

Computer Networks

Lesson 3: Encapsulation; Protocol layers; OSI Model

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September 2, 2008

Lesson Overview

cs485/ece440

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Review

Architecture

Assignments

- 1 Review
- 2 Network Architecture
- 3 Assignments

Section Outline

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Requirements

- Cost-Effective Resource Sharing
 - Statistical Multiplexing
- Support for Common Services
 - Abstraction: logical channel between processes
 - Identify common communication patterns
 - Reliability

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Network Architecture

- General blueprint to guide design and implementation of networks
 - Abstractions naturally lead to layering
 - Decomposes the problem
 - Provides a more modular design
 - Services in upper layer are implemented in terms of services from lower layer

Definition

Protocol: Provides a communication service for higher-level objects (e.g, other protocols, or apps.)

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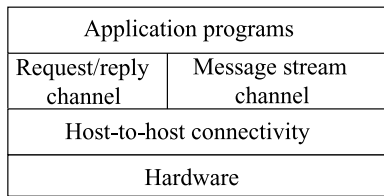
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Layered system with alternative abstractions available at a given layer.

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- OSI Architecture
- Internet Architecture

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Layering and Protocols

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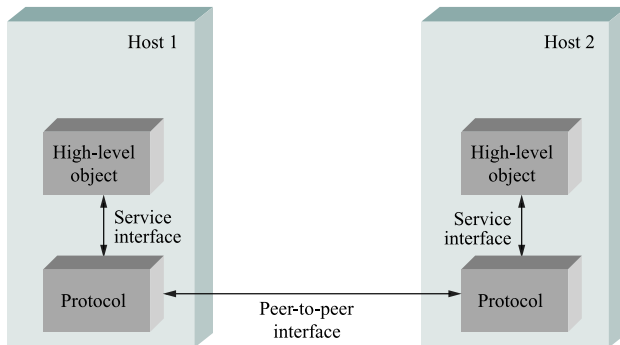
OSI Architecture
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Assignments

- A protocol defines two different interfaces:
 - *Service interface*: API used on local node to interact with protocol
 - E.g. HTTP supports function to get web page
 - *Peer interface*: Defines form and meaning of messages
 - E.g. structure of get command that goes over wire
- Communication between peers is indirect
- Only hardware layer sends data across medium

Layering and Protocols

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Service and peer interfaces

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Layering and Protocols

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In a protocol graph:

- Nodes are protocols
- Edges represent *depends on* relations
- E.g. **R**quest/**R**eply **P**rotocol and **M**essage **S**tream **P**rotocol
 - implement two types of process-to-process protocols
 - both depend on (use) **H**ost-to-**H**ost **P**rotocol
- E.g. File app uses *protocol stack* RRP/HHP
- A protocol can be implemented in different ways (programmer, OS, etc.)
- Must adhere to specification and inter-operate with peers

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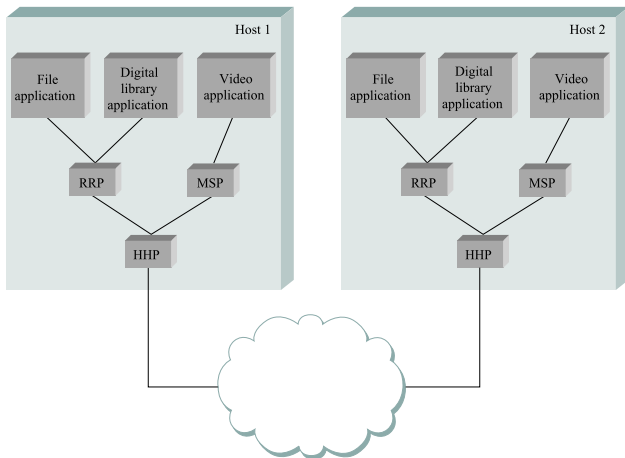
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Example of a protocol graph

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- Peers must interact with each other
- That information is stored in a *header* (or *trailer*)
- Format of headers is given by *protocol specification*
- Data transmitted by protocol is called *body* or *payload*
- Payload is not looked at by protocol
- Payload may contain headers and trailers from higher-level protocols
- Payload is *encapsulated* in a new message by a protocol

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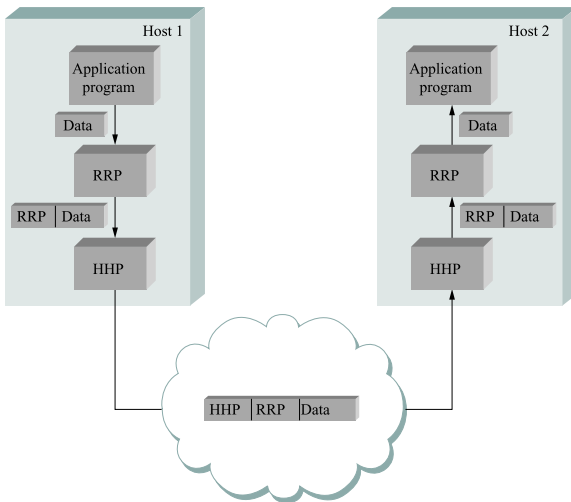
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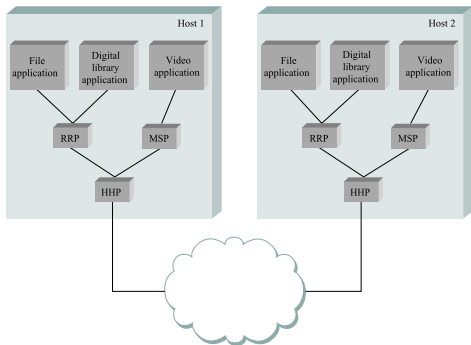
Assignments

