Computer Network I

Reti di Calcolatori I

Università di Napoli Federico II – Scuola Politecnica e delle Scienze di Base
Corso di Laurea in Informatica

Riccardo Caccavale

(riccardo.caccavale@unina.it)

Standardization

Needs for Standards and Protocols

- Computer networks (such as Internet) can be quite **complex and widespread** over different locations, countries, users, etc.

- Clearly, a **set of rules** or a common ground should be defined so that all participants know how **to provide or to use services**.

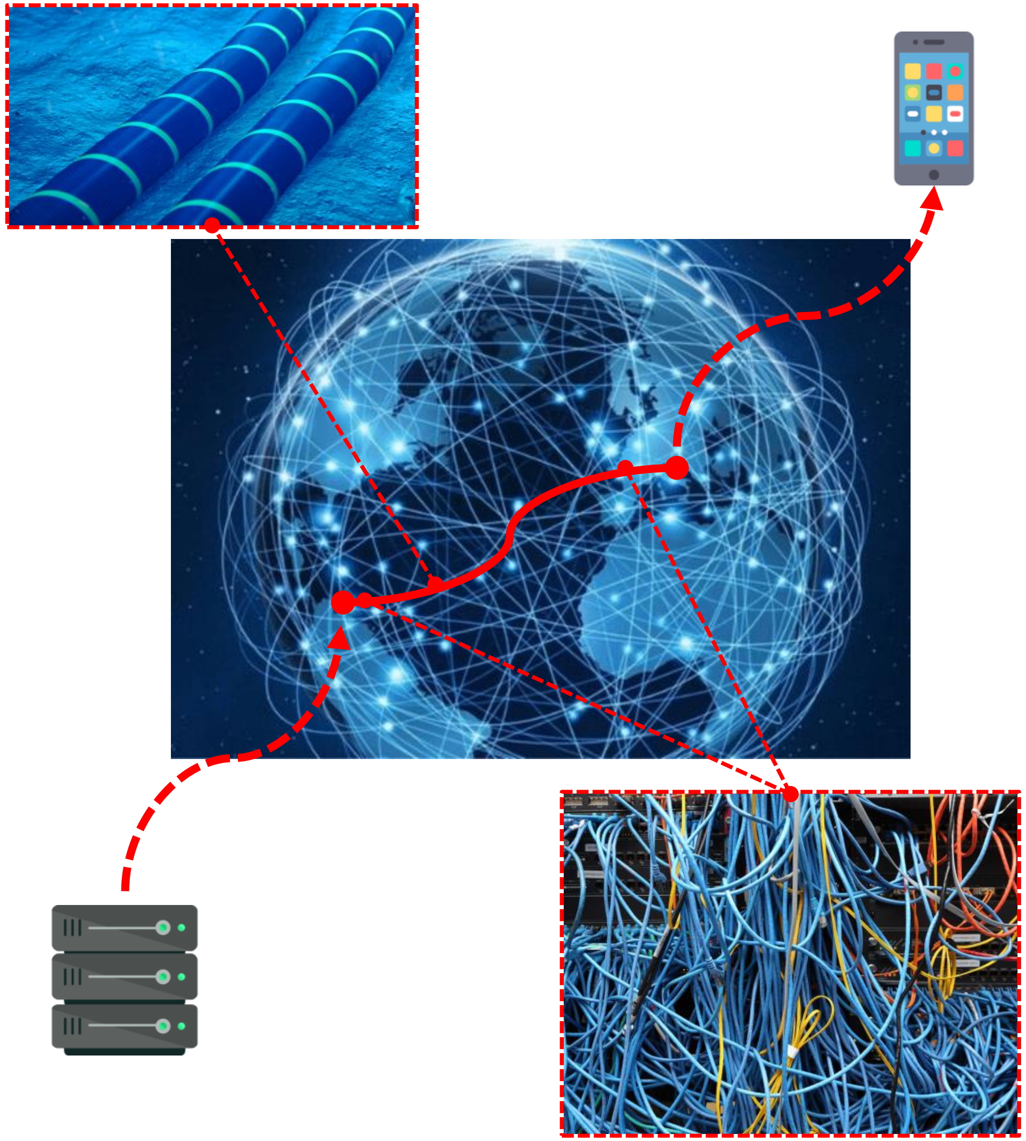
- From the beginning of Internet, one of the major effort has been made to define **protocols** and **standards** that regulate communication.

