Week 1: Introduction to Networks & Operating Systems

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Network is a system of links that interconnect “nodes” to move “information” to different nodes.

Types of Networks

- Internet
- Telephone Network
- Transportation Network
- Cellular Network
- Supervisory control & data acquisition networks
- Optical Network
- Sensor Network

Channels and times

Frquency division multiplexing (FDM) - different channels transmitted in different frquency bands

Time Division multiplexing (TDM) - time divided slots allocating a time instead of a channel

DSL - digital subscriber line → for telehpone networks and internet

$$\text{packet transmission delay} = \text{time needed to transmit } L\text{-bit packet into link} = \frac{L \text{ (bits)}}{R \text{ (bits/sec)}}$$

Key Concepts

- **Operating System (OS):** Software that manages hardware resources and provides services for computer programs
- **Network:** Collection of computers and devices interconnected to share resources and information

Operating System Functions

- Process Management
- Memory Management
- File System Management
- Device Management
- Security and Protection
- User Interface

Types of Operating Systems

- **Single-user:** Designed for one user at a time (e.g., Windows, macOS)
- **Multi-user:** Supports multiple users simultaneously (e.g., Unix, Linux)
- **Real-time:** Guarantees task completion within specific time constraints
- **Distributed:** Manages resources across multiple computers

Network Fundamentals

- **Network Types:**
  - LAN (Local Area Network)
  - WAN (Wide Area Network)

    - MAN (Metropolitan Area Network)
- **Network Components:**
    - Routers
    - Switches
    - Network Interface Cards (NICs)
    - Cables and Connectors

Network Protocols

- TCP/IP (Transmission Control Protocol/Internet Protocol)
- HTTP (Hypertext Transfer Protocol)
- FTP (File Transfer Protocol)
- SMTP (Simple Mail Transfer Protocol)

Key Learning Outcomes

- Understanding basic OS concepts and functions
- Identifying different types of networks and their components
- Knowledge of common network protocols
- Understanding the relationship between OS and networks

Network Tiers

- **Tier 1:**
    - Global reach with extensive network infrastructure.
    - Peer directly with other Tier 1 providers, essentially exchanging traffic for free.
    - Examples: Level 3, NTT, AT&T
- **Tier 2:**
    - Smaller geographical reach compared to Tier 1.

- Purchase transit from Tier 1 providers to access the wider internet.
- May offer peering with other Tier 2 providers in their region

- **Tier 3:**
  - Typically smaller regional ISPs.
  - Buy transit exclusively from Tier 1 or Tier 2 providers.
  - Primarily serve individual consumers and small businesses

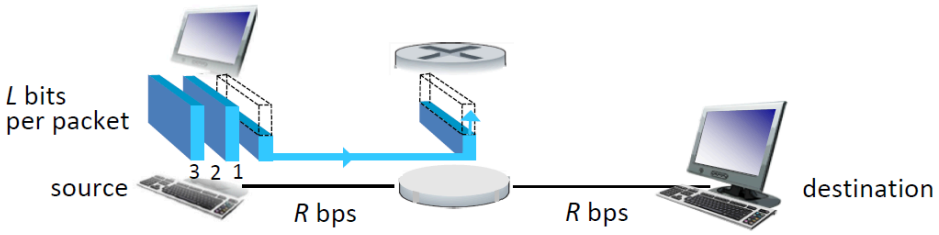
Scaling for total connections

N = Number of ISPs

Total connections = (N x (N - 1) / 2

Packet Switching for delays

Packet-switching: store-and-forward



- Transmission delay: takes *L*/*R* seconds to transmit (push out) *L*-bit packet into link at *R* bps
- *Store and forward: entire* packet must arrive at router before it can be transmitted on next link
- *End-end delay:* 2*L*/*R* (above), assuming zero propagation delay (more on delay shortly)

One-hop numerical example:
- *L* = 10 Kbits
- *R* = 100 Mbps
- one-hop transmission delay = 0.1 msec

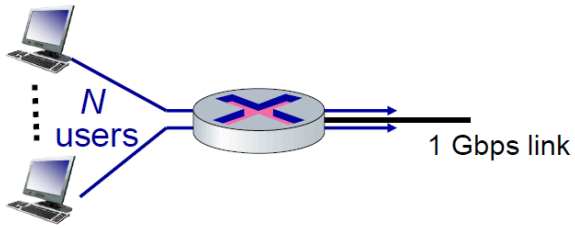
Probability within packet switching vs circuit switching

Packet switching versus circuit switching

packet switching allows more users to use network!

Example:

- 1 Gb/s link
- each user:
  - 100 Mb/s when "active"
  - active 10% of time



- *circuit-switching:* 10 users
- *packet switching:* with 35 users, probability > 10 active at same time is less than .0004 *

Q: how did we get value 0.0004?

Q: what happens if > 35 users ?

why probability > 10 active at same time is less than 0.0004

- Given scenario:
  - - Link capacity: 1 Gbps- Each user uses 100 Mbps when active
  - - Users are active only 10% of the time
  - - There are 35 users in total

$$f(x) = \mathrm{P}[X = x] = \binom{n}{x} p^x (1 -$$

The calculation steps:

1. We need to find P(X > 10) where X is the number of active users
   This equals 1 - P(X ≤ 10)
2. Using the Binomial Distribution formula: P(X = k) = C(n,k) × p^k × (1-p)^(n-k)
   - n = 35 (total users)
   - k = number of active users
   - p = 0.1 (probability of being active)
3. We need to sum: P(X ≤ 10) = P(X = 0) + P(X = 1) + ... + P(X = 10)
4. Then: P(X > 10) = 1 - P(X ≤ 10)

Packet switching VS circuit switching.

- The probability (.0004) refers to the likelihood that more than 10 users will be active simultaneously:

- 1. Capacity Check:- 10 simultaneous users × 100 Mbps = 1 Gbps
- This means the link can handle exactly 10 active users at full capacity

- 2. The Probability:
  - - This follows a binomial probability distribution because:
    - Each user has two states (active/inactive)
    - Users are independent
    - Each user has the same probability of being active (10%)

These notes provide a foundation for understanding both operating systems and networks. Future weeks will build upon these concepts in more detail.