SECTION – B

TCP/IP

Outline of the talk

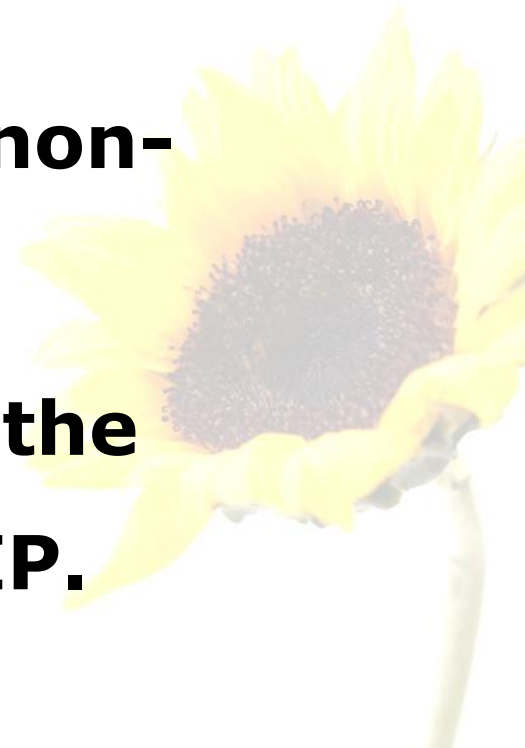
- Introduction to TCP/IP
- TCP/IP & Internet
- Network Layering in TCP/IP
- The Simplified 4-Layer Model
- TCP/IP Protocol Suite
- IP Datagrams

Introduction

- **TCP/IP is the first set of protocols used in Internet.**
- **Allows computers to communicate /share resources across a network.**
- **Work on TCP/IP started in the 1970s.**
  - **Funded by US Military**
  - **Advance Research Project Agency (ARPA)**
  - **Network protocols of ARPANET were upgraded.**

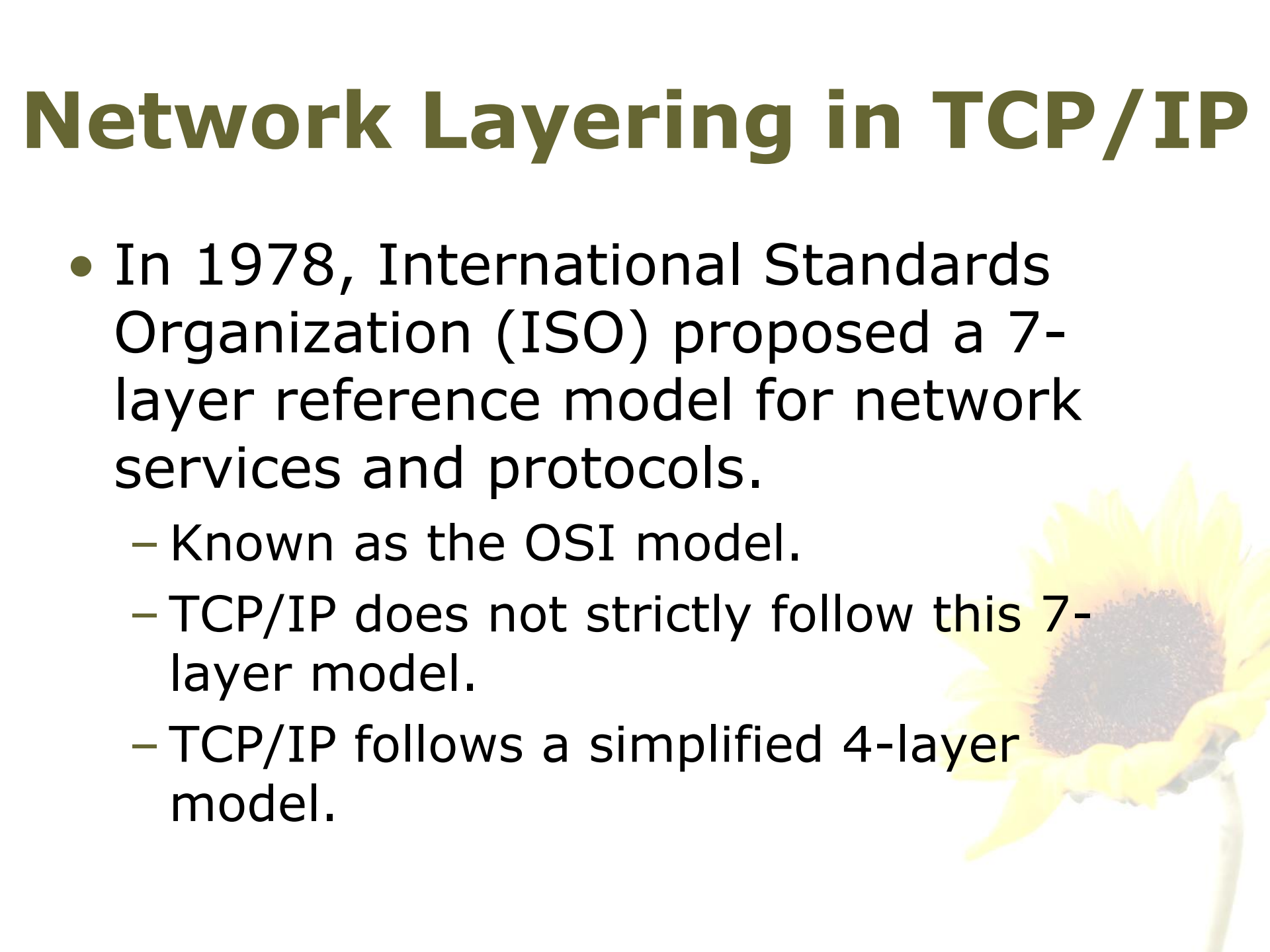
TCP/IP and the Internet

- **The modern Internet sits on top of the TCP/IP technology.**
  - **Used as a standard**
  - **To bridge the gap between non-compatible platforms.**
  - **All computers connected to the Internet understands TCP/IP.**



Network Layering in TCP/IP

- In 1978, International Standards Organization (ISO) proposed a 7-layer reference model for network services and protocols.
  - Known as the OSI model.
  - TCP/IP does not strictly follow this 7-layer model.
  - TCP/IP follows a simplified 4-layer model.