The Tower of Babel by Pieter Bruegel the Elder (1563).

Standardization

Needs for Standards and Protocols

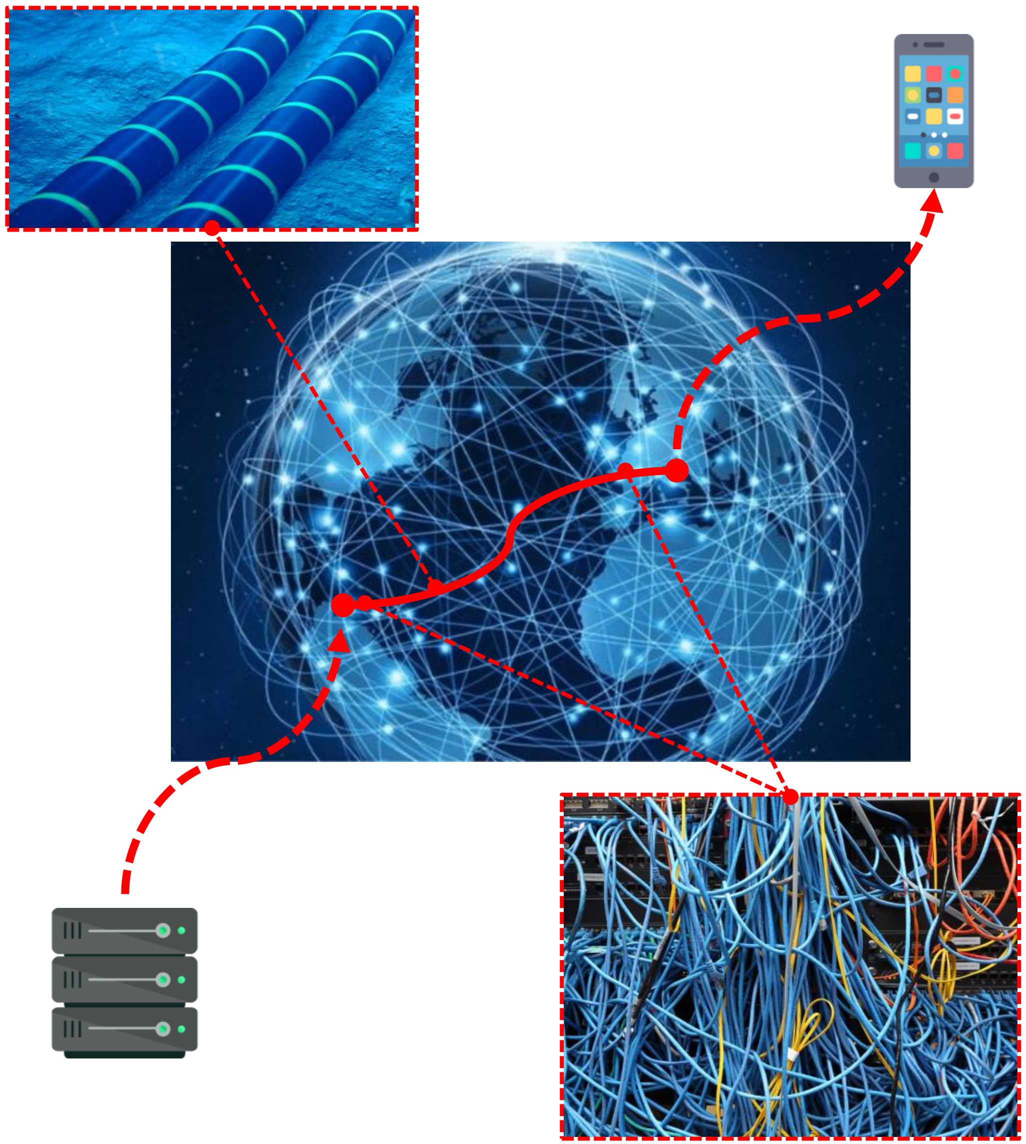
- The communication between devices involves **several problems**:
    - Physical transportation, addressing, error check, data conversion and regulation, security, synchronization, etc.
- To allow the communication both the receiver and the transmitter must agree to a **protocol**.
- When multiple/different devices from different places communicate they all must to agree on a common protocol, which becomes a **standard**.



