ECE/COMPSCI 356 Computer Network Architecture

Lecture 3: Network Architectures

Neil Gong

neil.gong@duke.edu

Slides credit: Xiaowei Yang, PD

Overview

- Network architectures
- Two examples of network architectures
  - OSI
  - Internet

Network architectures

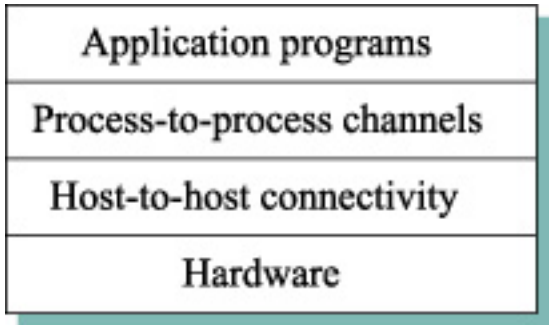
- The general blueprints that guide the design and implementation of computer networks are referred to as network architectures

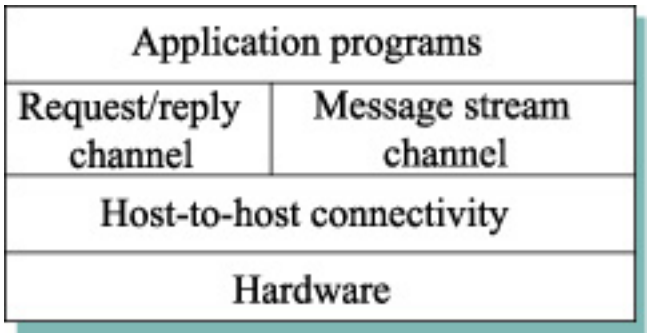
- Many different network architectures

Central concepts

- Layering
- Protocols
- Protocol graph
- Encapsulation
- Multiplexing & Demultiplexing

Layering



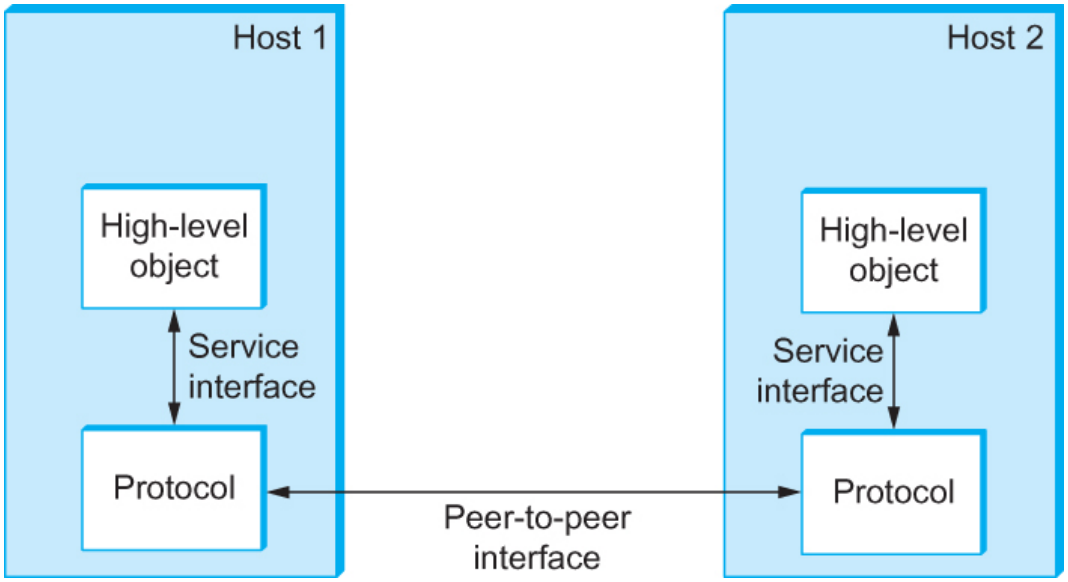


- Each layer is an abstraction
  - Handle complexity
    - Each layer implements simpler functions
  - Hide the details from the users and other layers
- Modular design
  - Can provide new services by modifying one layer

