IN2140:
Introduction to Operating Systems and Data Communication

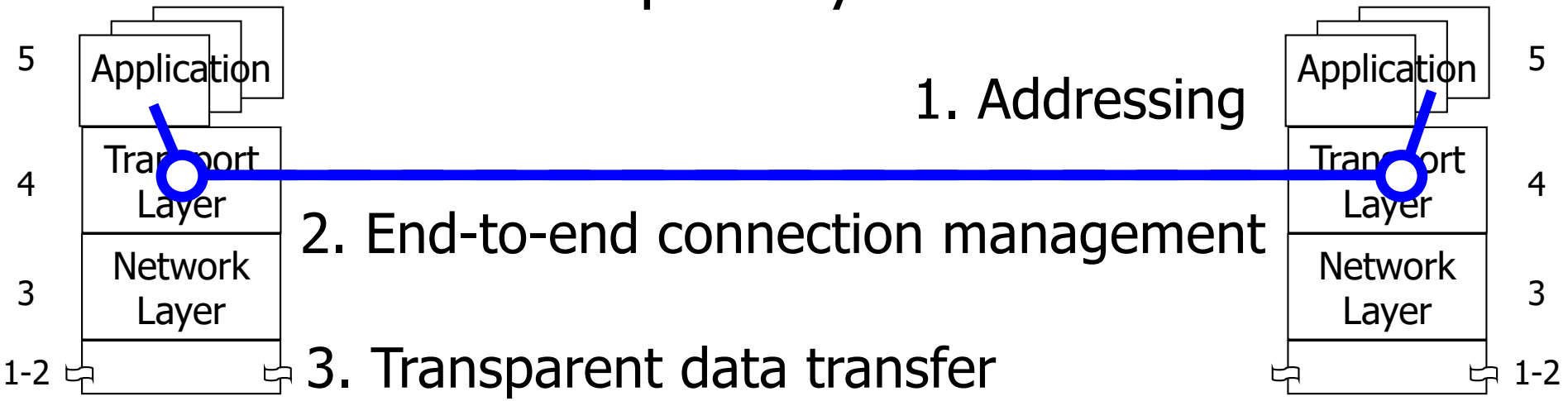


Transport Protocols in the Internet

Overview &
Essential of UDP

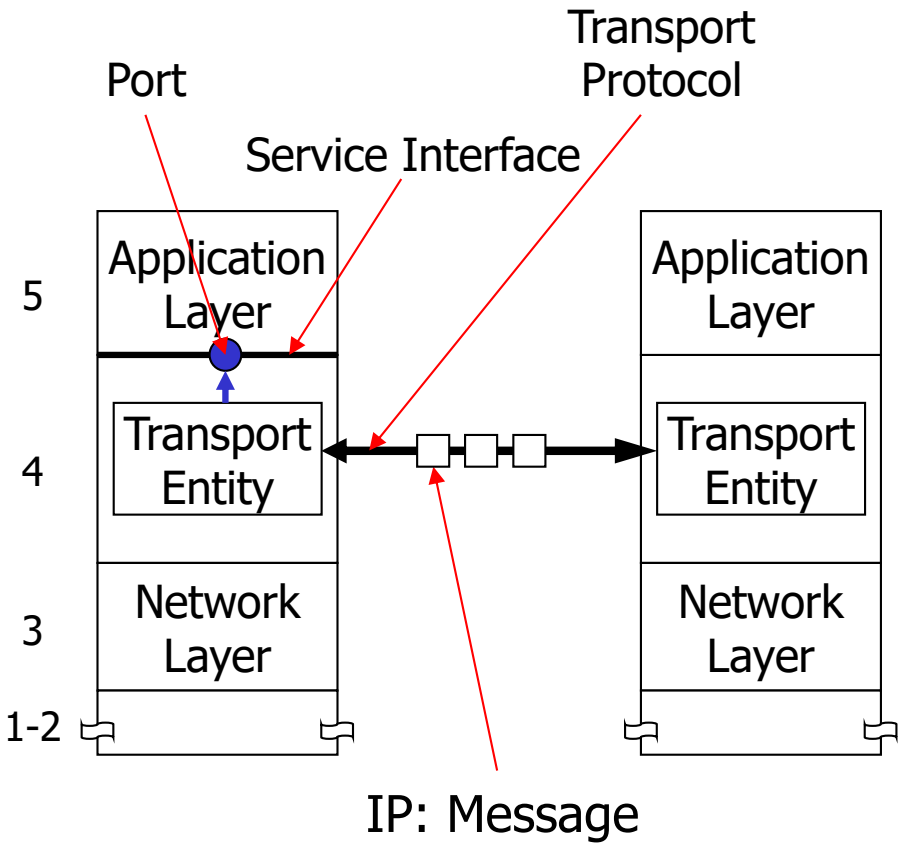
Transport Layer Function

Transport layer tasks



Transport Service

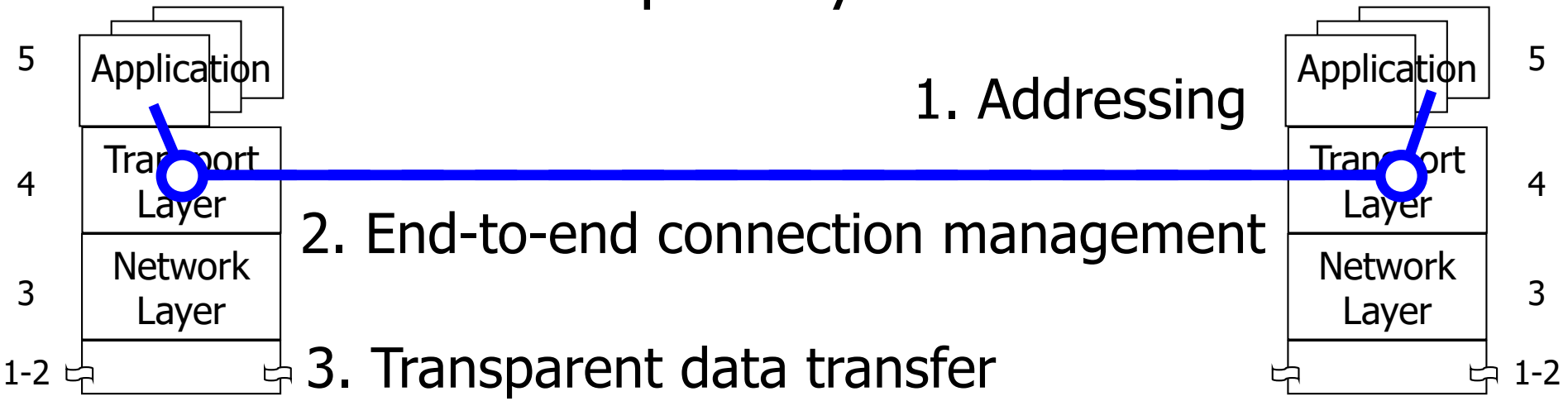
- Connection oriented service
  - 3 phases
    - connection set-up
    - data transfer
    - disconnect
- Connectionless service
  - Transfer of independent messages
- Realization: transport entity
  - Software and/or hardware
  - Software part usually contained within the kernel (process, library)



TCP/IP	1. Port 2. IP address !!
ISO	TSAP (transport service access point)

Transport Layer Function

Transport layer tasks



4. Quality of service options
   - Error recovery
   - Reliability
   - Flow control
   - Congestion control

Congestion and Flow Control

Opposite objectives

- End-system
  - Optimize its own throughput
  - Possibly at the expense of other end-systems

