“Since we got it, he hasn’t moved from that spot for eleven straight days. Oddly enough they call this ‘getting up and running’ on the internet.”
Today’s lecture

- How the Internet works
- Network protocols
What’s the Internet: “nuts and bolts” view

- millions of connected computing devices:
  - *hosts* = *end systems*
  - running *network apps*

- **communication links**
  - fiber, copper, radio, satellite
  - transmission rate: *bandwidth*

- **Packet switches**: forward packets (chunks of data)
  - *routers* and *switches*
What’s the Internet: a service view

- Infrastructure that provides services to applications:
  - Web, VoIP, email, games, e-commerce, social nets, ...

- Provides programming interface to apps
  - Hooks that allow sending and receiving app programs to “connect” to Internet
  - Provides service options, analogous to postal service

A closer look at network structure:

- **network edge:**
  - hosts: clients and servers
  - servers often in data centers

- **access networks, physical media:** wired, wireless communication links

- **network core:**
  - interconnected routers
  - network of networks
Packet-switching network

- Data is broken into **packets**, which are then sent on the best route in the network
- Each node on the route sends the packet onto its next destination, avoiding congested or broken nodes

The original message is **Green, Blue, Red**.
Types of networks

- Local Area Network (LAN)
  - Connect networking equipment located geographically close together (e.g., campus, office)

- Metropolitan Area Network (MAN)
  - Connect computing equipment over larger distances than a LAN (e.g., a city)

- Wide Area Network (WAN)
  - Connect LANs and other networks over large geographic distances.
How the Internet works

Networking hardware

IP addresses and Domain names

Protocols

Client and server software

The Internet
Networking hardware

- **Connection**
  - Wired, eg. Ethernet
  - Wireless, eg. Wi-Fi, cellular

- **Network card**
  - Can be built into the motherboard or an expansion card
  - Some network cards support wired and wireless connections

- **Switch**
  - Used to connect multiple devices to the same network

- **Router**
  - Directs traffic around the network and connects networks together
Networking hardware

- **Modem (modulator/demodulator)**
  - Responsible for transmitting and receiving data on the physical medium
  - For example, a modem:
    - **Modulates** data from computer/router onto a phone line
    - **Demodulates** signals from a phone line and sends to the computer/router

- There are different kinds of modems
  - Dial-up modems up to 56Kbs
  - Broadband (DSL - digital subscriber line) modems between 256Kbs to 20Mbs
Protocol

- Protocol: a standardised method of communication
- Ensures that the sender and receiver can communicate properly
- Protocols define
  - Format
  - Order of messages sent and received among network entities
  - Actions taken on message transmission, receipt
Protocols

- Common Internet protocols:
  - TCP: transports data reliably
  - UDP: transports data faster but less reliably
  - FTP: used for transferring files over a network
  - HTTP: used for client/server communication such as transferring web pages

- Many protocols used in networking are defined in a RFC (Request for Comments) document
  - RFC 791: IP
  - RFC 2616: HTTP
IP Address

- Every host on the Internet needs an IP address.

- Version 4
  - 32-bit number
  - Maximum addresses possible $2^{32}$ (~4.3 billion)

- Version 6
  - 128-bit number

https://www.thegeekstuff.com/2012/01/ip-address-fundamentals/
IP addresses and domain names

- Domain name system (DNS) is used to convert between IP addresses and human-readable text (domain name)

- DNS servers perform the translation between IP address and URL
Client and server software

- Client software:
  - Web browsers
  - Email clients:

- Server software:
The Internet’s backbone

- High-capacity fibre optic cables laid on land and under the sea
- Owned by companies who rent out capacity on the cables
- They connect countries together to form the global Internet so are extremely important
  - Having multiple backbone cable connections provides extra capacity and redundancy
The Internet’s backbone

Go to www.submarinercablemap.com to see the undersea backbone cables
Questions

- What network model does the Internet use?
- What protocol should your program use if it is time-sensitive?
- What is the name of the documents that describe the technical details of protocols?
Answers

- What network model does the Internet use?
  - Packet-switched network

- What Internet protocol should your program use if it is time-sensitive?
  - UDP - user datagram protocol

- What is the name of the documents that describe the technical details of protocols?
  - RFCs - request for comments
Summary

- The Internet is a packet-switching network consisting of multiple networks joined together.

- A number of protocols and technologies underpin the Internet.

- As more people use the Internet, organisations tasked with maintaining it need to ensure the Internet can handle the increased demand (e.g., moving from IPv4 to IPv6).