Protocols

- Protocol defines the interfaces between the layers in the same system and with the layers of peer system
- Each protocol object has two different interfaces
  - service interface: operations on this protocol
  - peer-to-peer interface: messages exchanged with peer

Protocol interfaces

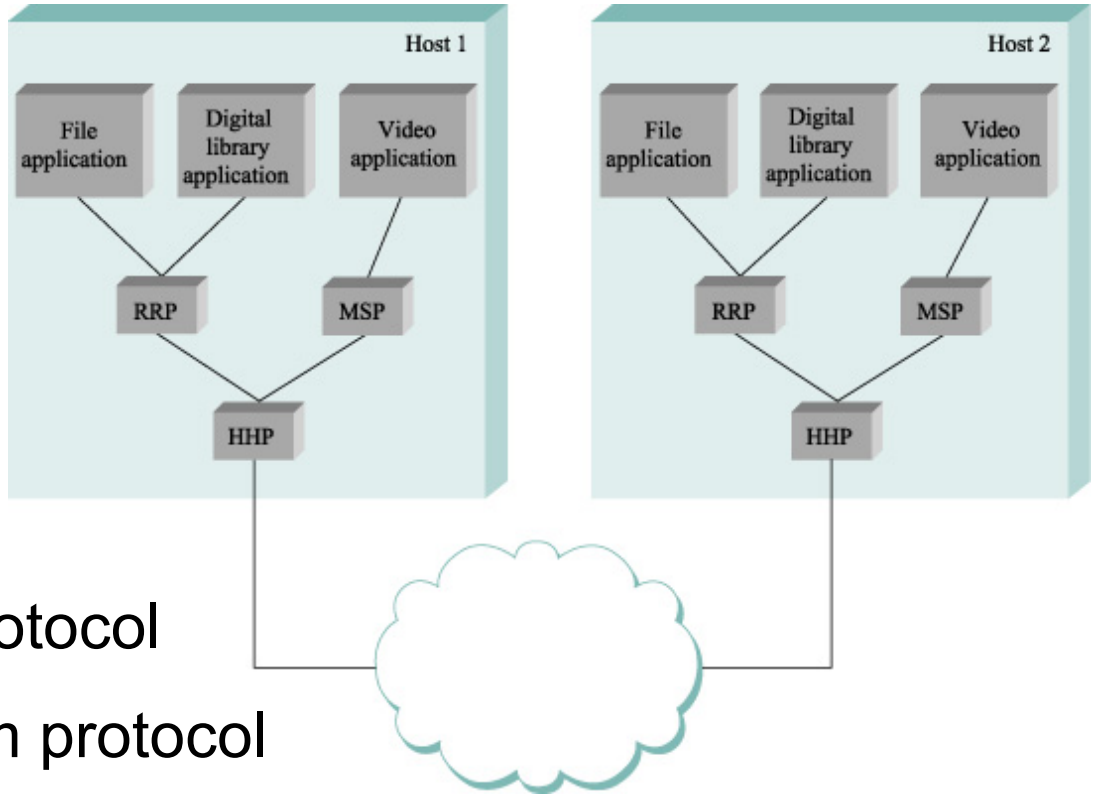


Service and Peer Interfaces

Protocol graph

- Potentially multiple protocols at each layer
- Organize the suite of protocols using a protocol graph