Two different problems

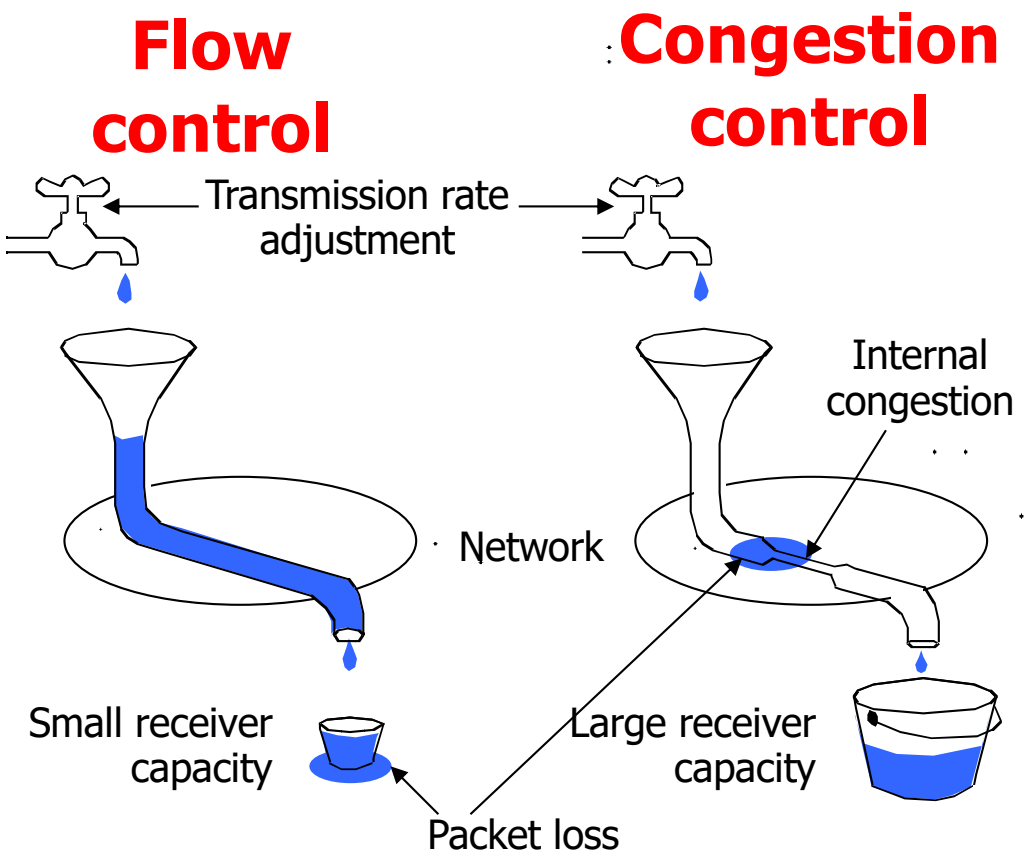
- Receiver capacity
- Network capacity

Cannot be distinguished easily at all places

But should be differentiated

Opposite objectives

- Network
  - Optimize overall throughput



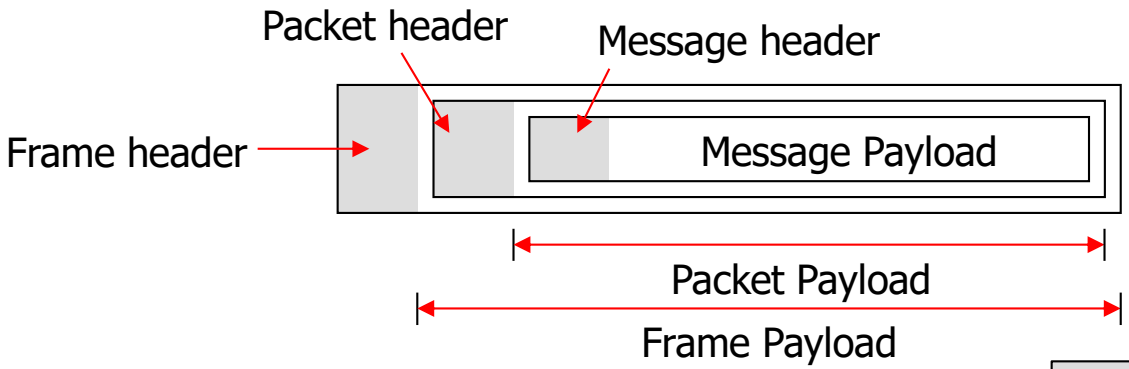
Transport Layer Function

- Transport protocols of TCP/IP protocol suite
  - Services provided implicitly

	UDP	DCCP	TCP	SCTP
Connection-oriented service		X	X	X
Connectionless service	X			
Ordered			X	X
Partially Ordered				X
Unordered	X	X		X
Reliable			X	X
Partially Reliable				X
Unreliable	X	X		X
With congestion control		X	X	X
Without congestion control	X			
Multicast support	X	X		
Multihoming support				X

Transport Service: Terminology

- Nesting of messages, packets, and frames



Layer	Data Unit
Transport	Message, Packet
Network	Packet
Data link	Frame
Physical	Bit/symbol (bitstream)

TCP/IP Message

ISO TPDU (transport protocol data unit)

TCP name for Message Payload: **Segment**

UDP name for Message: **Datagram**

Internet terminology

- TCP sends a stream of bytes
  - it doesn't offer a packet service to the application layer
- TCP content could be divided across multiple IPv4 packets (fragmentation)
  - but then all content is destroyed with the loss of one IPv4 packet
  - also, fragmentation in IPv6 is only allowed at the sender (using an option), where TCP can do it better
  - so TCP splits its content into segments that fit into an L3 packet
- hence normally ***message*** = ***packet***
  - and in everyday work:
    packet ≈ message or packet ≈ segment
  - distinction from context