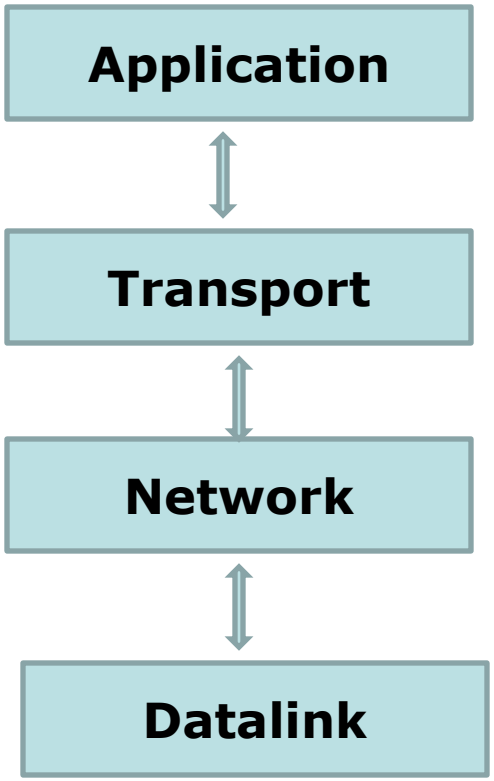
Why Layering ?

- **To provide well defined interfaces between adjacent layers.**
  - **A change in one layer does not affect the other layers.**
  - **Interface must remain the same.**
- **Allows a structured development of network layer.**

The 7-layer OSI Model

Application	Host – to – host
Presentation	
Session	
Transport	
Network	Point – to – point
Data link	
Physical	

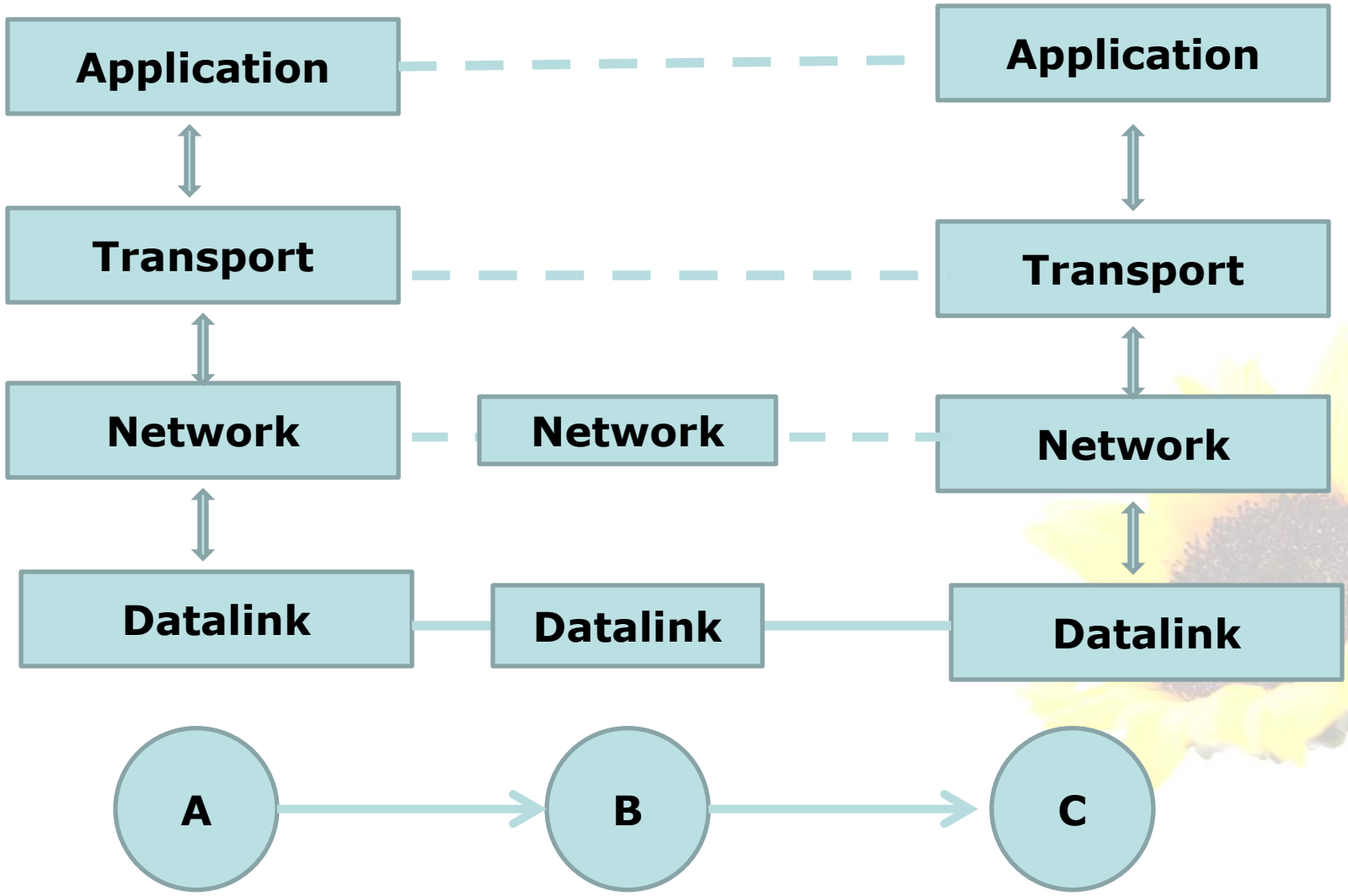
The Simplified 4-layer Model



- Runs on top of layers 1,2 and 3
- End-to-end message transfer
- Packet delivery across internet
- Frame transmission over link

+ Physical

Data Flow in 4-layer Model



Connection-Oriented and Connectionless Services

- **Layers can offer two types of service to the layers above them**
  - **Connection-oriented**
  - **Connectionless service.**

Connection oriented service

- Modeled after Telephone System
- You pick up phone---dial num---talk—n hang up
- Similarly connection oriented service first establish the connection---uses the connection and then releases it
- In most cases bits arrive in the same order as released.
- In some cases sender and receiver negotiate about parameters like maximum message size, quality of service etc

Connectionless Service

- Modeled after a postal service
- Each message carries full destination address
- Each one is routed through the system independent of all the others
- Order may not be necessarily followed

Packet switching network

- A **packet-switched network** is a digital communications network that groups all transmitted data, irrespective of content, type, or structure into suitably sized blocks, called *packets*.
- The network over which packets are transmitted is a shared network which routes each packet independently from all others and allocates transmission resources as needed.
- The principal goals of packet switching are to optimize utilization of available link capacity, minimize response times and increase the robustness of communication.