A sample protocol graph



RRP: request/reply protocol

MSP: message stream protocol

HHP: host to host protocol

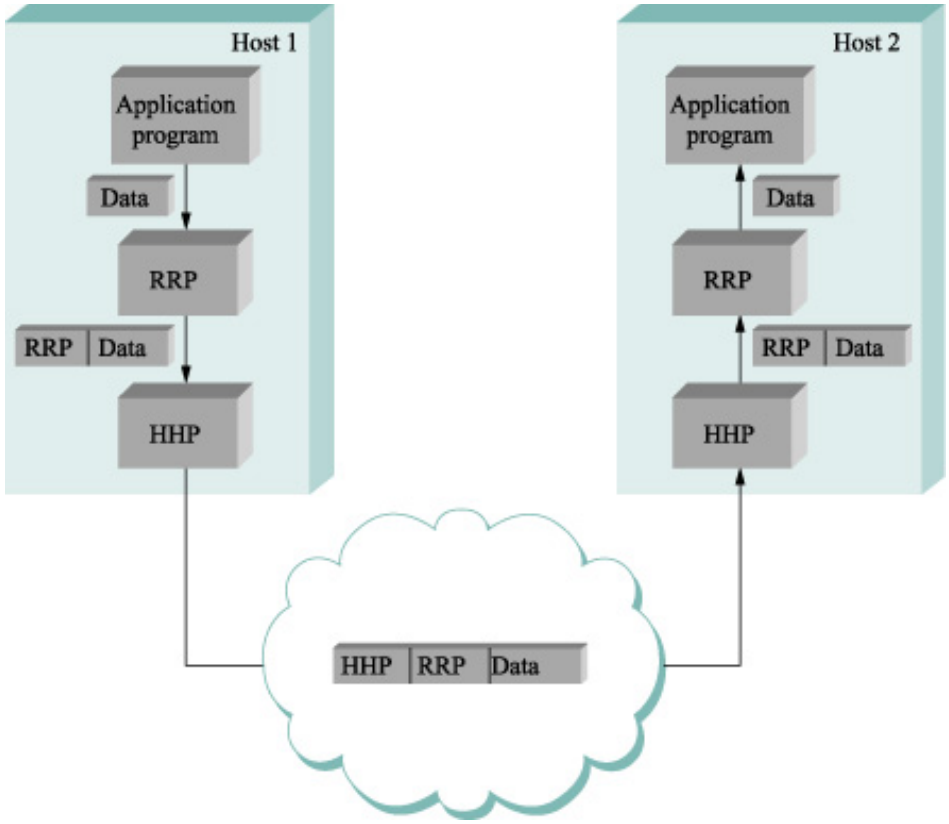
Protocol standardization

- Governed by IETF: Internet Engineering Task Force
  - introducing, validating, and approving protocols

