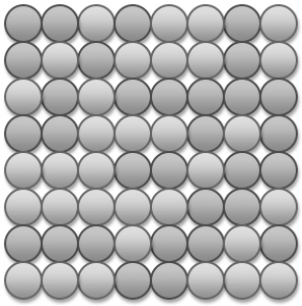


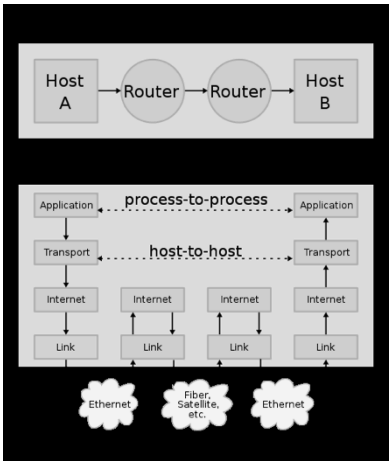
UNIT 11B

The Internet: Network Layers, Protocols

Communications Protocol

- Protocol:
  agreement between communicating parties
  - syntax: how are the messages' contents organized?
  - semantics: what do the messages mean?
  - synchronization: when are messages sent?
- Computers use protocols to communicate with each other.

Layers of the TCP/IP Reference Model

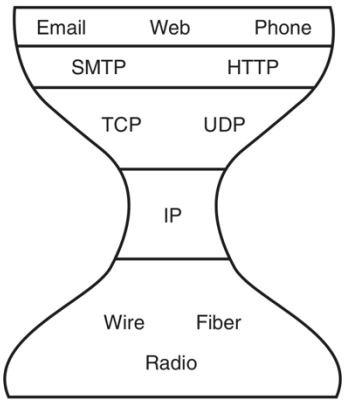


wikipedia.org/wiki/File:IP_stack_connections.svg

Layers of the TCP/IP Reference Model

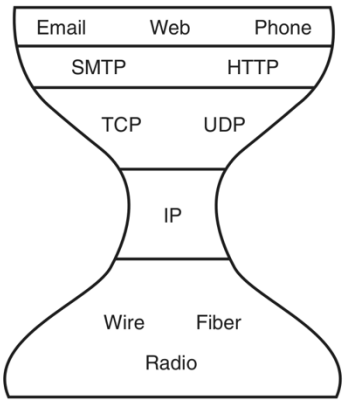
- Application Layer
  - Handles requests from the user for data on the Internet.
- Transport Layer
  - Handles splitting messages into packets for delivery.
- Internet Layer
  - Handles the task of sending packets across one or more networks.
- Link Layer
  - Handles the physical transfer and reception of bits.

Examples of Protocols



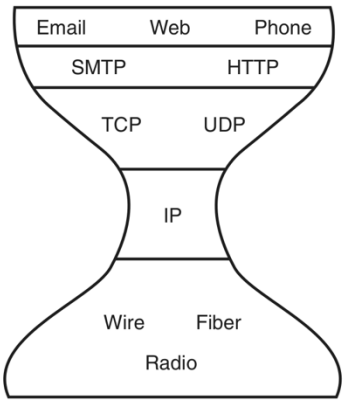
- Application
  - Hypertext Transfer Protocol (HTTP)
  - Simple Mail Transfer Protocol (SMTP)
  - Domain Name System (DNS)
    - XYZ.com **! w.x.y.z**
  - Secure Shell (SSH) Protocol
    - ssh unix.andrew.cmu.edu
  - Voice Over IP (Phone calls)
    - Session Initiation Protocol (SIP)
    - Real-time Transport Protocol (RTP)

Examples of Protocols



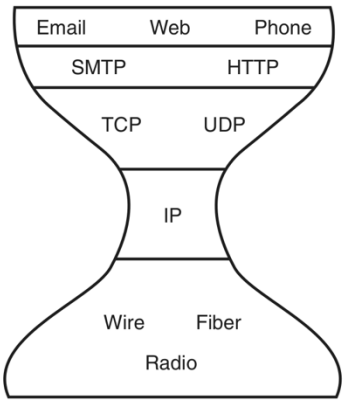
- Transport
  - Transmission Control Protocol (TCP)
    packet transmission with checks for dropped packets to resend missing packets
  - User Datagram Protocol (UDP)
    best effort delivery, good for streaming

Examples of Protocols



- Internet
  - IPv4
    handles directing packets to the appropriate destination, routing
  - IPv6

Examples of Protocols



- Link
  - 1000BaseT
    — Gigabit Ethernet
  - Data Over Cable Service Interface Specification
    — Cable Modems
  - Long Term Evolution (LTE)
    – 4G cell phone
  - 802.11N (Wi-Fi) — Wireless Ethernet

Host Names

Domain Name Service (DNS)

- gets the IP address for a given name over TCP or UDP
- hierarchical
  - root name servers knows how to find dns servers for each top-level domain (e.g., "edu")
  - top-level domain servers know how to find dns servers for each second-level domain (e.g., "cmu.edu")
  - second-level domain servers know how to find each host in directly in the second-level domain (e.g., "www.cmu.edu") and how to find dns servers for each third-level domain (e.g., "andrew.cmu.edu")

Web

Hypertext Transfer Protocol (HTTP)

- retrieves documents (in HTML and other formats) over TCP (port 80)
- can also send form data to the server
- support multiple requests per connection

An HTTP Request

`http://www.cs.cmu.edu/~vonronne/hello.txt`

TCP connection to port 80 at 128.2.217.13:

```
GET /~vonronne/hello.txt HTTP/1.1
Host: www.cs.cmu.edu
```

Content Agnostic IP Routers?

- Do router's know or need to know what kind of data they are carrying?
  - No. Everything is just an IP packet with a destination, and some data.
  - But they could, e.g., look at the data inside the packet and prioritize based on the contents.
- Why might an ISP do this?
  - quality of service (avoiding dropped calls)
  - prioritizing some content over others

Net Neutrality

- Should different kinds of packets be treated differently?
- The principle of net neutrality advocates no restrictions by ISPs or governments on consumers' access to networks that participate in the Internet.

Net neutrality means simply that all like Internet content must be treated alike and move at the same speed over the network. The owners of the Internet's wires cannot discriminate. This is the simple but brilliant "end-to-end" design of the Internet that has made it such a powerful force for economic and social good.
– Lawrence Lessig and Robert W. McChesney (Washington Post, June 8, 2006)

Benefits and Costs of Legislating Net Neutrality

Pros

- control of data
- digital rights and freedoms
- competition and
- innovation
- preservation of internet
- standards
- end-to-end principle

Cons

- property rights
- innovation and investment
- counterweight to server
- side non-neutrality
- bandwidth availability
- opposition to legislation