Standardization

Needs for Standards and Protocols

- There are **hundreds of protocols** which regulate all aspects of communication from physical links to applications:
  - How **cables and links** should be created (materials, shielding, frequencies, etc.).
  - How **addresses** should be assigned.
  - How data should be wrapped into **packets or frames** for transmission.
  - How **errors** should be detected or corrected.
  - How **applications** should exchange data.
  - …



Standardization
Who Standardize Standards?

- Todays Internet standards and protocols are defined by a community of experts called **Internet Engineering Task Force** (IETF).

IETF®

- IETF is typically organized in **open working groups**, each one focused on specific aspects of internet, whose members interacts by mailing list and meetings.

- Each one of these working groups produces numbered documents called **Request For Comments** (RFC) including description and definition of protocols, concepts, methods underlying a standard.
  - For example, the IPv4 protocol was defined in RFC 791 (1981).

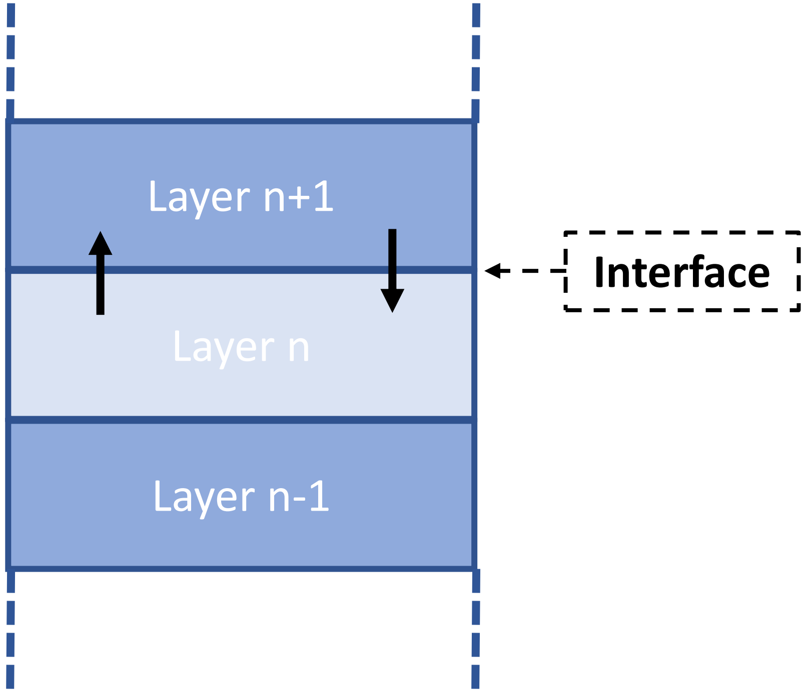
Standardization

Network Models: Layered Model

- A reasonable approach to face the different communication problems is to design a **layered model** (*Divide et Impera*):
  - Each layer is conceptually **responsible for one specific task** (solves one problem).
  - Each layer rely on services from the **lower layer** and provides services to the **upper layer**.