Encapsulation

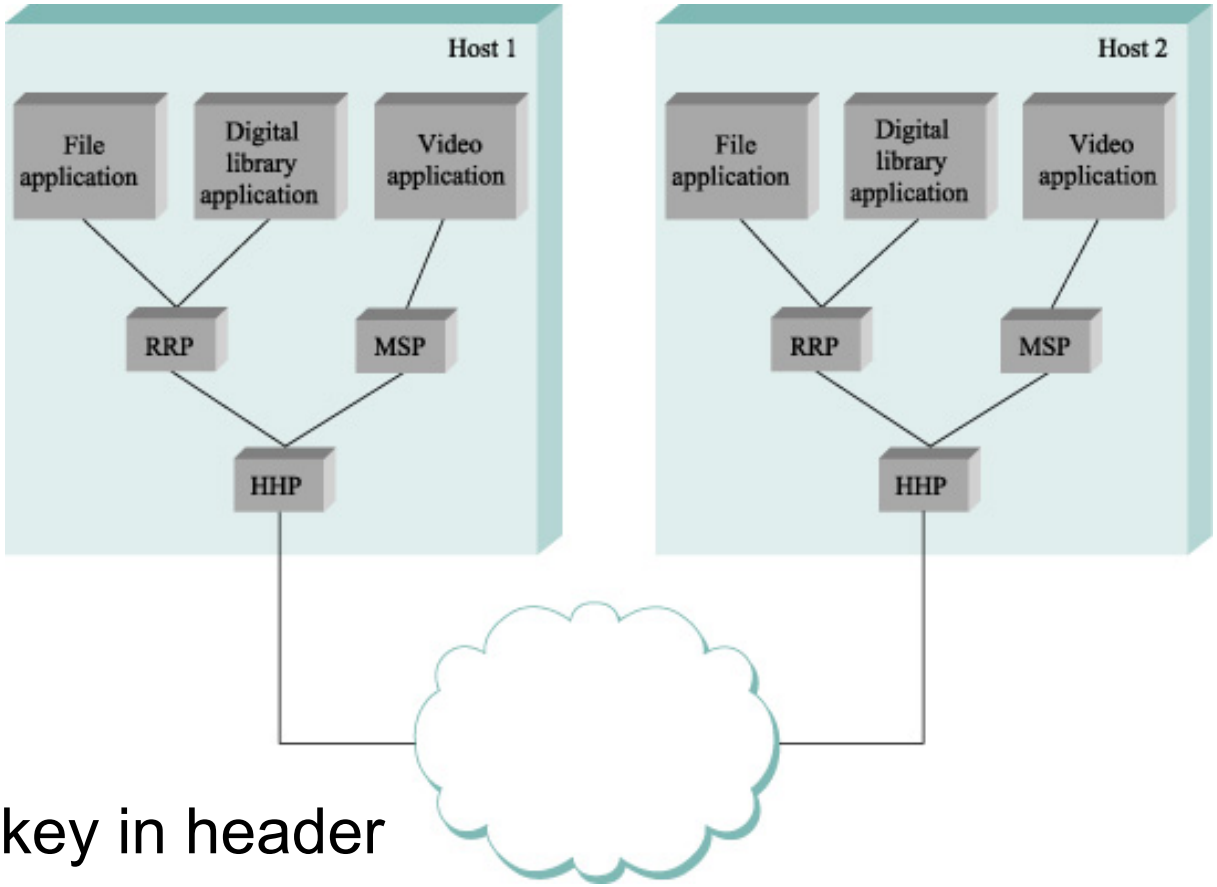
- Each protocol adds a small data structure to a message
  - Header
    - attached to the front
  - Trailer
    - added to the end
- Message is called payload or data
- This process is called encapsulation

