CS31204: Computer Networks

Spring 2024

“We typed the L and we asked on the phone,

"Do you see the L?"

"Yes, we see the L," came the response.

We typed the O, and we asked, "Do you see the O."

"Yes, we see the O."

Then we typed the G, and the system crashed …

Yet a revolution had begun"

General Information

- Books:
  - *Data & Computer Communications* (10th ed.) by William Stallings
  - *Internetworking with TCP/IP Volume 1* (6th ed.) by Douglas Comer
  - *TCP/IP Guide* by Charles M. Kozierok

- Course website:

  http://cse.iitkgp.ac.in/~agupta/networks

Introduction

What is a Network?

- A collection of machines/devices that communicate with each other over some communication medium
- Two machines may be directly connected, or can communicate through other machines
  - Different topologies possible
- Some machines are sources and destinations of data
- Some devices do not generate data, but facilitate in the transfer (ex. a router)

Protocols

- Rules for communications between two communicating entities
- Entities can be
  - Applications – e-mail, telnet, ftp, web browser…
  - Systems – terminals, computers…
- Must speak the same language to understand each other
- Specifies syntax, semantics, and timing of communication

A Bit of History

- Telephone networks
  - Established direct communication between distant, indirectly connected systems (telephone handsets)
  - Established paths through multiple telephone exchanges using a technique called circuit switching
  - First telephone switch: 1878, New Haven, Connecticut, USA

Beginning of Packet Switching

Robert Taylor was promoted to the head of the information processing office at **Defense Advanced Research Projects Agency (DARPA)** in June 1966. He intended to realize **Licklider's** ideas of an interconnected networking system. Bringing in **Larry Roberts** from MIT, he initiated a project to build such a network. The first ARPANET link was established between the **University of California, Los Angeles (UCLA)** and the **Stanford Research Institute** at 22:30 hours on October 29, 1969.

Kleinrock said in an interview: "We typed the L and we asked on the phone,

"Do you see the L?"

"Yes, we see the L," came the response.

We typed the O, and we asked, "Do you see the O."

"Yes, we see the O."

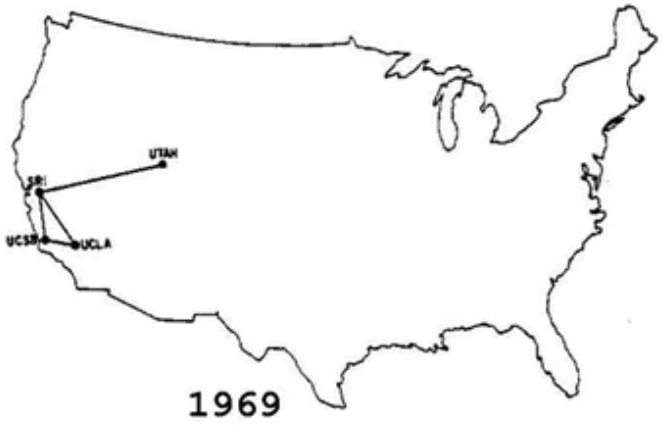
Then we typed the G, and the system crashed …

Yet a revolution had begun"

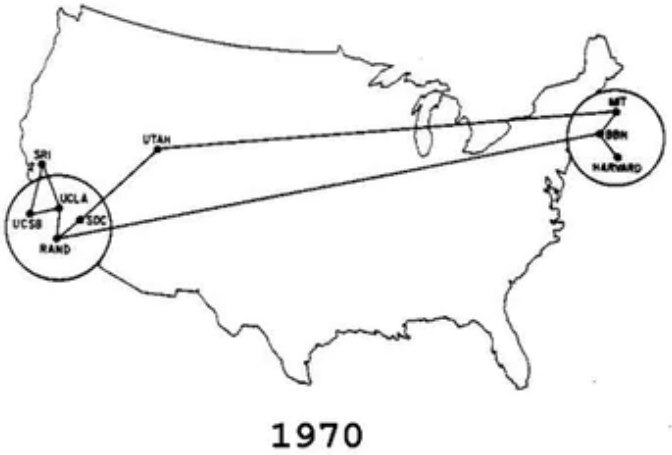
By December 5, 1969, a 4-node network was connected by adding the University of Utah and the University of California, Santa Barbara.