- Pros:
  - **Modularity**: layers are simple and independent
- Cons:
  - **Scalability**: climbing too much layers is inefficient

Toward applications (high-level)



Toward hardware (low-level)

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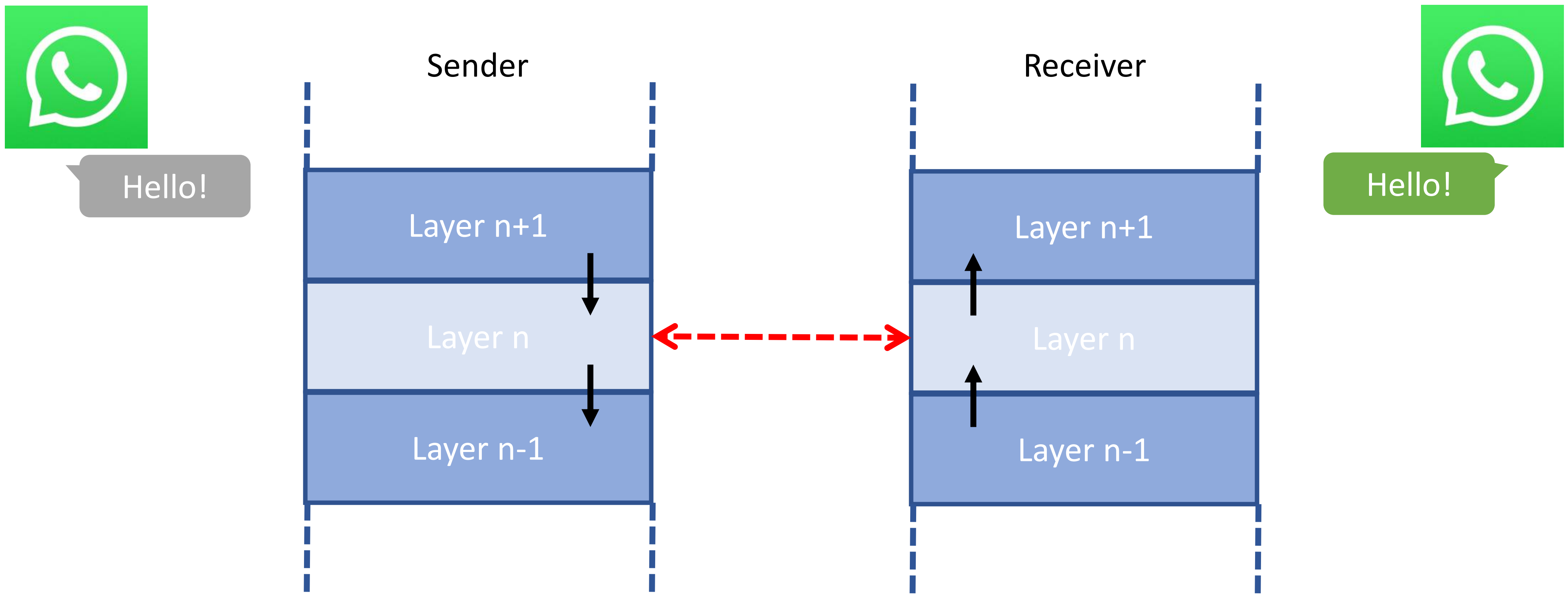
Network Models: Layered Model

- When two devices communicate, **each layer on the sender communicates with the same layer on the receiver** by means of a specific protocol.