An example for encapsulation



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

Multiplexing & Demultiplexing



demux key in header

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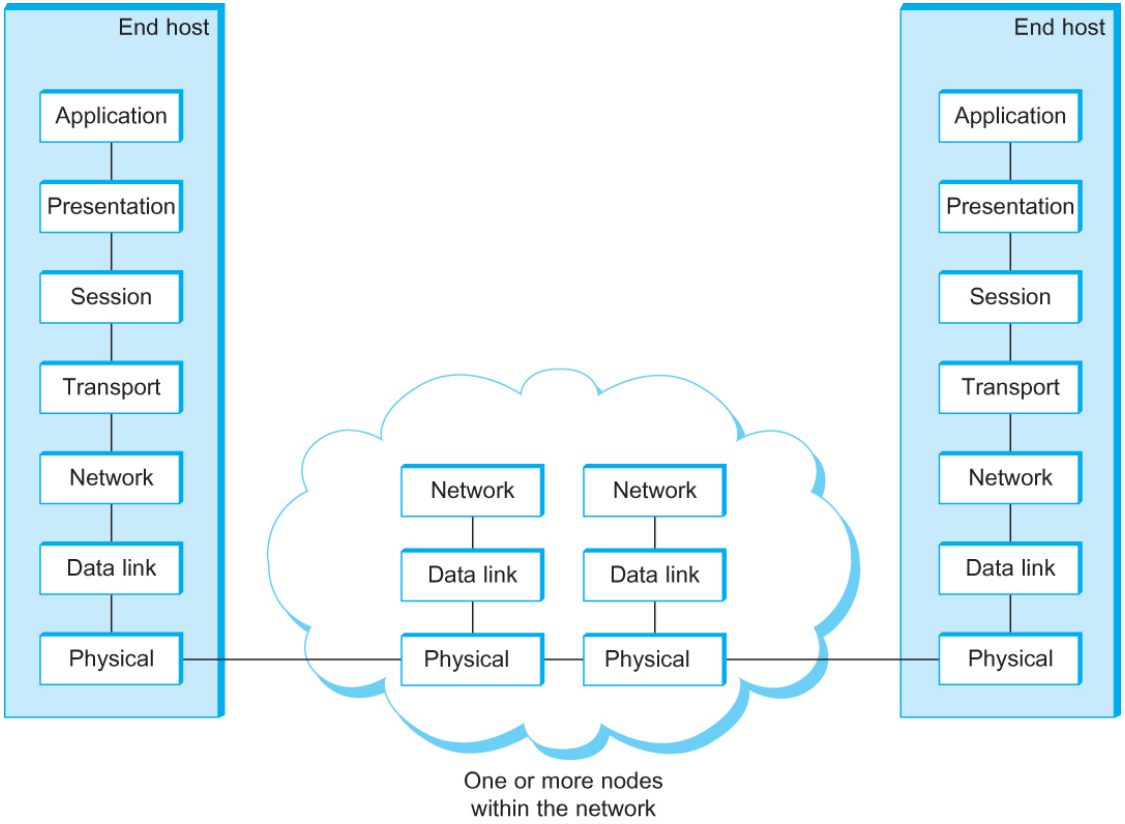
OSI Architecture



The OSI 7-layer Model

OSI – Open Systems Interconnection

Description of Layers

- Physical Layer
  - Handles the transmission of raw bits over a communication link
- Data Link Layer
  - Collects a stream of bits into a larger aggregate called a *frame*
  - Network adaptor along with device driver in OS implement the protocol in this layer
  - Frames are actually delivered to hosts
- Network Layer
  - Handles routing among nodes within a packet-switched network
  - Unit of data exchanged between nodes in this layer is called a *packet*

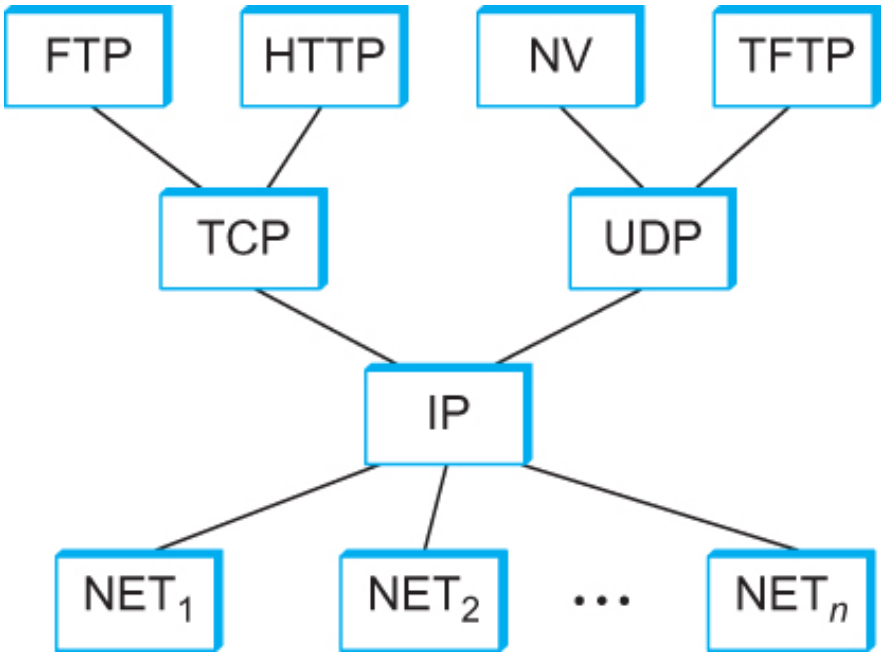
The lower three layers are implemented on all network nodes

