buffer
Byte Order

- Networks connect to heterogeneous end-systems
- Different end-systems implement things differently
- Byte order: arrangement of bytes that make up word

- Little endian:

- Big endian:

- Which systems implement what order?
  - Intel architecture: little endian
  - Network byte order: big endian
Byte Order Conversion

- Typical OS functions to adjust byte order:

<table>
<thead>
<tr>
<th>Function</th>
<th>data size</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ntohs</td>
<td>16 bits</td>
<td>Network byte order to host’s byte order</td>
</tr>
<tr>
<td>htons</td>
<td>16 bits</td>
<td>Host’s byte order to network byte order</td>
</tr>
<tr>
<td>ntohl</td>
<td>32 bits</td>
<td>Network byte order to host’s byte order</td>
</tr>
<tr>
<td>htonl</td>
<td>32 bits</td>
<td>Host’s byte order to network byte order</td>
</tr>
</tbody>
</table>

- This is a major source of programming errors!

- Side note: What are other annoying system convention that cause interoperability problems?
Next Class

• Ramu will present:
  – Packet classification
  – Scheduling
  – Read chapters 6 & 9

• Next Tuesday:
  – IP lookup paper (everybody read the paper!)
  – Protocol software on conventional processor (chapter 7)

• Other issue:
  – Presentation evaluation form