Announcements

- Homework 8 due Monday, 5/7. Online soon
- Final Project:
  - Demos in lab
  - Code snapshot due Wed./Thurs.
Today's Plan

- Transport protocols
  - UDP and ports
  - TCP and reliability
Networks Are Like Ogres
Networks Are Like Ogres

Data Link Layer

Physical Layer

Start bits

Packet Formats

On Off Keying ...
Networks Are Like Ogres

Network Layer
Data Link Layer
Physical Layer

Packet Switching
Start bits
On Off Keying ...

Ethernet
Packet Formats
WiFi
Networks Are Like Ogres

Internet Layer
Network Layer
Data Link Layer
Physical Layer

Physical Layer
On Off Keying ...
Packet Formats
Packet Switching
Start bits
Ethernet
WiFi
IP

Networks Are Like Ogres
Networks Are Like Ogres

Application Layer

HTTP

POP

SMTP

XMPP

Internet Layer

Packet Switching

Ethernet

WiFi

Network Layer

Packet Formats

Start bits

On Off Keying ...

Data Link Layer

Physical Layer
Computers Are Like Ogres

- ImageViewer
- SimplifierDriver
- POPClient
- ChatClient
- Squint
- Swing
- Abstract Windowing Toolkit
- MacOS X
- Linux
- Windows
- Intel X86

Intel X86 Computers Are Like Ogres
Networks Are Like Ogres

- Application Layer
  - HTTP
  - POP
  - SMTP
  - XMPP

- Internet Layer
  - IMAP

- Network Layer
  - Packet Switching
  - Ethernet
  - WiFi

- Data Link Layer
  - Start bits
  - Packet Formats

- Physical Layer
  - On Off Keying
Networks Are Like Ogres

- Application Layer
  - HTTP
  - POP
  - SMTP
  - XMPP

- Internet Layer
  - IMAP

- Network Layer
  - Packet Switching
  - Ethernet
  - WiFi

- Data Link Layer
  - Start bits
  - Packet Formats

- Physical Layer
  - On Off Keying

- Physical Layer
  - Start bits
  - Packet Formats
  - Ethernet
  - WiFi

- Internet Layer
  - IMAP

- Application Layer
  - HTTP
  - POP
  - SMTP
  - XMPP

- Network Layer
  - Packet Switching
  - Ethernet
  - WiFi
Network Applications

Firefox

Mail

UDP MODULE
TCP MODULE
IP MODULE
OPERATING SYSTEM

Apache

Server Applications

ISA DNS
Qpopper

UDP MODULE
TCP MODULE
IP MODULE
OPERATING SYSTEM

THE INTERNET
**IP Datagram Format**

<table>
<thead>
<tr>
<th>4</th>
<th>4</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP version</td>
<td>Hdr len</td>
<td>Service class</td>
<td>Packet Length</td>
</tr>
<tr>
<td>Packet Number</td>
<td>Fragment Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTL</td>
<td>Protocol</td>
<td>Error Check</td>
<td></td>
</tr>
<tr>
<td>From Addr</td>
<td>To Addr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DATA (up to 65516 bytes)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**UDP Packet Format**

<table>
<thead>
<tr>
<th>Source Port</th>
<th>Destination Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Length</td>
<td>Optional Error Check</td>
</tr>
<tr>
<td>DATA</td>
<td></td>
</tr>
</tbody>
</table>
## UDP packet inside IP packet

<table>
<thead>
<tr>
<th>4</th>
<th>4</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP version</td>
<td>Hdr len</td>
<td>Service class</td>
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<td>Protocol</td>
<td>Error Check</td>
<td></td>
</tr>
<tr>
<td>From Addr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To Addr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source Port</td>
<td>Destination Port</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>Optional Error Check</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DATA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
...inside Ethernet packet!

<table>
<thead>
<tr>
<th>PREAMBLE</th>
<th>TO</th>
<th>FROM</th>
<th>LENGTH/TYP</th>
<th>ERROR CHECK</th>
</tr>
</thead>
<tbody>
<tr>
<td>64</td>
<td>48</td>
<td>48</td>
<td>16</td>
<td>32</td>
</tr>
</tbody>
</table>

- **PREAMBLE**: 64 bits
- **TO**: 48 bits
- **FROM**: 48 bits
- **LENGTH/TYP**: 16 bits
- **ERROR CHECK**: 32 bits
Reasons IP packets get lost . . .
Electrical Interference
Back Hoes

http://www.scourstop.com/images/photos/full/backhoe.jpg
A Postal Service employee in Brooklyn told investigators he “made sure to deliver the important mail” after he was charged with stashing approximately 17,000 pieces of undelivered mail.