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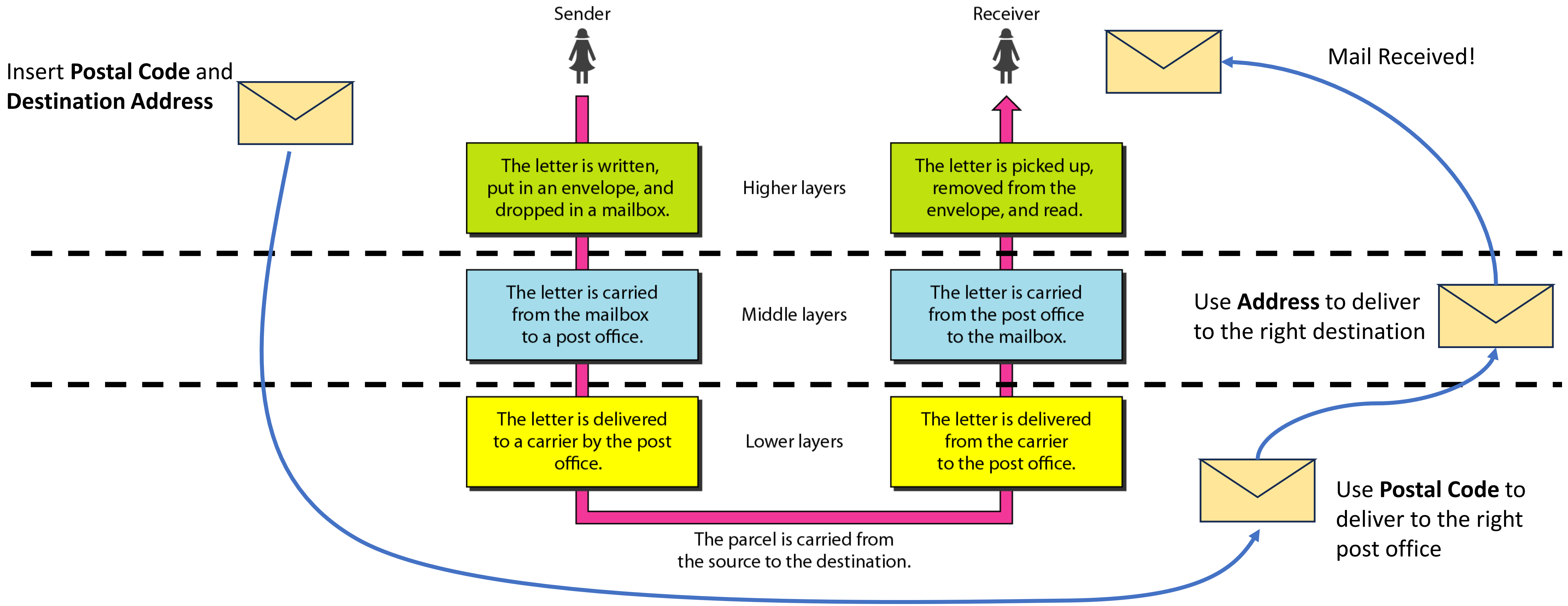
Network Models: Layered Model (example)

- When two devices communicate, **each layer on the sender communicates with the same layer on the receiver** by means of a specific protocol.



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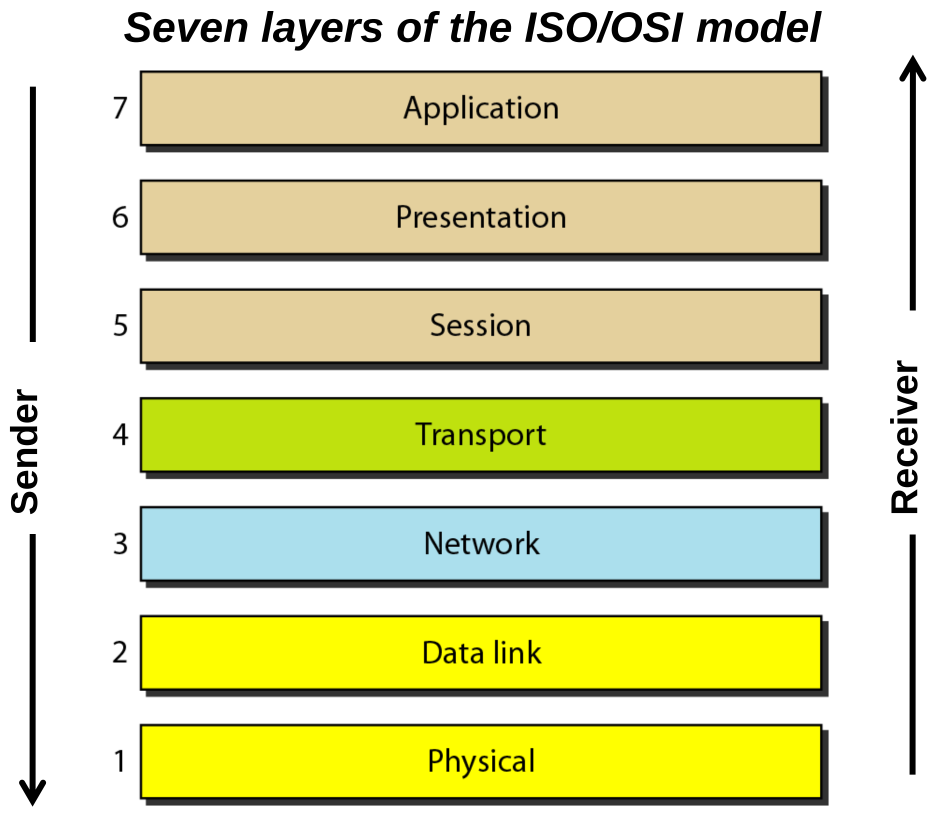
Network Models: The OSI Model