Transport Protocols

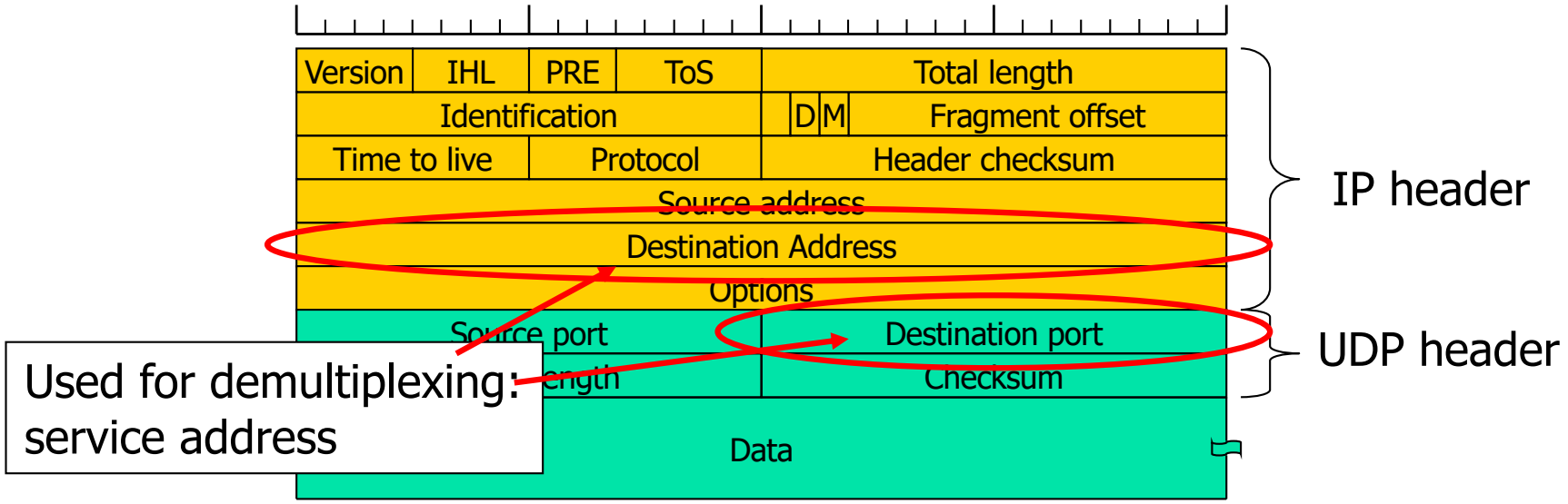
UDP

UDP - User Datagram Protocol

- UDP is a simple transport protocol
  - Unreliable
  - Connectionless
  - Message-oriented

- UDP is mostly IP with short transport header
  - De-/multiplexing
  - Source and destination port
  - Ports allow for dispatching of messages to receiver process

UDP: Message Format

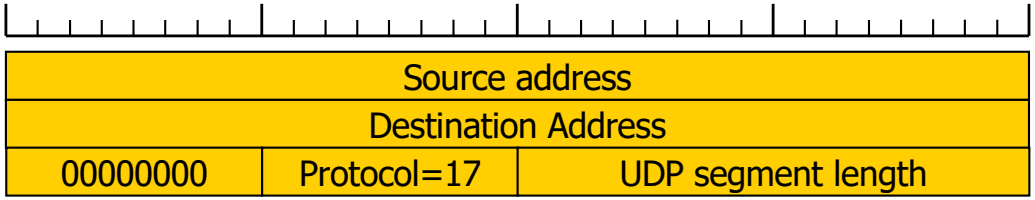


- Source port
  - **Optional**
  - 16 bit sender identification
  - Response may be sent there
- Destination port
  - Receiver identification
- Packet length
  - In byte (including UDP header)
  - Minimum: 8 (byte)
    i.e. header without data
- Checksum
  - **Optional** in IPv4
  - Checksum of header and data for error detection

UDP: Message Format – Checksum

- Purpose
  - Error detection (header and data)

- UDP checksum includes
  1. UDP header (checksum field initially set to 0)
  2. Data
  3. Pseudoheader
     - Part of IP header
       - source IP address
       - destination IP address
       - Protocol
       - length of (UDP) data
     - Allows to detect misdelivered UDP messages



- Use of checksum optional
  - i.e., if checksum contains only "0"s, it is not used
    - Transmit 0xFFFF if calculated checksum is 0

UDP: Ranges of Application

- Suitable
  - For simple client-server interactions, i.e. typically
    - 1 request packet from client to server
    - 1 response packet from server to client
  - When delay is worse than packet loss and duplication
    - Video conferencing
    - IP telephony
    - Gaming

- Used by e.g.
  - DNS: Domain Name Service [1]
  - NTP: Network Time Protocol [1]
  - SNMP: Simple Network Management Protocol
  - BOOTP: Bootstrap protocol
  - TFTP: Trivial File Transfer Protocol
  - NFS: Network File System [1]
  - RTP: Real-time Transport Protocol [1]

[1] can also be used with TCP