Fundamentals of Computer Networks
ECE 478/578

Lecture #2
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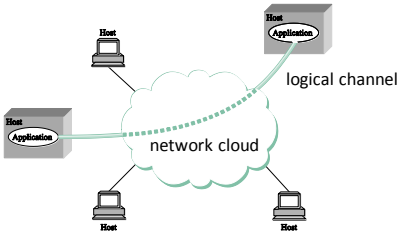
Building Applications

Network applications involve communication of two or more hosts

Often, complex functions need to be realized

Can think of application communication in an abstract way



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Common Services

Many applications may share common functionalities

Can you think of examples?

These functionalities need to be integrated on each application

Or be abstracted in common services

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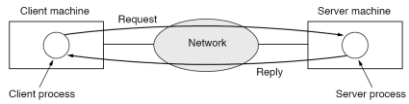
E.g. FTP vs. Video-on-Demand

Both follow the server-client model



Establish a request/reply channel, and message stream channel (one reliable, other unreliable)

Use smallest number of channel abstractions

FTP utilizes request/reply

Video-on-demand uses message stream channel

Both use a host-to-host communication protocol

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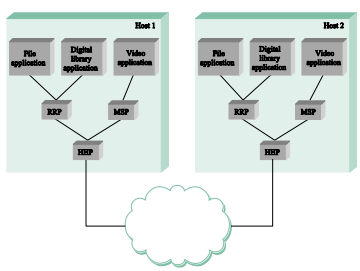
A simple layering example

RRP: Request/reply protocol

MSP: Message streaming protocol

HHP: Host-to-host protocol



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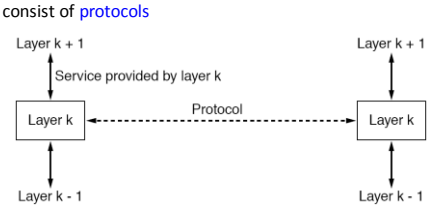
Layering Abstraction

Layer: A set of functionalities encapsulated in an object that can be used by other network components

Example: The network layer implements the end-to-end packet delivery

Why layering? Think complexity and common services

Layers consist of protocols



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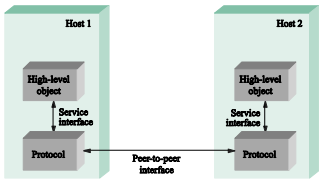
Looking into layers a bit closer

Protocols in each layer have

- Service interface with upper layer/lower layer
- Peer-to-peer interface with host on same layer



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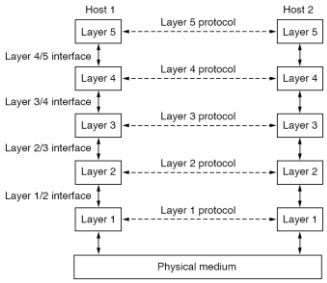
Hierarchical Layer Structure

Layering implies the use of a layer hierarchy



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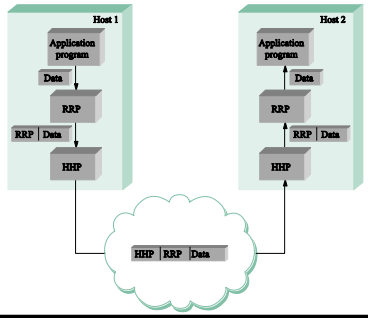
Encapsulation

The process of embedding a header or trailer



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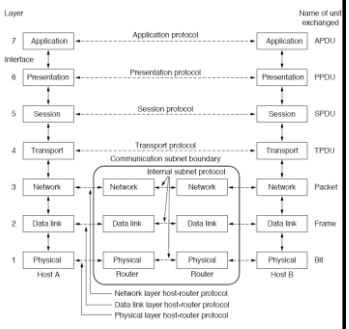
The OSI Network Architecture

OSI: Open Systems Interconnection

7 layers X. protocol specifications for each layer

Acts like a reference model rather than a real-world protocol graph

First three layers are implemented in all nodes



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Layers of the OSI model

Physical Layer: Transmission/reception of raw bits

Data Link Layer: Maps bits into frames, dictates sharing of common medium, corrects/detects errors , re-orders frames

Network Layer: Routes packets to destination, may perform fragmentation and re-assembly.

Transport Layer: Flow (congestion) control, error control, transparent transport to upper layers

Session Layer: Establishes connection among hosts, duplex, half-duplex, graceful connection termination, combination of streams

Presentation Layer: Negotiation of format of data exchanged between hosts

Application layer: Application services such as FTP, X.400 (mail), HTTP

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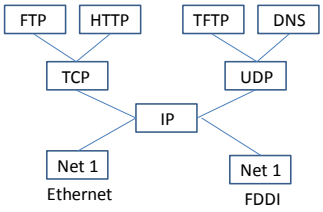
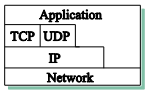
The Internet Architecture





FTP: File Transfer Protocol
HTTP: Hypertext Transport Protocol
TFTP: Trivial File Transfer Protocol

TCP: Transmission Control Protocol
UDP: User Datagram Protocol
IP: Internet Protocol

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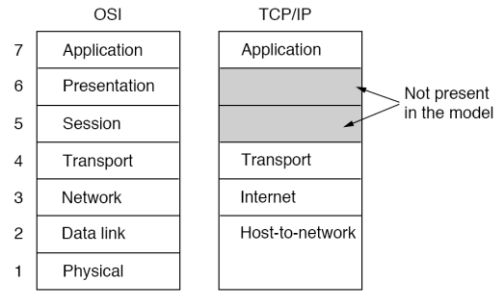
Comparison of the two architectures



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Motivation for IP Networks (In Order)

Communication should continue despite failures
- Survive equipment failure or physical attack
- Traffic between two hosts continue on another path

Support multiple types of communication services
- Differing requirements for speed, latency, & reliability
- Bidirectional reliable delivery vs. message service

Accommodate a variety of networks
- Both military and commercial facilities
- Minimize assumptions about the underlying network

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Other Driving Goals, Somewhat Met

Permit distributed management of resources
- Nodes managed by different institutions
- … though this is still rather challenging

Cost-effectiveness
- Statistical multiplexing through packet switching
- … though packet headers and retransmissions wasteful

Ease of attaching new hosts
- Standard implementations of end-host protocols
- … though still need a fair amount of end-host software

Accountability for use of resources
- Monitoring functions in the nodes
- … though this is still fairly limited and immature

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