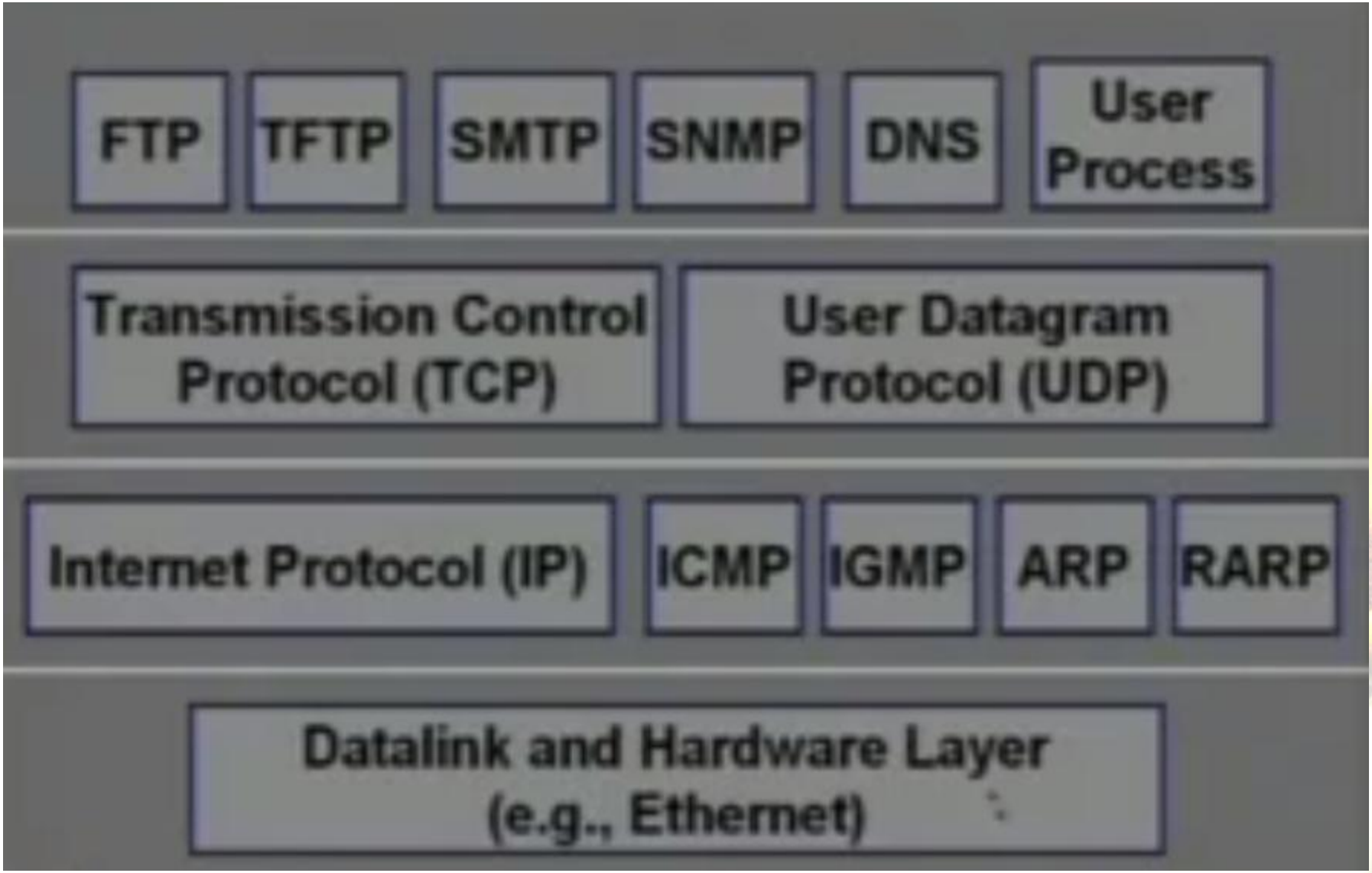
Datagram

- A **datagram** is a basic transfer unit associated with a packet-switched network in which the delivery, arrival time, and order of arrival are not guaranteed by the network service.

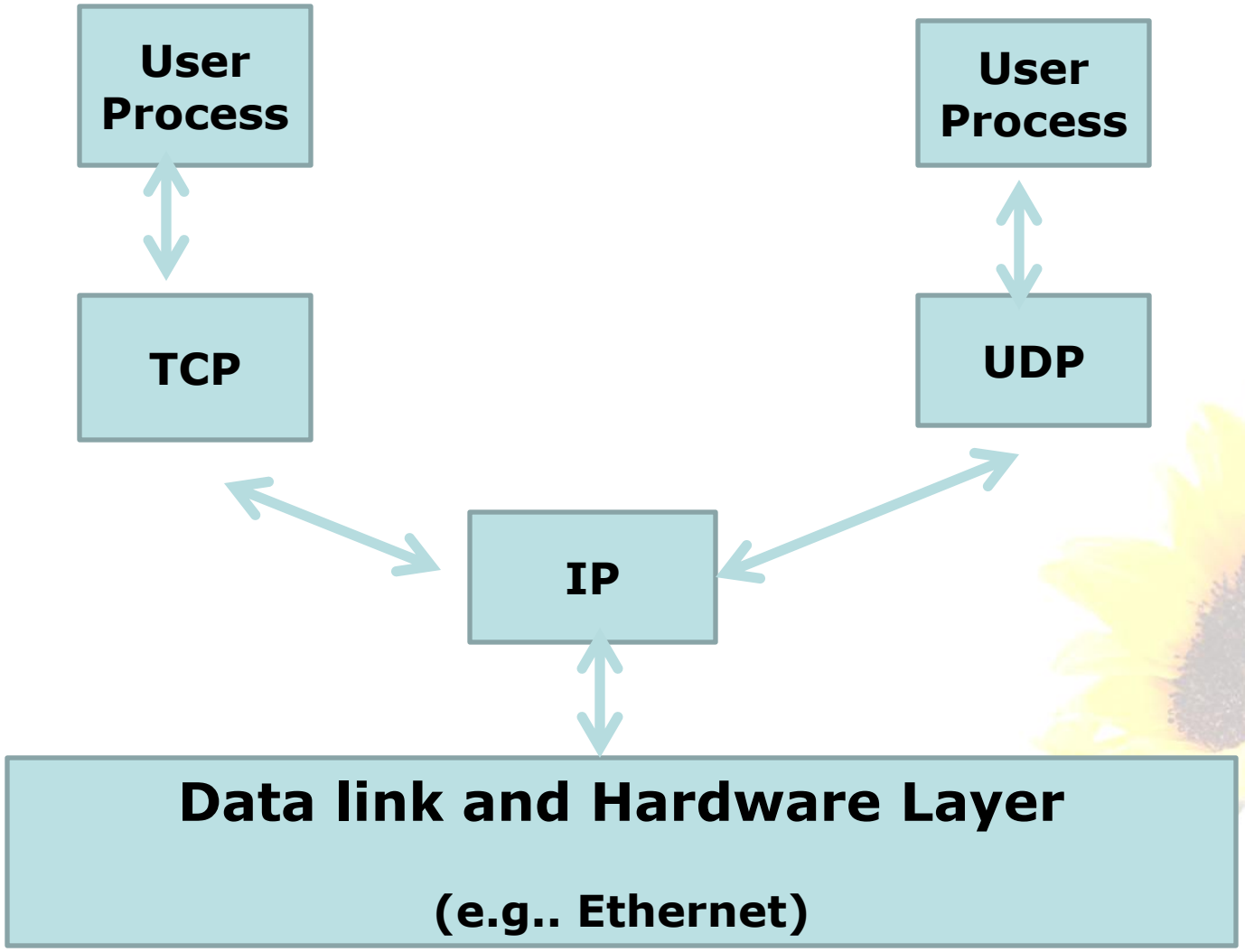
TCP/IP Protocol Suite

- Refers to a family of protocols.
- The protocols are built on top of connectionless technology.
  - Data sent from one node to another as a sequence of datagrams.
  - Each datagram sent independently.
  - The datagrams corresponding to the same message may follow different routes.
- Variable, delay, arrival order at destination.