- In the ‘80 the **ISO** (International Standards Organization) defined a layered model for computer networks: the **OSI** (Open System Interconnection) model.
- The ISO/OSI model includes 7 layers:
  1. Physical transmission of raw bits.
  2. Data format definition (frames).
  3. Routing of messages through the net.
  4. Transmission protocols (TCP, UDP).
  5. Management of ports and sessions (continuity of data stream).
  6. Translation of messages (encoding, compression, decryption, etc.).
  7. Data use and human-computer interaction (file sharing, emails, streaming videos, etc.).



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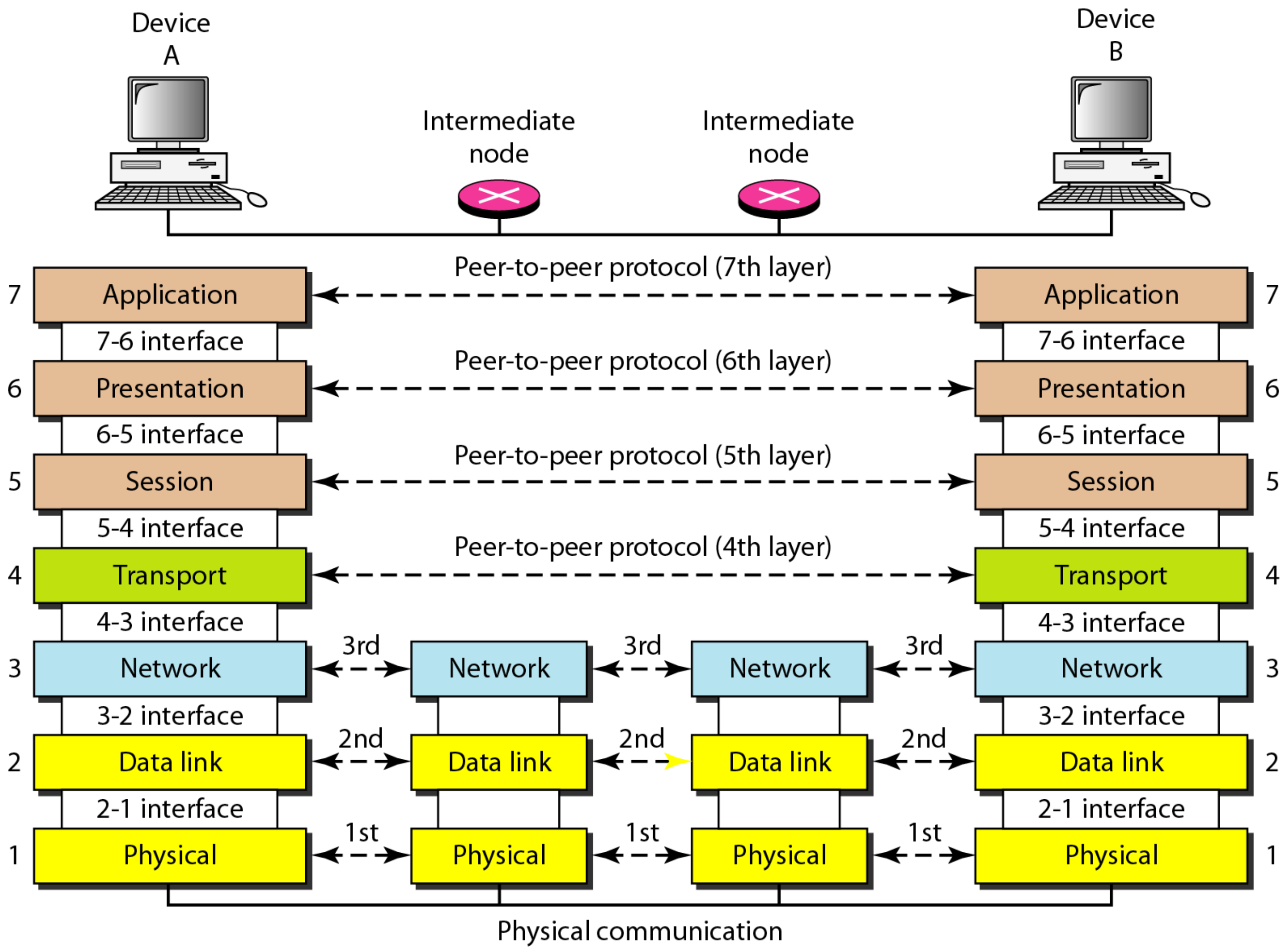
Network Models: The OSI Model