Courtesy:Wikipedia

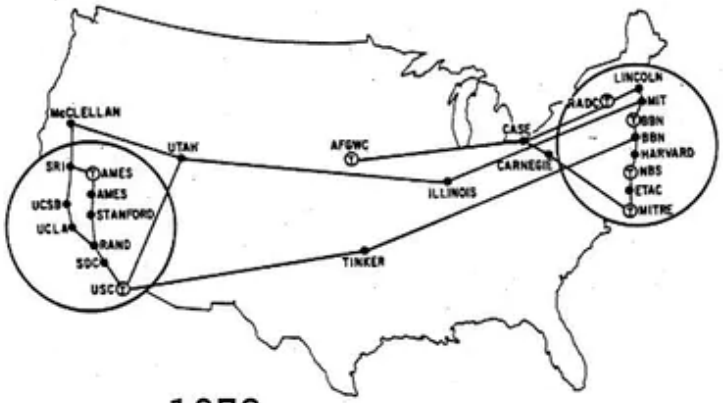
ARPANET



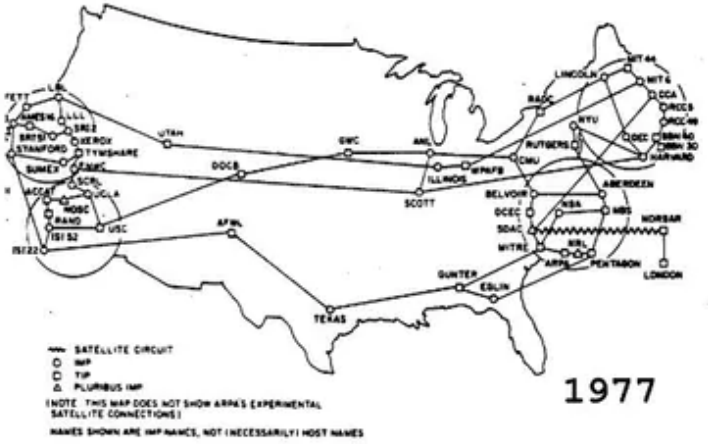
1969



1970



1972



1977

- ARPANET extended by NSF to provide connectivity to academic institutions (1981)
  - CSNET
- NSF funded 5 supercomputing centers in mid 80's, connected them with network
  - NSFNET (1986)
- ARPANET formally decommissioned in 1990
- NSFNET Backbone speeds
  - 56 Kbps in 1986
  - 1.55 Mbps in 1988
  - 45 Mbps in 1991
- Huge growth of networks operated by commercial operators since then, NSF had major role to play in the early years in architecting the current Internet

Local Area Networks: Ethernet

- Developed in Xerox PARC in early 1970s
  - ***Ethernet: Distributed Packet Switching for Local Computer Networks, by Robert M. Metcalfe and David R. Boggs (****Communications of the ACM, Vol. 19, No. 5, July 1976)*
- DIX standard published in 1980 by DEC, Intel, Xerox
- Revised as Ethernet-II standard in 1982
- IEEE 802.3 published in 1983
- De-facto standard for LANs
- From original 10 Mbps LANs, we now talk about 100+ Gbps LANs

Types of Networks

- Local Area Networks (LAN)
  - A set of nodes interconnected by switches
  - Spans a small geographical area
  - Under a single administrative domain
- Wide Area Networks (WAN)
  - A set nodes interconnected by switches/routers
  - Spans a large geographical area
  - Different parts may be under different administrative domains
    - But following agreed-upon protocols for interoperation
- Will discuss LAN and WAN in more detail later

Organization of the Course

- Basics of data communication
- Suppose you have only two machines connected directly by a link. How can you make them communicate reliably?
  - Synchronization, encoding, flow control, error detection, error control
- Suppose you have more than two machines, but still connected directly by a single link. How can you make them communicate reliably?
  - How can more than two machines be even connected with a single link?
  - How do they share the link without conflict?
    - Medium access control, addressing

Organization of the Course (contd.)

- Building networks with any number of machines, which may not be connected with direct links
  - How to organize the hardware and software
    - Protocol architecture, layering, OSI and TCP/IP layers and their functions
  - Local Area Networks (LANs) - Ethernet
  - Wide Area Networks (WANs)
    - How to find and maintain a path between two machines
      - Packet and circuit switching, Routing algorithms
    - TCP and IP for end-to-end communication
- Configuration and naming protocols –DHCP, DNS
- Application Layer Protocols
- Other advanced topics depending on time

Goals

- Understand the architecture of modern day networks, and the basic protocols and devices used
  - Tradeoffs involved in protocol design, scaling networks, device interconnections
- At the end of this course, you should be able to explain how some of the everyday things you use over the network works underneath
  - How does your mail reach its recipients, a web page opens, file transfer over the net happens, your google search reaches google, …
  - Should be able to explain the protocols in play, the packet formats, the path and transformation of the packets on their way
  - Should have an idea about the design of these protocols
  - Should be able to identify the physical infrastructure/devices that makes it possible and their interconnection
  - There will be some gaps (this is just one course), but a large part of it should be clear (at least, we will try to ☺)