TCP/IP Family Members



Typical Scenario

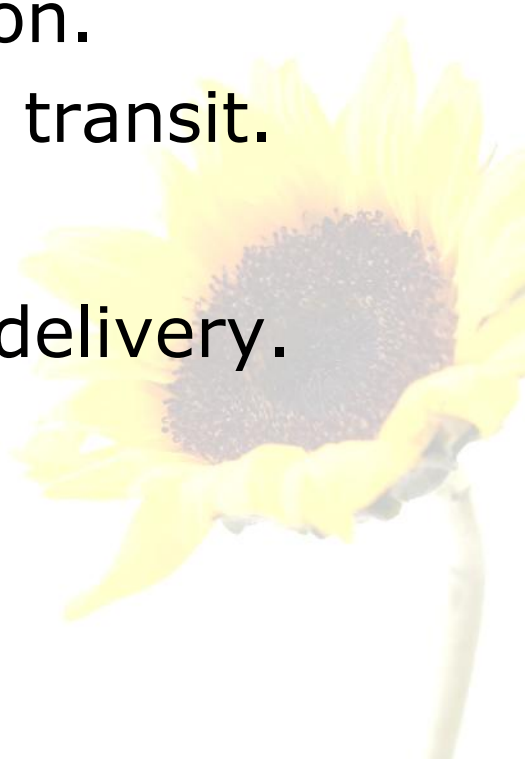


What does IP do ?

- IP transports datagrams (packets) from the source node to the destination node.
  - Responsible for routing the packets.
  - Breaks a packet into smaller packets, if required.
  - Unreliable service. (does not do any error control)
    - A packets may be lost in transit.
    - Packets may arrive out of order.
    - Duplicate packets may be generated. (in case of time out and retransmission)

What does TCP do?

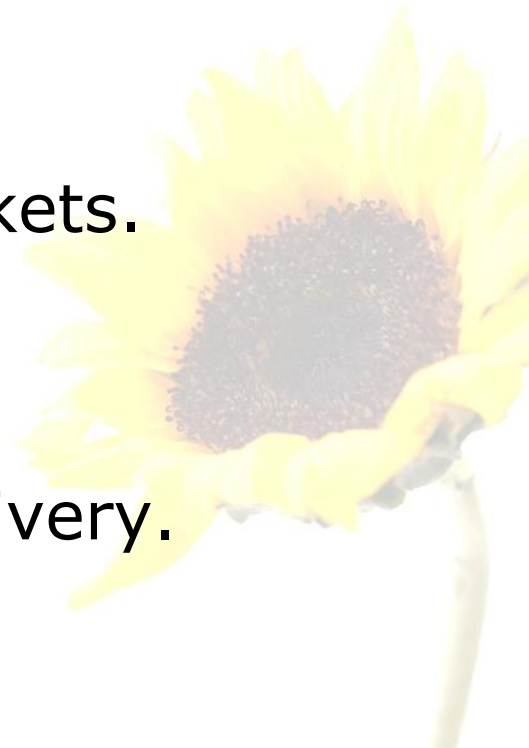
- **TCP provides a connection-oriented, reliable service for sending messages.**
  - Splits a message into packets.
  - Reassemble packets at destination.
  - Resend packets that were lost in transit.
- **Interface with IP:**
  - Each packet forwarded to IP for delivery.
  - Error control is done by TCP.



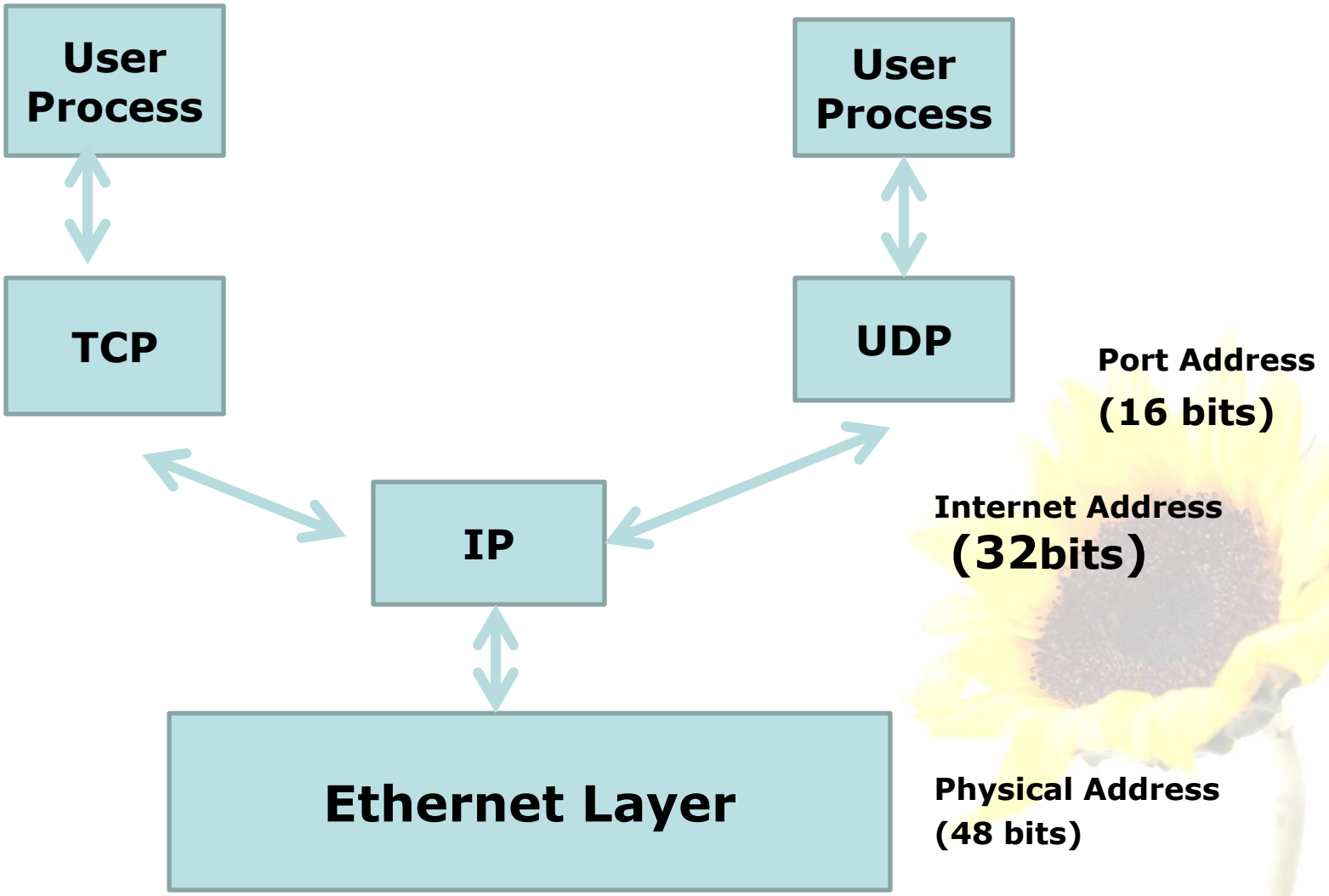
What does UDP do ?

