Introduction

What is a computer network?

Components of a computer network:

- hosts (PCs, laptops, handhelds)
- routers & switches (IP router, Ethernet switch)
- links (wired, wireless)
- protocols (IP, TCP, CSMA/CD, CSMA/CA)
- applications (network services)
- humans and service agents

Hosts, routers & links form the *hardware* side.

Protocols & applications form the *software* side.

Protocols can be viewed as the "glue" that binds everything else together.

A physical network:

Protocol example: low to high

- NIC (network interface card): hardware

  → e.g., Ethernet card, WLAN card
- device driver: part of OS
- ARP, RARP: OS
- IP: OS
- TCP, UDP: OS
- OSPF, BGP, HTTP: application
- web browser, ssh: application

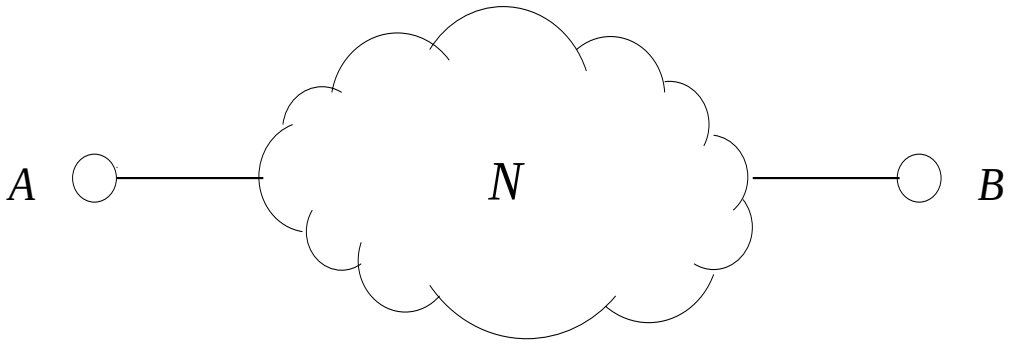
  ⟶ multi-layered glue

What is the role of protocols?

⟶ facilitate communication or networking

Simplest instance of networking problem:

> Given two hosts A, B interconnected by some network N, facilitate communication of information between A & B.



Information abstraction

- representation as objects (e.g., files)
- bytes & bits

  $\rightarrow$ digital form
- signals over physical media (e.g., electromagnetic waves)

  $\rightarrow$ analog form

Minimal functionality required of A, B

- encoding of information
- decoding of information

$\longrightarrow$ data representation & a form of translation

Additional functionalities may be required depending on properties of network N

- information corruption

  $\rightarrow 10^{-9}$ for fiber optic cable

  $\rightarrow 10^{-3}$ or higher for wireless

- information loss: packet drop
- information delay: like toll booth, airport
- information security

Network N connecting two or more nodes can be

- point-to-point links
- multi-access links
- internetworks

  $\longrightarrow$ physical vs. logical topology

  $\longrightarrow$ e.g., peer-to-peer, VPN

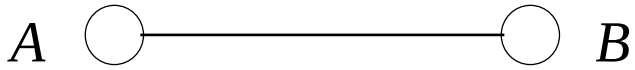
Network medium may be

- wired
- wireless

Node (e.g., hosts, routers) may be

- stationary
- mobile

Point-to-point links

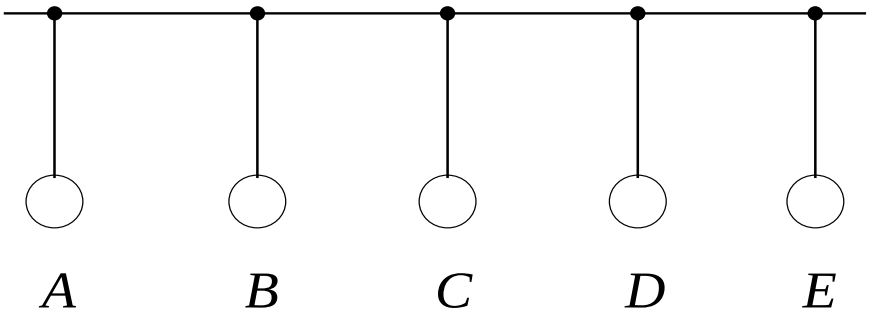


- various "cables"
- line of sight wireless communication

  → directional antennas
- no addressing necessary

  → special case

Multi-access links



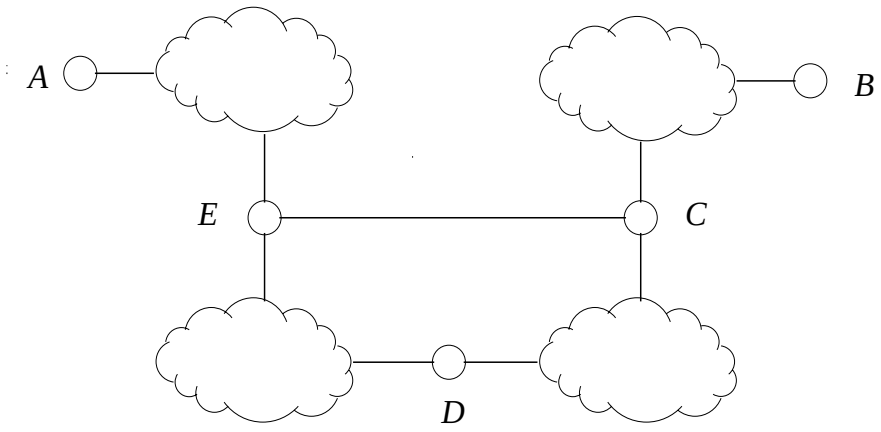
- bus (e.g., old Ethernet)
- wireless media

  → omni-directional antennas
- broadcast mode (physical; not logical)

  → listen to everything: promiscuous mode
- access control: i.e., bus arbitration

  → resolve contention and recover from interference
- addressing necessary

Internetwork



- recursive definition

  → point-to-point and multi-access: internetwork

  → composition of one or more internetworks

- addressing necessary
- path selection between sender/receiver: routing
- how much to send: congestion control
- protocol translation: internetworking
- location management: e.g., Mobile IP

LAN (local area network) vs. WAN (wide area network) distinction:

- LAN: point-to-point, multi-access
- WAN: internetwork

  $\longrightarrow$ geographical distinction is secondary

  $\longrightarrow$ often go hand-in-hand

  $\longrightarrow$ counter example?

Myriad of different LAN technologies co-existing in a WAN. For example:

- Fast Ethernet (100 Mbps)
- Gigabit Ethernet (1000 Mbps)
- WLAN (54 or 11 Mbps)
- FDDI (Fiber Distributed Data Interface)
- wireless Ethernet (11 Mbps, 54 Mbps)
- SONET
- ATM
- modem/DSL

$\longrightarrow$ WAN is a collection of LANs

Each LAN, in general, speaks a different language.

⟶ message format

⟶ procedural differences

Internetworking solves this problem by translating everything to IP . . .

⟶ technical definition of **I**nternet

But:

⟶ IP is not necessary

⟶ e.g., large systems of layer 2 switches

⟶ trend: L2 (70s & 80s) → IP (90s) → L2 (Y2K+)

⟶ IP remains central glue

Remark on addresses (aka names):

Communicating entities are *processes* residing on nodes A and B running some operating system.

Thus an *address* must also identify which process a message is destined for on a host.

$\longrightarrow$ e.g., port number abstraction