- Not always all layers are implemented.
- Typically, in intermediate nodes (switches, routers), **only 2 or 3 layers** are implemented (media layers).
- Only the **end-points implement the whole stack** up to the application layers.



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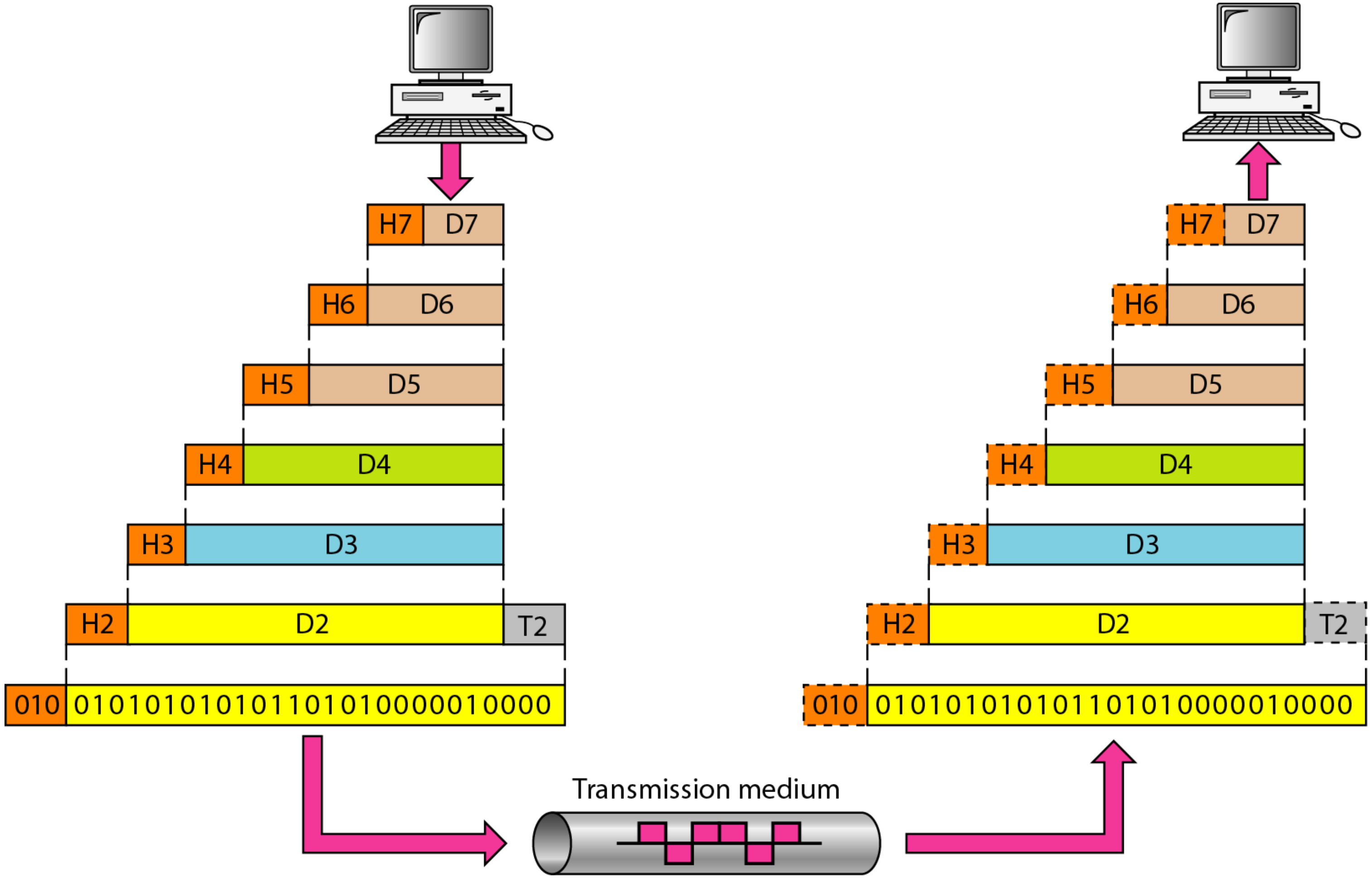
Network Models: The OSI Model