- UDP provides a connectionless, unreliable service for sending datagrams (packets).
  - Messages small enough to fit in a packet (e.g., DNS query).
  - Simpler (and faster) than TCP.
  - Never split data into multiple packets.
  - Does not care about error control.
- **Interface with IP:**

  - Each UDP packet sent to IP for delivery.

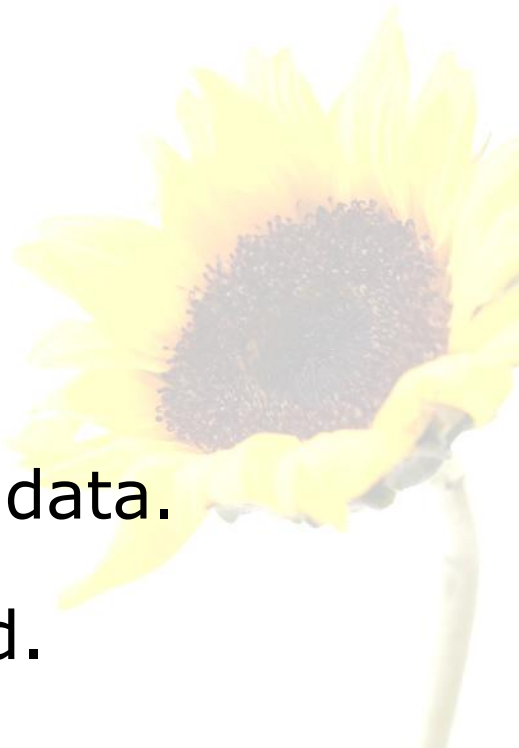


Addresses in TCP/IP

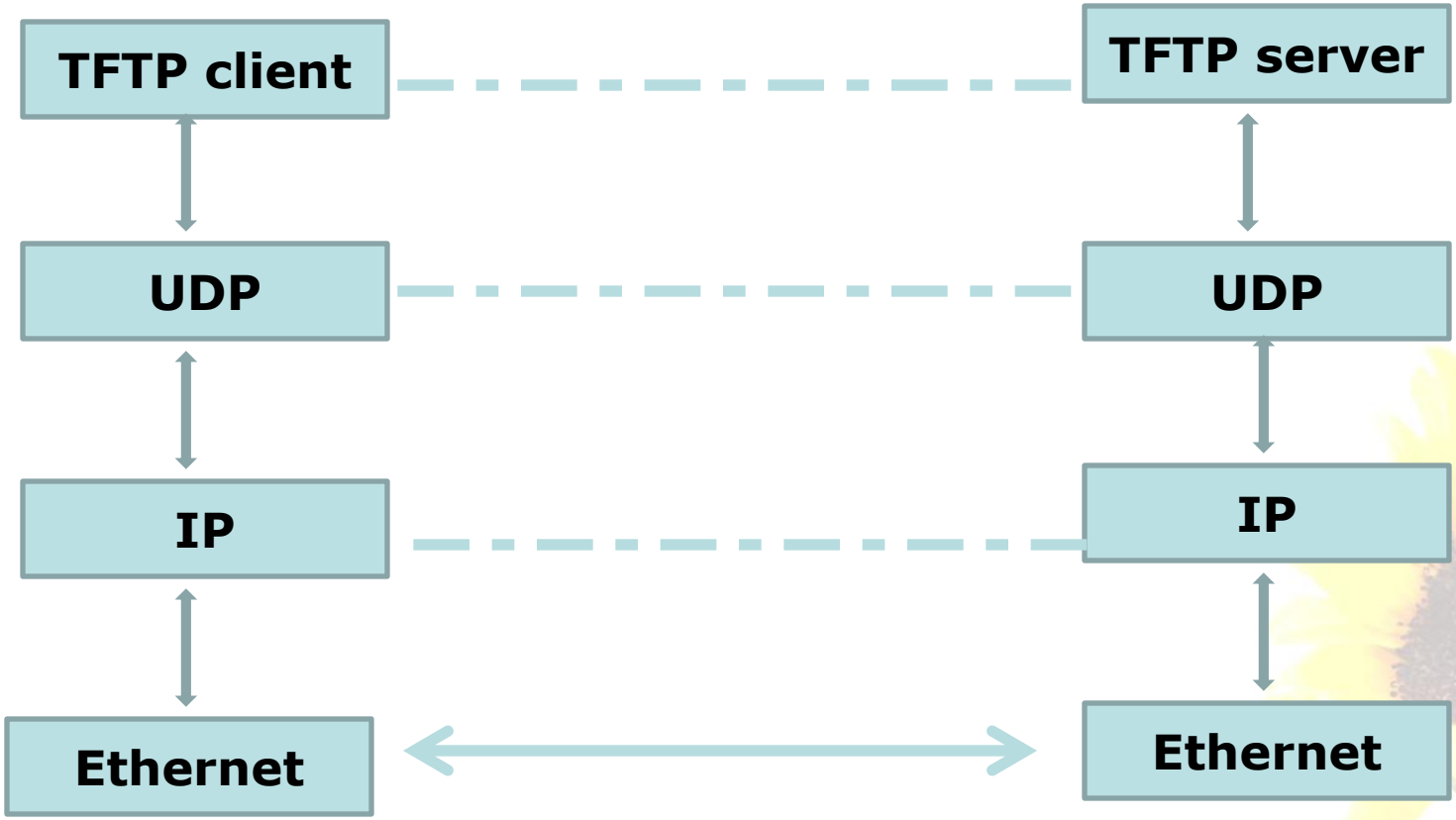