By Luis Ferré-Sadurní

April 21, 2018

A mail carrier in Brooklyn stashed about 17,000 pieces of undelivered mail for more than a decade because he was “overwhelmed” by the amount he had to deliver, the authorities said.
Queens postal worker busted for allegedly dumping 2,000 pieces of mail

By John Marzulli / New York Daily News / Wednesday, May 20, 2015, 11:26 AM

Norberto Cintron is the latest city postal worker to be busted for allegedly failing to deliver mail.

The Postal Service has uncovered another Newman in its ranks.

A Queens mail carrier was arrested Tuesday on charges of dumping at least 2,000 pieces of mail in the garbage.

Norberto Cintron, 30, assigned to the Queens Village postal station, was allegedly playing the real-life role of the “Seinfeld” show’s no-good, fictional mail carrier.
BELLMORE, Long Island — A postal worker was arrested Monday after dozens of bags filled with undelivered mail were found behind his home on Long Island, authorities said.

Postal agents visited the home of Richard A. Schaaf at Bellmore Avenue and West Adler in Bellmore last Tuesday.

Agents in search of missing mail opened the home’s backyard shed and found the postage stuffed into bags like garbage. They were acting on a tip, the inspector general said.

The bags contained more than 1,000 pieces of undelivered mail, some dating back as far as March 2017. The mail was intended to be delivered to residents and businesses in Nassau County, including the Bethpage area.

QUEUING

R4

R3

R1

R2
QUEUING

R4 - R3 - R2 - R1
QUEUING
D/R + L/C + queue delay
1. Article Addressed to:
Dennis Dillon
Nassau County District Attorney
262 Old Country Rd.
Mineola, NY 11501
Letter - Court Corruption

2. Article Number
7003 3110 0001 1629 5492

PS Form 3811, August 2001
Domestic Return Receipt
102535-02-M-1540

UNITED STATES POSTAL SERVICE

* Sender: Please print your name, address, and ZIP+4 in this box *
NORMAL TCP DATA TRANSMISSION

DATA

ACKNOWLEDGMENT
DATA LOSS

Timer expires → Retransmission → Data loss
ACKNOWLEDGMENT LOSS + PACKET DUPLICATION VS.
<table>
<thead>
<tr>
<th>SENDER: COMPLETE THIS SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete items 1, 2, and 3. Also complete Item 4 if Restricted Delivery is desired.</td>
</tr>
<tr>
<td>Print your name and address on the reverse so that we can return the card to you.</td>
</tr>
<tr>
<td>Attach this card to the back of the mailpiece, or on the front if space permits.</td>
</tr>
</tbody>
</table>

1. Article Addressed to:
   Dennis Dillon
   Nassau County District Attorney
   262 Old Country Rd.
   Mineola, NY 11501
   Letter-Court Corruption

2. Article Number
   (Transfer from service label)
   7003 3110 0001 1629 5492

<table>
<thead>
<tr>
<th>COMPLETE THIS SECTION ON DELIVERY</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Signature □ Agent</td>
</tr>
<tr>
<td>X</td>
</tr>
</tbody>
</table>

B. Received by (Printed Name) |
[Signature]

C. Date of Delivery |
[Signature]

D. Is delivery address different from item 1? □ Yes
   If YES, enter delivery address below: □ No

8. Service Type
   □ Certified Mail
   □ Express Mail
   □ Registered
   □ Return Receipt for Merchandise
   □ Insured Mail
   □ C.O.D.

4. Restricted Delivery? (Extra Fee) □ Yes

PS Form 3811, August 2001
Domestic Return Receipt
102596-62-M-1540

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**UNITED STATES POSTAL SERVICE**

* Sender: Please print your name, address, and ZIP+4 in this box *
Sequence and Acknowledgment Numbers

Loss Case

No Loss Case