



Networks, Part 1

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Networks

What is a Network?

- A system containing at least two components that can communicate
- Communication done via point to point links
- Most networks have shared links
 - Lower cost, assuming sufficient bandwidth
 - Tradeoff - Introduces complexity

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Networks, cont.

Isynchronous Networks

- Connections are set up and torn down
- Fixed-length messages sent at regular intervals
- Messages don't need source/destination addresses
- Predictable bandwidth, reliable transport

➡ Works great for voice

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Networks, cont.

Asynchronous Networks

- No explicit connections, no explicit state
- Variable-length messages, sent at any time
- Messages need to be addressed, and possibly broken down into smaller units
- No guarantees - "best effort" delivery of data, variable latency

➡ Works better for bursty traffic (e.g., the Internet)

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Store and Forward Network

- A type of asynchronous network
- Packet Switchers receive and route packets through a network interconnect
- Computers attach to the interconnect via well-defined Network Access Points
- Queuing delay - how long a packet is held before it is transmitted
 - Queuing theory predicts delay will increase exponentially as network utilization increases

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Problem: Congestion

- Happens when a packet switcher's buffer overflows
 - High-cost solutions: increase buffer size, add more links
 - Inexpensive solution: Drop packets
 - Tradeoff: Dropped packets vs. busy signals

➔ End to End design - sometimes dropping packets matters, sometimes it doesn't

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Network Layering

- Problem: Reduce the complexity of dealing with a network
- Approach: Network layering
- A network layer is an abstraction over the underlying layer
 - Still have the same ol' network underneath
 - New layer presents a different network protocol
- Protocol - a contract by which all users of a network must abide
 - e.g., Ethernet, TCP/IP, Appletalk, 802.11b

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Open Systems Interconnection Layers

Layer	Description	Examples
Application	Protocols that are designed to meet the communication requirements of specific applications, often defining the interface to a service.	HTTP, FTP, SMTP, CORBA IIOP
Presentation	Protocols at this level transmit data in a network representation that is independent of the representations used in individual computers, which may differ. Encryption is also performed in this layer, if required.	Secure Sockets (SSL), CORBA Data Rep.
Session	At this level reliability and adaptation are performed, such as detection of failures and automatic recovery.	
Transport	This is the lowest level at which messages (rather than packets) are handled. Messages are addressed to communication ports attached to processes. Protocols in this layer may be connection-oriented or connectionless.	TCP, UDP
Network	Transfers data packets between computers in a specific network. In a WAN or an internetwork this involves the generation of a route passing through routers. In a single LAN no routing is required.	IP, ATM virtual circuits
Data link	Responsible for transmission of packets between nodes that are directly connected by a physical link. In a WAN transmission is between pairs of routers or between routers and hosts. In a LAN it is between any pair of hosts.	Ethernet MAC, ATM cell transfer, PPP
Physical	The circuits and hardware that drive the network. It transmits sequences of binary data by analogue signalling, using amplitude or frequency modulation of electrical signals (on cable circuits), light signals (on fibre optic circuits) or other electromagnetic signals (on radio and microwave circuits).	Ethernet base-band signalling, ISDN

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Simplify Into Three Layers

- Link - Connect packet switches to each other and to end users
- Network - Get packets from source to destination
- End-to-End - Builds application-specific abstraction over the "best efforts" network

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Link Layer

- Typical approach to implementation:
 - A phase-locked loop to read the signals
 - An encoding that creates signal transitions for the PLL (e.g., 1 as 01, 0 as 10)
- Framing - separate packets (e.g., 6 1's + bit stuffing)
- Error detection/correction - use checksums

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Link Layer, cont.

- Provide link multiplexing and multi-network protocol support for network layer
- Transmission properties: simplex, duplex, half-duplex, full-duplex, broadcast

➔ Link layer supports lots of different types of physical links

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Network Layer

- Implements store and forward to/from computers on the network
 - Implements a notion of network addresses
 - Must help route packets (where to next?)
- Pushes packet up to end-to-end layer when packet reaches destination

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Network Layer, cont.

- Must help route packets (where to next?)
 - optimizing routing is non-trivial
- A linear table does not scale
- A hierarchical approach scales much better
 - What about mobility?
- Internet uses 4 8-bit addresses, but that's too few