Encapsulation

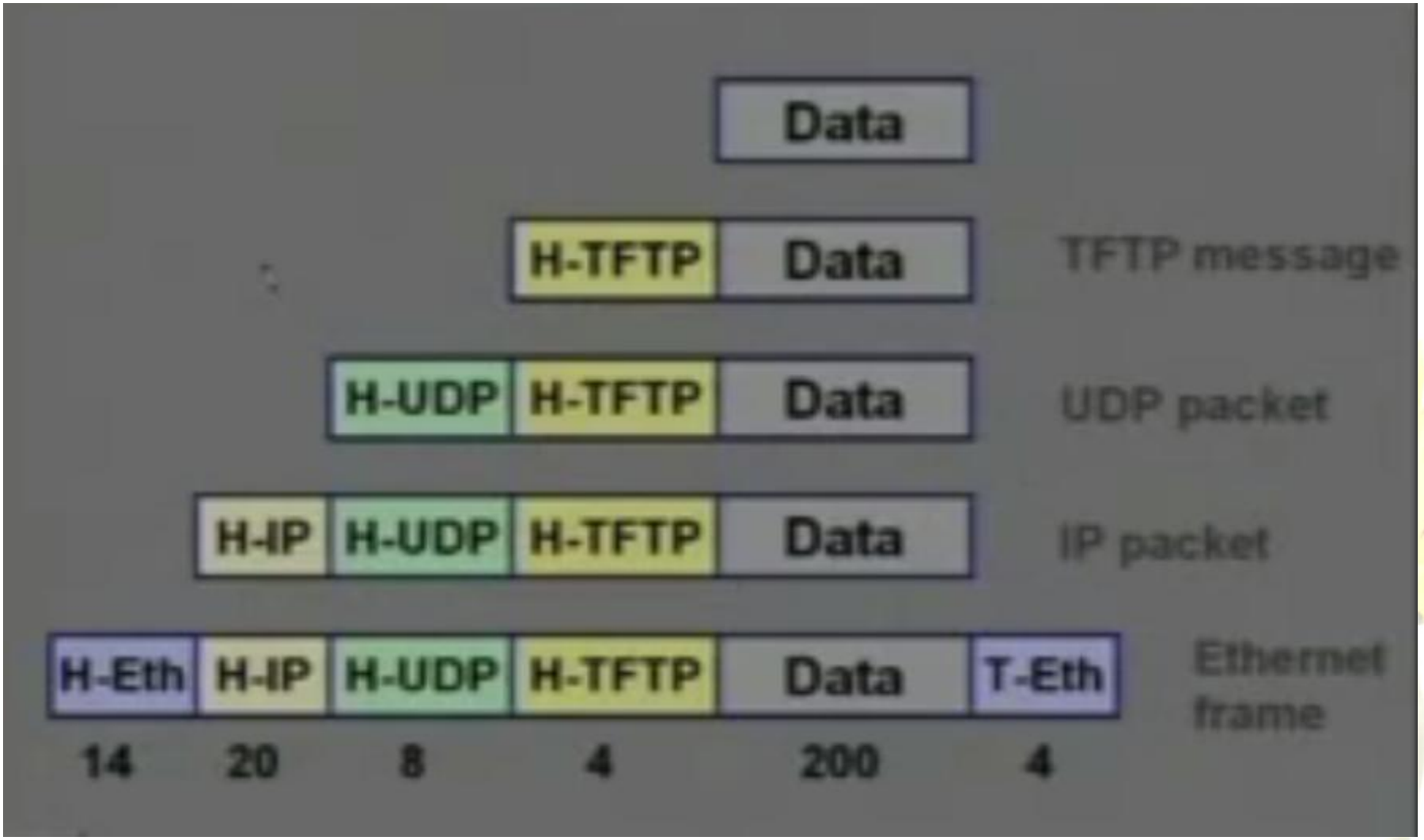
- **Basic concept:**
  - As data flows down the protocol hierarchy, headers (and trailers) get appended to it.
  - As data moves up the hierarchy, headers (and trailers) get stripped off.
- **An example to illustrate:**
  - Trivial file transfer protocol (TFTP)
  - TFTP client transfers 200 bytes of data.
  - 4 bytes of TFTP header gets added.