Description of Layers

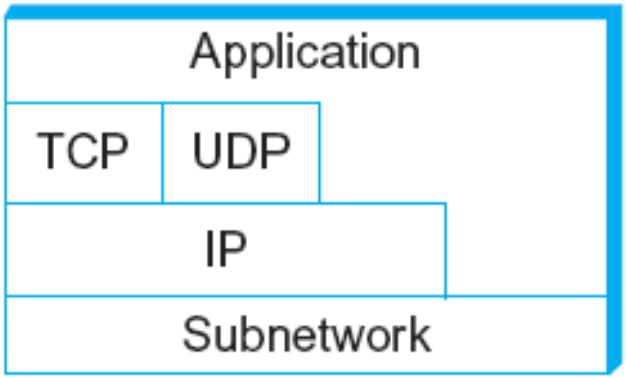
- Transport Layer
  - Implements a process-to-process channel
  - Unit of data exchanges in this layer is called a *message*
- Session Layer
  - Provides a name space that is used to tie together the potentially different transport streams that are part of a single application
- Presentation Layer
  - Concerned about the format of data exchanged between peers
- Application Layer
  - Standardize common type of exchanges

The transport layer and the higher layers typically run only on end-hosts and not on the intermediate switches and routers

Internet Architecture



Internet Protocol Graph



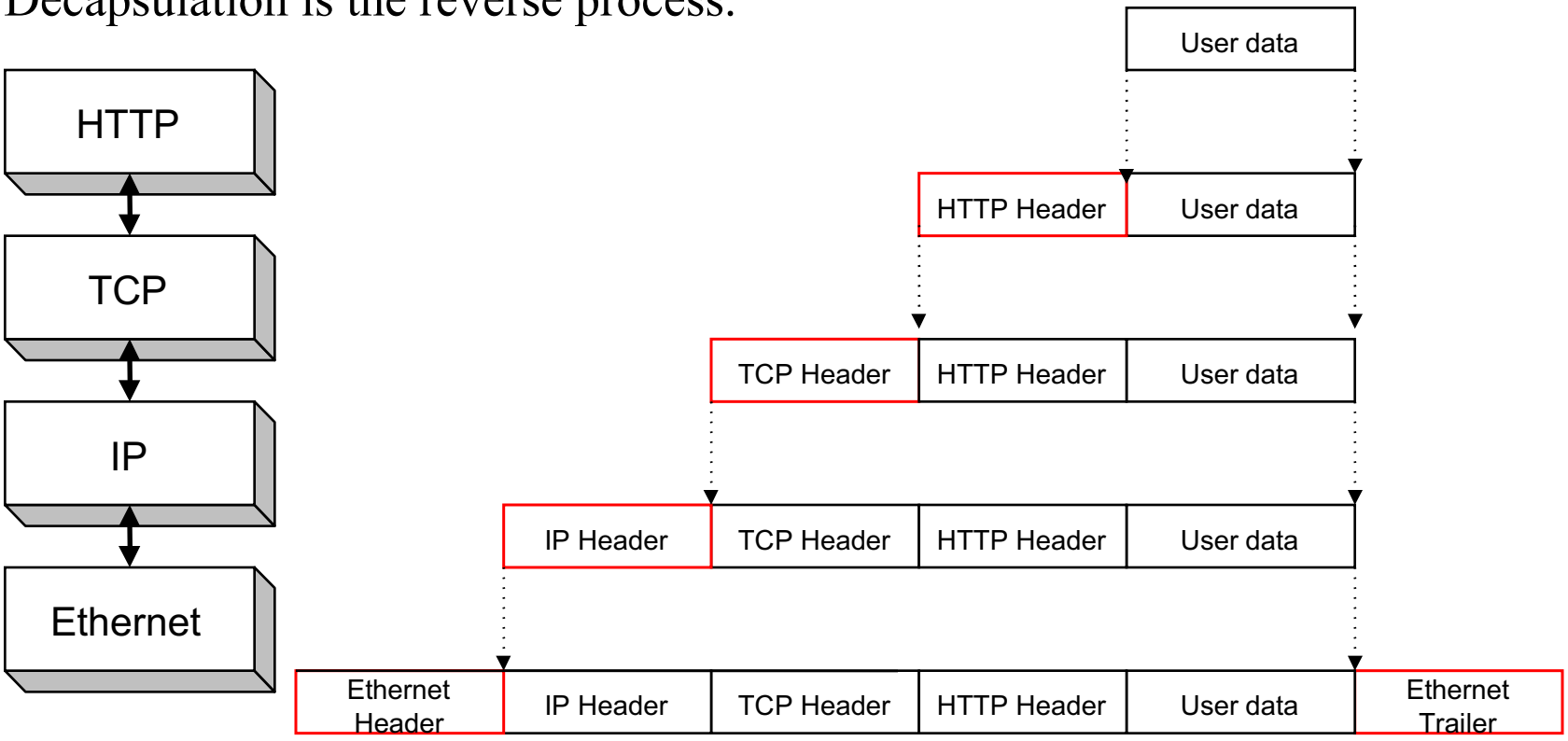
Alternative view of the Internet architecture. The "Network" layer shown here is sometimes referred to as the "sub-network" or "link" layer.

