ICS 351: Today's plan

- introduction to the HTTP protocol
- introduction to the TCP protocol
- introduction to the IP protocol
- introduction to the Ethernet protocol
- introduction to the 802.11/WiFi protocol

Introduction to the HTTP protocol

- HyperText Transfer Protocol
- data always sent over TCP/IP
- server is usually on port 80, sometimes on other ports
- protocol format includes a header and an optional body

HTTP example

- example request:

```
GET /~esb/ HTTP/1.1
Host: www2.hawaii.edu
Accept: */*
Connection: close
```

- example reply (beginning only):

```
HTTP/1.1 200 OK
Date: Wed, 03 Sep 2008 04:33:31 GMT
Server: Apache
Last-Modified: Sat, 10 May 2008 08:06:17 GMT
ETag: "de109-170-48255779"
Accept-Ranges: bytes
Content-Length: 368
Connection: close
Content-Type: text/html
```

- in-class exercise: what do this request and this reply tell us?
- HTTP data is always encoded using ASCII characters, not binary (e.g. the content length is a decimal number)

Introduction to the TCP protocol

- Transmission Control Protocol
- TCP is designed to run over packet-oriented protocols, such as IP, that don't guarantee to deliver all their packets
- TCP provides the abstraction of a stream of bytes sent reliably end-to-end
- TCP also provides different ports so different server applications may be reachable on the same machine (UDP also provides ports)
- the TCP header is always encoded in binary big-endian format, and includes:

    * a source and a destination port number,

    * a sequence number for the data carried in the packet,

    * an acknowledgement number

TCP connection setup

- TCP sends three packets to establish the connection before sending any data (the SYN, SYN-ACK, and initial ACK packet)
- tcpdump of the start of a TCP connection to www.hawaii.edu (edited for clarity):

```
% tcpdump host www.hawaii.edu
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 96 bytes
18:50:07.566744 IP zero.ics.hawaii.edu.52718 > www.hawaii.edu:
        S 1100198413:1100198413(0) win 5840 <
          mss 1460,sackOK,timestamp 568120014 0,nop,wscale 5>
18:50:07.567633 IP www.hawaii.edu > zero.ics.hawaii.edu.52718:
        S 3441676781:3441676781(0) ack 1100198414 win 24616 <
          nop,nop,timestamp 433923892 568120014,nop,wscale 0,
          nop,nop,sackOK,mss 1460>
18:50:07.567690 IP zero.ics.hawaii.edu.52718 > www.hawaii.edu:
        . ack 1 win 183
18:50:07.568045 IP zero.ics.hawaii.edu.52718 > www.hawaii.edu:
        P 1:554(553) ack 1 win 183
```

Introduction to the IP protocol

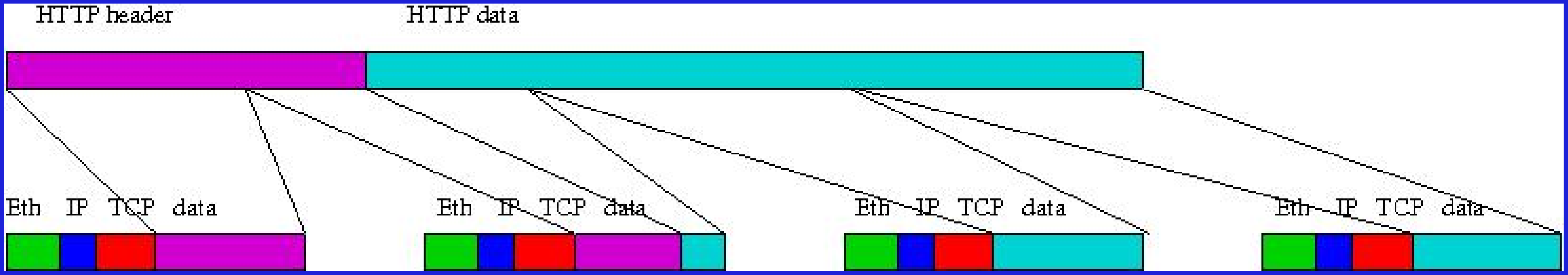
- the IP protocol adds a header to what comes from TCP
- this header includes the source and destination IP addresses, e.g. 127.171.25.102 (IPv4) or fe80::202:2ab:0e15:3223 (IPv6)
- IP then consults its routing table (even on a host) to determine the next hop and the interface to use to reach the next hop
- the packet is sent to that next hop using whatever mechanism is appropriate for the network connected to that interface, e.g. Ethernet, WiFi, PPP, etc

Introduction to the Ethernet protocol

- the Ethernet protocol adds a header to what comes from IP
- this header includes the source and destination Ethernet (hardware, MAC) addresses, e.g. 01:ab:0e:15:32:23
- an automatically constructed table, the Address Resolution Protocol table (ARP table), is used to determine the Ethernet address of the next hop given the IP address of the next hop
- Ethernet performs Medium Access Control (MAC): it has to determine when nobody else is sending on the same medium so it is OK to send a packet

HTTP over TCP over IP over Ethernet

- HTTP always runs over TCP, TCP always runs over IP
- IP can run over many different local area technologies, including PPP, Ethernet, WiFi, etc.
- the TCP protocol splits the application stream so it is carried by successive IP packets (and retransmitting when necessary)
- the HTTP request header is at the start of the TCP connection, the HTTP reply header is at the start of the TCP data sent in the opposite direction
- each packet contains an Ethernet header followed by an IP header followed by a TCP header followed by the TCP data, which is part of the HTTP request or reply



Introduction to the 802.11/WiFi protocol

- 802.11 is in some ways very similar to Ethernet (802.3): the header is added to each IP packet, and it contains the source and destination address
- 802.11 is different in the way MAC is done:

  o a transmitter cannot tell whether its message is colliding with another message

  o so instead, transmitter and receiver exchange short packets to tell everyone in range to keep quiet for the duration of the data packet

  o the short packets are Request To Send (RTS) and Clear To Send (CTS)

  o the data packet is acknowledged with a short ACK packet
- 802.11 also provides different forms of security: WEP (very weak), or 802.11i (much better), which provides WPA and WPA2