

# Transport Layer

## Study-Ready Notes

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# 1 Introduction to Transport Layer Services

- Transport layer provides logical communication between application processes running on different hosts
- Key services include:
  - Multiplexing and demultiplexing
  - Connectionless transport: UDP
  - Principles of reliable data transfer
  - Connection-oriented transport: TCP
  - Principles of congestion control
  - TCP congestion control
  - Evolution of transport-layer functionality

[Summary: The transport layer enables communication between application processes across networks, providing essential services like multiplexing, reliable data transfer, and congestion control through protocols like TCP and UDP.]

## 2 Transport Layer Overview

### 2.1 Learning Objectives

- Understand principles behind transport layer services:
  - Multiplexing and demultiplexing
  - Reliable data transfer
  - Flow control
  - Congestion control
- Learn about Internet transport layer protocols:
  - UDP: connectionless transport
  - TCP: connection-oriented reliable transport
  - TCP congestion control

## 3 Transport Services and Protocols

### 3.1 Core Functions

- Provides **logical communication** between application processes running on different hosts

- Transport protocols actions in end systems:
  - **Sender**: breaks application messages into **segments**, passes to network layer
  - **Receiver**: reassembles segments into messages, passes to application layer
- Two transport protocols available to Internet applications:
  - **TCP** (Transmission Control Protocol)
  - **UDP** (User Datagram Protocol)

## 3.2 Network Architecture Context

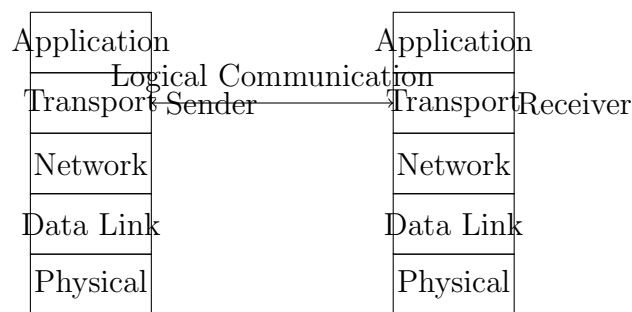


Figure 1: Transport layer in network protocol stack

[Summary: Transport protocols operate at end systems, segmenting application messages for transmission and reassembling them upon receipt, with TCP and UDP as the primary Internet protocols.]

## 4 Transport vs. Network Layer Services

### 4.1 Household Analogy

- **Hosts** = houses
- **Processes** = kids
- **Application messages** = letters in envelopes
- 12 kids in Ann's house sending letters to 12 kids in Bill's house

### 4.2 Layer Responsibilities

- **Network layer**: logical communication between hosts
- **Transport layer**: logical communication between processes
- Transport layer relies on and enhances network layer services

Network Layer	Transport Layer
Host-to-host communication	Process-to-process communication
Logical communication between hosts	Logical communication between processes
Provides basic datagram delivery	Enhances delivery with reliability, ordering, etc.

Table 1: Comparison of Network vs. Transport Layer Services

[Mnemonic: "Houses Host, Kids Process" - Network layer connects houses (hosts), Transport layer connects kids (processes) within houses.]

## 5 Transport Layer Actions

### 5.1 Sender Operations

1. Receives application-layer message
2. Determines segment header field values
3. Creates segment with header and payload
4. Passes segment to IP (network layer)

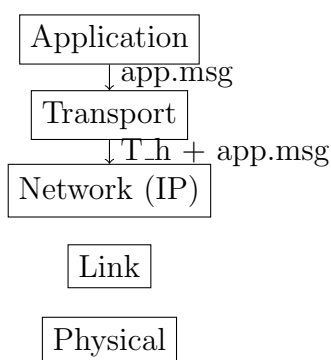


Figure 2: Sender-side transport layer processing

### 5.2 Receiver Operations

1. Receives segment from IP (network layer)
2. Checks header values for correctness
3. Extracts application-layer message from segment
4. Demultiplexes message up to application via appropriate socket

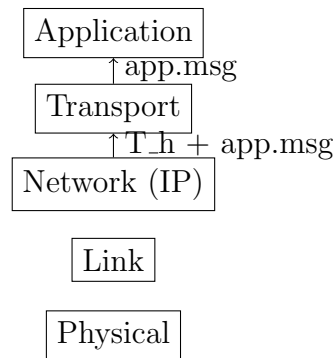


Figure 3: Receiver-side transport layer processing

[Summary: The transport layer segments application data at the sender and reassembles it at the receiver, handling header processing and message demultiplexing to the correct application process.]

## 6 Internet Transport Protocols

### 6.1 TCP: Transmission Control Protocol

- **Reliable, in-order delivery:** Ensures all data arrives correctly and in sequence
- **Congestion control:** Prevents network overload by adjusting transmission rate
- **Flow control:** Prevents overwhelming the receiver
- **Connection setup:** Requires establishment of connection before data transfer

### 6.2 UDP: User Datagram Protocol

- **Unreliable, unordered delivery:** No guarantees on delivery or ordering
- **No-frills extension of "best-effort" IP:** Minimal overhead beyond IP
- **Services not available:**
  - Delay guarantees
  - Bandwidth guarantees

[Concept Map: Transport Layer → TCP (reliable, connection-oriented, flow/congestion control) vs UDP (unreliable, connectionless, minimal overhead) → Applications choose based on reliability vs performance needs.]

TCP Features	UDP Features
Connection-oriented	Connectionless
Reliable delivery	Best-effort delivery
In-order delivery	No ordering guarantees
Flow control	No flow control
Congestion control	No congestion control
Higher overhead	Lower overhead
<b>Use cases:</b> Web, email, file transfer	<b>Use cases:</b> DNS, VoIP, streaming

Table 2: Comparison of TCP vs. UDP Protocols

## 7 Study Aids

### 7.1 Key Concepts

- Understand the difference between network layer (host-to-host) and transport layer (process-to-process) communication
- Memorize the characteristics and use cases for TCP vs UDP
- Be able to describe the segmentation process at sender and reassembly at receiver
- Know the household analogy for understanding layer responsibilities

### 7.2 Practice Questions

1. **Compare and contrast** the services provided by TCP and UDP. When would you choose one over the other?
2. Describe the process of **multiplexing and demultiplexing** at the transport layer. How does the transport layer ensure messages reach the correct application process?
3. Explain the **household analogy** for understanding the difference between network and transport layer services.
4. What are the key **transport layer actions** performed by the sender and receiver during data transmission?
5. Why is **congestion control** an important transport layer function, and which protocol provides it?

[Mnemonic: "TCP: Reliable Connection, UDP: Unreliable Datagram" - TCP establishes reliable connections while UDP sends unreliable datagrams.]