Internet Architecture

- Defined by IETF
- Three main features
  - Does not imply strict layering. The application is free to bypass the defined transport layers and to directly use IP or other underlying networks
  - An hour-glass shape – wide at the top, narrow in the middle and wide at the bottom. IP serves as the focal point for the architecture
  - In order for a new protocol to be officially included in the architecture, there needs to be both a protocol specification and at least one (and preferably two) representative implementations of the specification

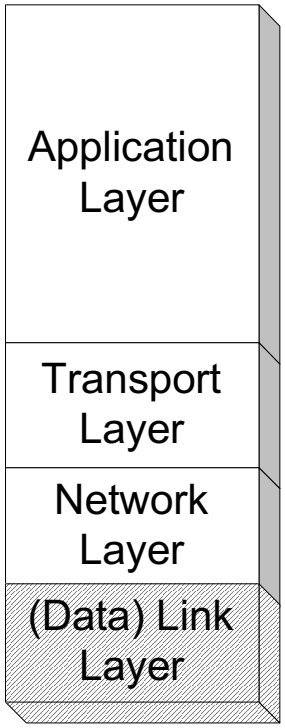
Encapsulation and Decapsulation

- Encapsulation: As data is moving down the protocol stack, each protocol is adding layer-specific control information.
- Decapsulation is the reverse process.

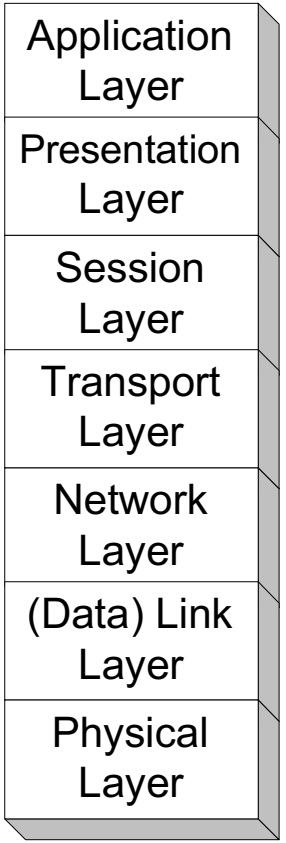


Internet (TCP/IP) vs. OSI

The TCP/IP protocol stack does not define the lower layers of a complete protocol stack



TCP/IP Suite



OSI Reference Model

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