Layering and Protocols



High-level messages are *encapsulated* inside low-level messages

Layering and Protocols



- Data going up in protocol stack needs to be *demultiplexed*
- Field in header says which upper level protocol or application to deliver data to
- Protocol strips (its) header before passing data up

- Open Systems Interconnection (OSI) architecture defined by ISO
- Not a protocol graph; OSI is a reference model for a protocol graph
- ISO publishes protocol specifications based on OSI architecture; e.g., X.25, X.400, X.500, etc.

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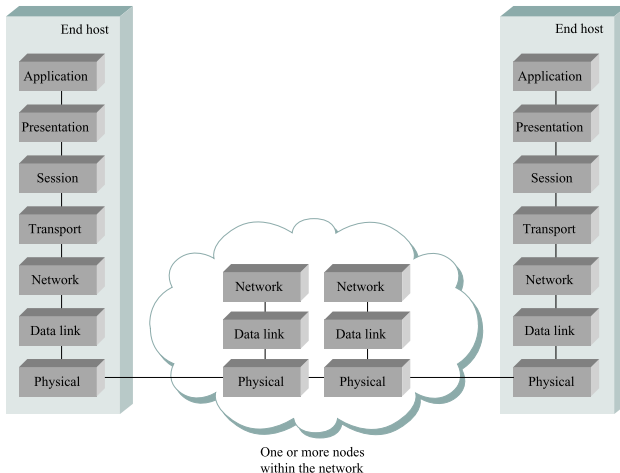
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OSI Architecture

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OSI network architecture

- Implemented on all nodes:
 - **Physical layer:** transmission of raw bits (NIC)
 - **Data link layer:** bundles stream of bits into frames (NIC)
 - **Network layer:** packet routing
- Implemented (typically) on end hosts only:
 - **Transport layer:** process-to-process channel for messages
 - **Session layer:** aggregate streams; e.g. video and audio
 - **Presentation layer:** data format, byte order, size of ints
 - **Application layer:** e.g. FTP

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- Internet (TCP/IP) architecture predates OSI model
- Uses only four layers
 - **Network layer:** (subnetwork or link layer) Ethernet, FDDI, wireless, etc.
 - May contain several sub-layers
 - Internet architecture makes no assumptions about them
 - **IP layer:** aggregate net technologies into single, logical internetwork
 - **Transport layer:** main protocols:
 - Transmission Control Protocol (TCP): reliable byte stream channel
 - User Datagram Protocol (UDP): unreliable datagram (msg) channel
 - **Application layer:** application protocols

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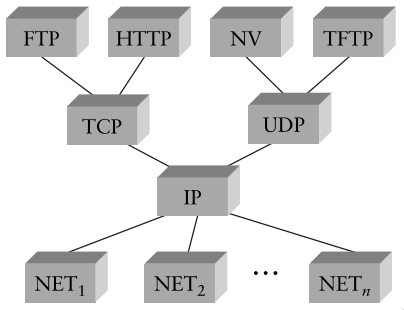
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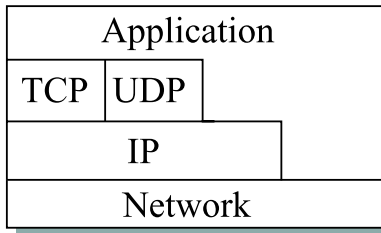
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Internet Architecture

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Internet protocol graph



Alternative view

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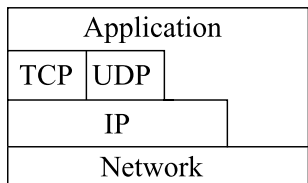
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- Applications:
 - Firefox, Internet Explorer, Safari, etc.
- Application protocols:
 - HTTP
- Application protocols provide interoperability
- Can use any browser to access HTTP server



Alternative view

- Not strictly layered
- Apps can bypass TCP and UDP
- Programmers can implement new channel abstractions on top of any existing protocol

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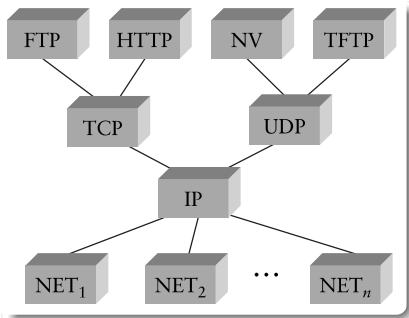
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Internet Architecture

- Hourglass shaped
- Central philosophy of Internet arch:
 - IP is focal point of arch
 - Defines common methods to exchange packets on wide collection of networks
 - Transport protocols are built on top of IP: TCP/IP, UDP/IP, etc.
- Hourglass narrow waist is minimal and carefully chosen set of global capabilities



- Hourglass enables rapid adaptation to new user demands and changing technologies

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- Obtain text book and start reading Chapter 1
- Sign up for class mailing list: <http://www.cs.unm.edu/cgi-bin/mailman/listinfo/cs485>
- Look at syllabus at <http://www.cs.unm.edu/~riesen/cs485>
- Homework 1, due September 9, 2008