CS4254

Computer Network Architecture and Programming

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Introduction

Outline

- Introduction
- Internet Layers
- Internet Data Packet transmission and Addressing
- Network Protocols
- A glimpse at the OSI model and Internet protocol suite

Introduction 1/2

- What is a network? Set of nodes connected by communication links
  - ➢ Components
    - ✓ (Network edge) Computing devices (end hosts, PDAs, …) connected to the network
    - ✓ (Network core) Routers/switches that move data through the network
    - ✓ (Media) Physical links that carry information (fiber, copper, radio, and satellite)
    - ✓ Applications that communicate with each other to provide services (Email, file transfer, and Web browsing).
- What is an internetwork? A network of networks (an internet)
  - Specific example is the ***Internet***

Introduction 2/2

- Network physical topology
  - ➢ Geometric representation of the relationship of all the links and nodes to one another
  - ➢ Categories: *mesh*, *star*, *bus*, and *ring*
- Network Categories
  - Local-Area Network (LAN)
  - Metropolitan-Area Network (MAN)
  - Wide-Area Network (WAN)
  - Personal-Area Network (PAN)

The Internet 1/2

- ARPA (Advanced Research Projects Agency) in DoD wanted to find a way to connect computers that were stand-alone in mid 1960s
- In 1967, ARPA presented idea for ARPANET (an ACM meeting)
- In 1969, ARPANET was a reality (4 nodes → UCLA, UCSB, Stanford Research Institute SRI, and Univ. of Utah)
- In 1973, landmark paper (by Vint Cerf and Bob Khan) outlined protocols to achieve end-to-end delivery of packets (TCP)
- Split TCP into 2 protocols: IP to handle datagram routing, and TCP higher-level functions such as segmentation, reassembly, and error detection
- For Internet pioneers, see http://www.ibiblio.org/pioneers/

The Internet 2/2

- Not a simple hierarchical structure (For a host count, see http://www.isc.org/ops/ds/host-count-history.php)
- Internet Service Providers
  - ➢ International/National/Regional service providers versus Local service providers (direct service to end-users)
- Internet Standards → RFCs (Request For Comments) by IETF (Internet Engineering Task Force)
- Internet Protocols: control sending and receiving of messages (TCP, IP, HTTP, FTP, …)
- Communication Services →Connectionless or Connection-oriented

Connection-oriented versus Connectionless 1/2

•Connection-oriented

➢Setup data transfer ahead of time (through *handshaking*)

➢Internet's connection-oriented service is TCP (Transmission Control Protocol) [RFC 793]. It provides

✓reliable, in-order byte delivery

✓flow control

✓congestion control.

➢Applications using TCP: Email (SMTP), web browsing (HTTP), and file transfer (FTP)

Connection-oriented versus Connectionless 2/2

•Connectionless

➢Internet's connectionless service is UDP (User Datagram Protocol) [RFC 768] . It provides

✓unreliable data transfer

✓no flow control

✓no congestion control

➢Applications using UDP: streaming media, video conferencing, and IP telephony

Network Protocols

•Applications to communicate across a computer network

➢Invent a *protocol* (an agreement how will communicate)

➢Which application is expected to initiate communicate and when responses are expected

✓Syntax: format of data

✓Semantics: meaning of each section of bits (How it is interpreted and what action (s) to be taken)

✓Timing: when data should be sent and how fast?

•Example: Web Server and Web client

•Other examples? Other modes of communication?

Protocol "Layers" 1/2

•Used in daily life! → 2 friends communicating through the mail (sender, receiver, and a carrier)

•Sender side

➢Layer 1: Write letter, insert letter in envelope, write sender and receiver address, drop letter in mailbox

➢Layer 2: letter picked up by carrier and delivered to post office

➢Layer 3: letter stored at post office, a carrier transports the letter

•On the way → Letter on the way to recipient's local post office (maybe through a central office), transported by truck, train, airplane, boat, or a mix

•Receiver Side → Layer3, then Layer 2, then Layer 1

Protocol "Layers" 2/2

•Characteristics

➢Each layer implements a service

➢Via its own internal-layer actions (a layer is a *black-box*)

➢Relying on services provided by layer below

•Why layering?

➢explicit structure allows identification, relationship of complex system's pieces (modular approach)

✓layered reference model for discussion

➢modularization eases maintenance, updating of system

✓change of implementation of layer's service transparent to rest of system

➢layering considered harmful?

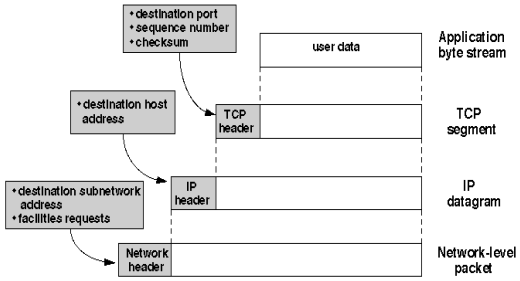
✓Different layers may duplicate functionality

✓Different layers may need access to same information

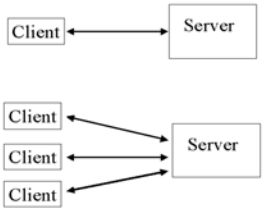
Internet Layers

Application	Supporting network applications (HTTP, FTP, DNS, …)
Transport	Transporting application-layer ***messages*** between client and server sides of an application (TCP and UDP)
Network	Routing ***datagrams*** from one host to another (IP protocol: IPv4 and IPv6)
Data Link	Move entire ***frames*** from one network element to an *adjacent* network element (Ethernet, PPP, …)
Physical	Move individual ***bits*** within the frame from one network element to an adjacent network element (coaxial cable, fiber optic, …)

TCP/IP Data Packet Transmission and Addressing

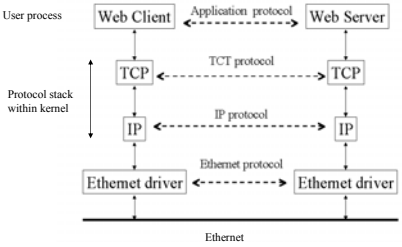


Servers and Clients



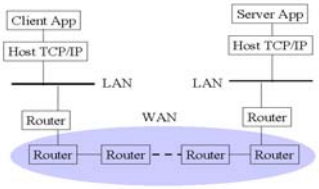
Multiple Layers of Network Protocols

Client and Server on same Ethernet



Multiple Layers of Network Protocols

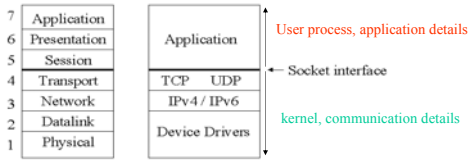
Client and server on different LANs connected through a WAN



Layers in OSI Model and Internet Protocol Suite

OSI: Open Systems Interconnection model for computer communications

ISO: International Organization for Standardization



A look ahead

- How is data transferred thought the network?
  - Circuit switching versus packet switching
- How do end systems connect to an edge router?
- Physical Media