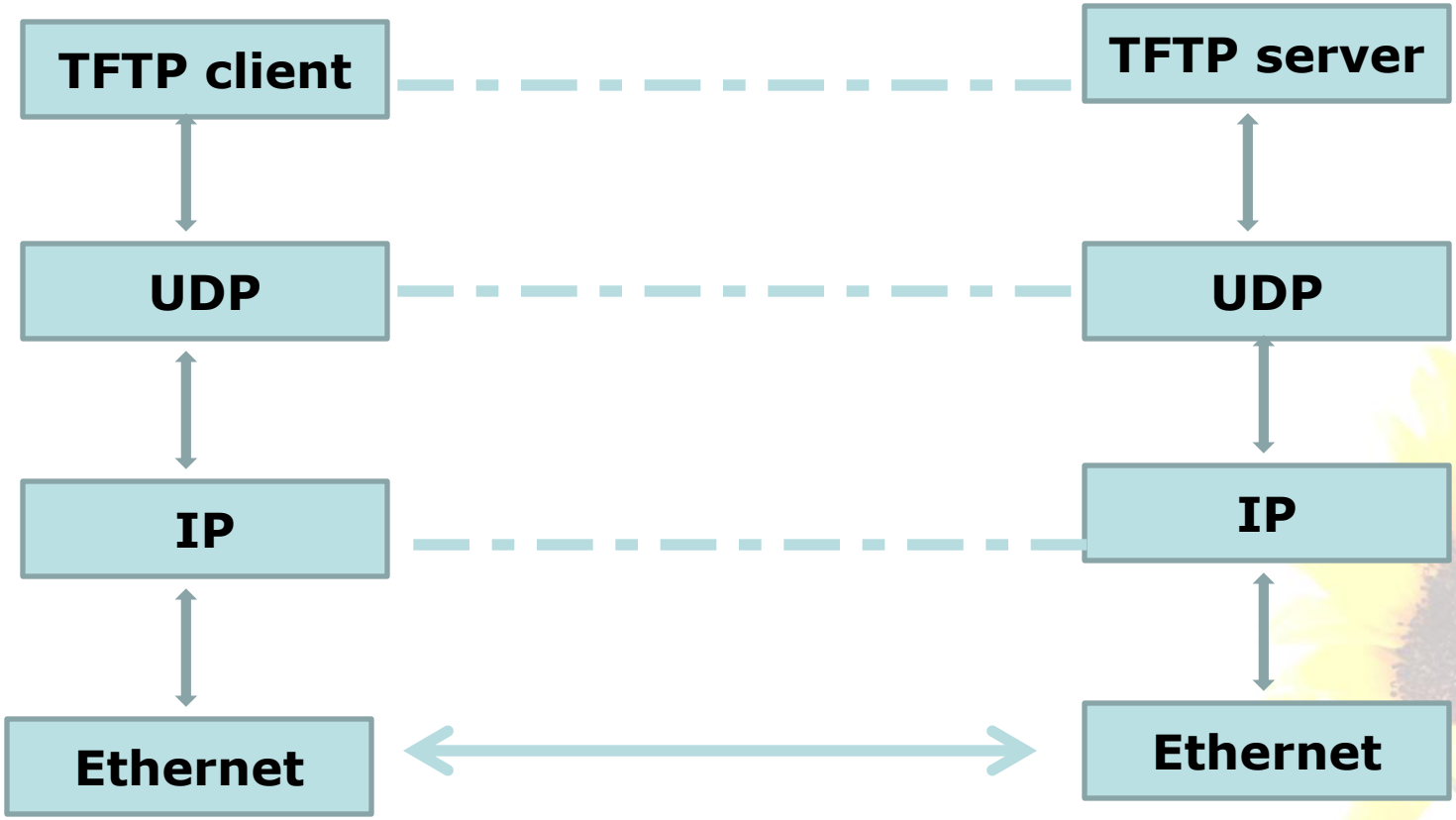
TFTP over Ethernet



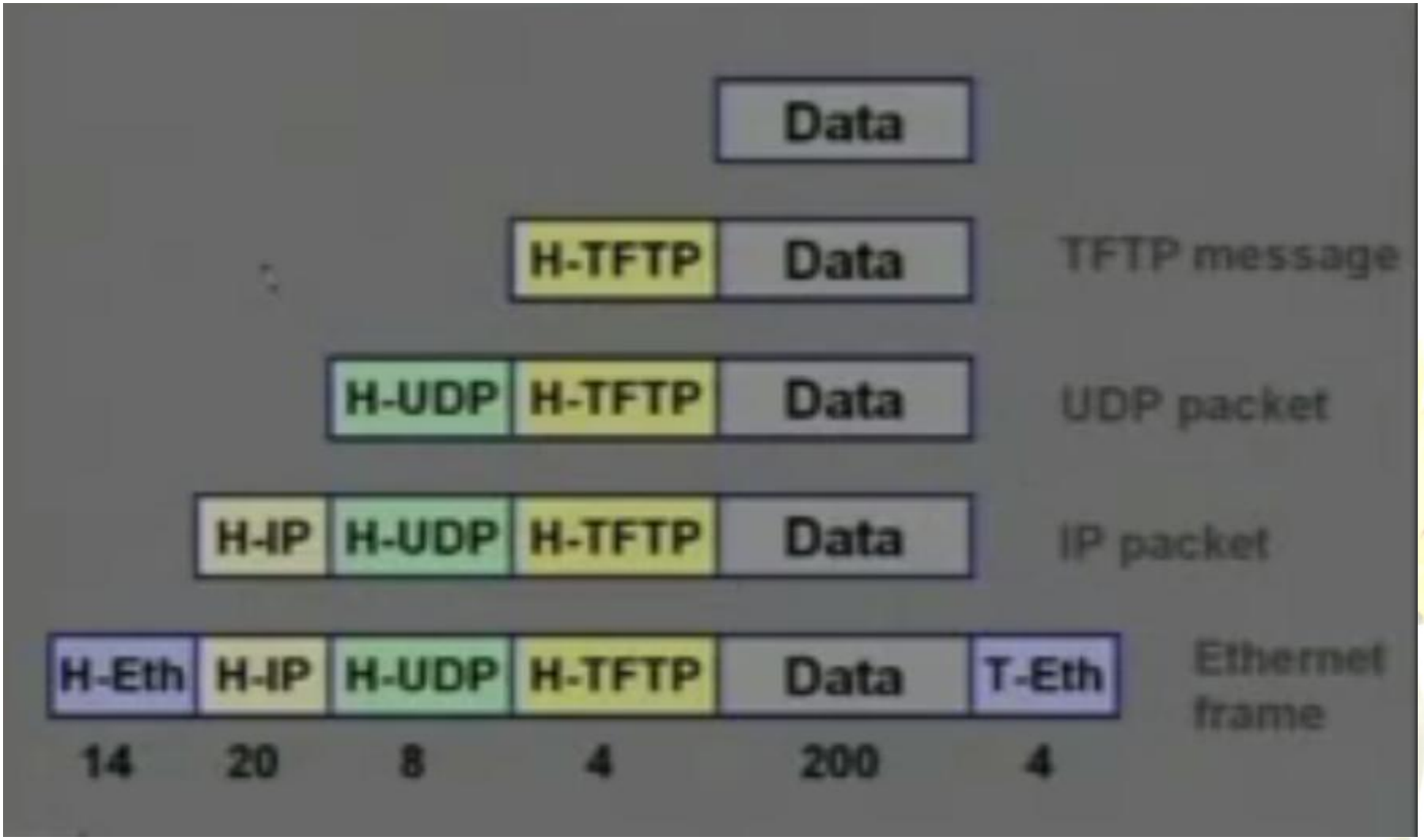
Encapsulation in TFTP



TFTP over Ethernet



Encapsulation in TFTP



IP Datagrams

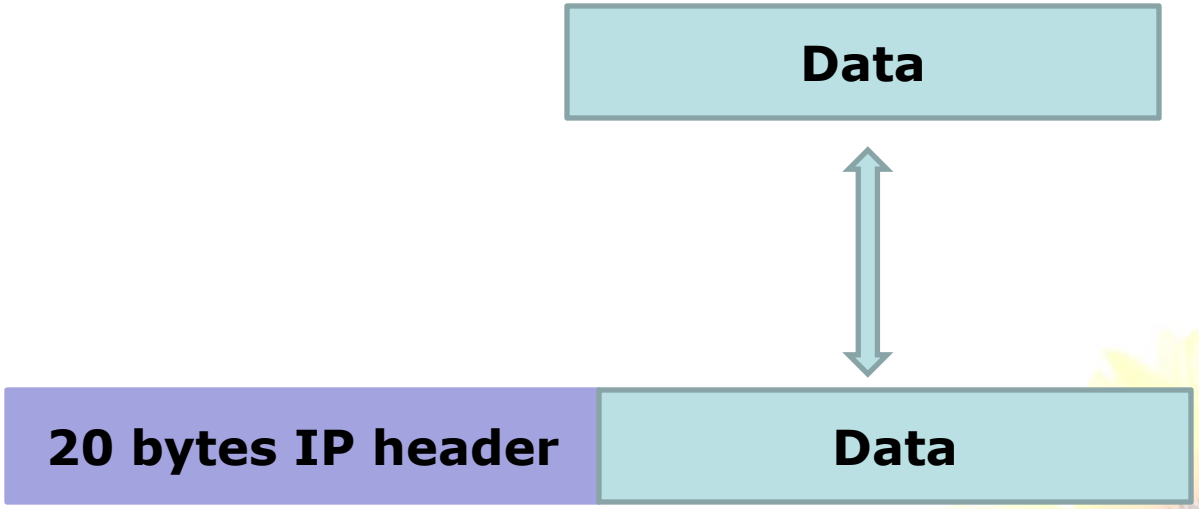
The IP Layer

- IP layer provides a connectionless, unreliable delivery system for packets.
  - Mentioned before.
- Each packet is independent of one another.
  - IP layer need not maintain any history.
  - Each IP packet must contain the source and destination addresses.

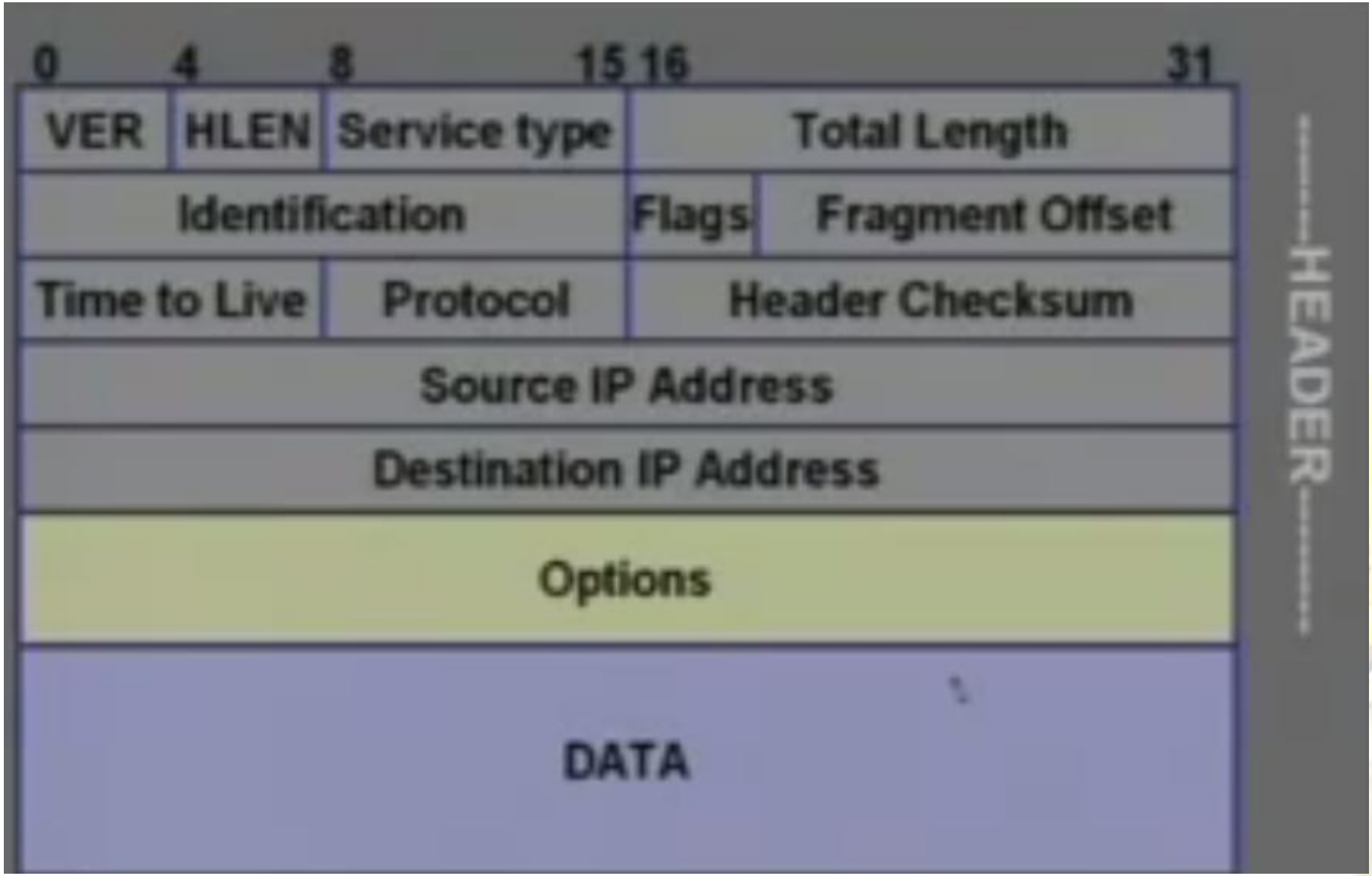
The IP Layer (cont.)

  - IP layer does not guarantee delivery of packets.
- IP layer encapsulation
  - Receives a data chunk from the higher layer (TCP or UDP)
  - Prepends (adds) a header of minimum 20 bytes.
- Containing relevant information for handling routing and flow control.

Illustration



Format of IP Datagram



IP Header Fields

- **VER (4-bits)**
  - **Version of the IP protocol in use (typically 4).**
- **HLEN(4 bits)**
  - **Length of the header, expressed as the number of 32-bits words.**
  - **Minimum size is 5, and maximum 15.**
- **Total Length (16 bits)**
  - **Length in bytes of the datagram, including headers.**
  - **Maximum datagram size:: 2^{16} = 65536 bytes.**

IP Header Fields (contd.)

- **Service Type (8 bits)**
  - Allows packet to be assigned a priority.
  - Router can use this field to route packets.
  - Not universally used.
- **Time to Live (8 bits)**
  - Prevents a packet from traveling in a loop.
  - Senders sets a value, that is decremented at each hop. If it reaches zero, packet is discarded.

IP Header Fields (contd.)

- **Source IP address (32 bits)**
  - Internet address of the sender.
- **Destination IP address (32 bits)**
  - Internet address of the destination.
- **Identification, Flags, Fragment Offset**
  - Used for handling fragmentation.
  - To be discussed later.
- **Options (variable width)**
  - Can be given provided router supports
  - Source routing, for example.

IP Header Fields (contd.)

- Header Checksum (16 bits)
  - Covers only the IP header
  - How computed?
    - Header treated as a sequence of 16-bit integers.
    - The integers are all added using ones complement arithmetic.
    - Ones complement of the final sum is taken as the checksum.
  - A mismatch in checksum causes the datagram to be discarded.