- **Encapsulation** (top-down): every layer of the sender adds a layer-specific field to the message (payload) in the form of a header (H) or trailer (T).

- **Decapsulation** (bottom-up): Those fields are removed and interpreted by the same layer in the receiver.



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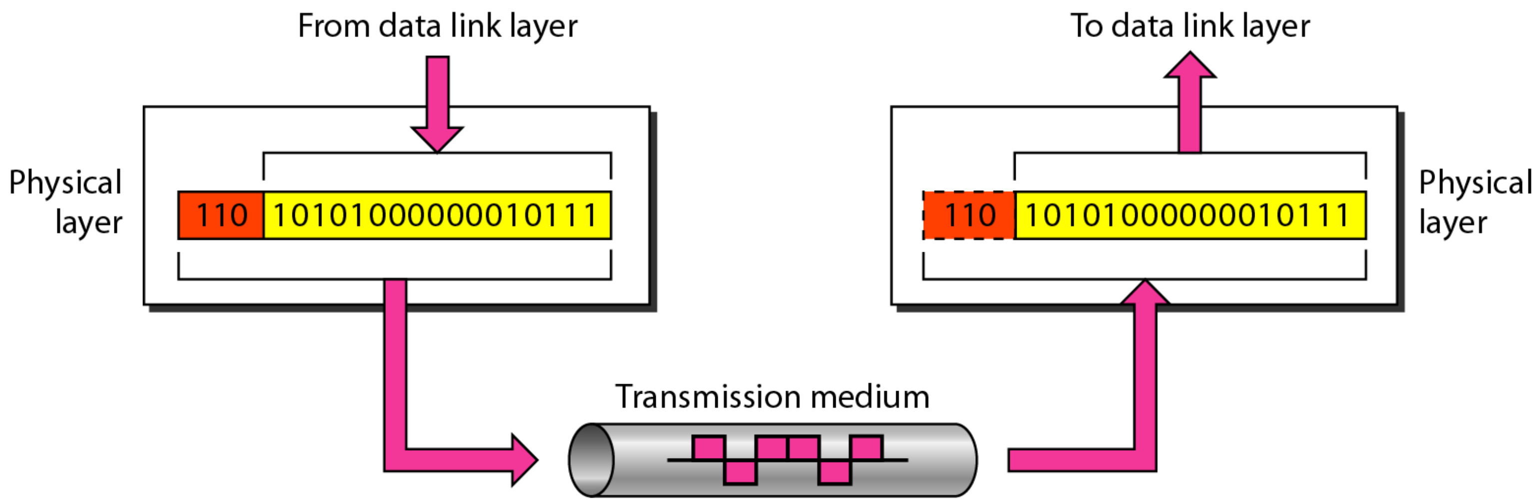
OSI Model: 1. Physical Layer

- The **physical layer** is responsible for movements of individual bits from one hop (node) to the next.
  - Physical characteristics of interfaces and media (connectors, cables, electric signals)
  - Line configuration (point-to-point or multipoint)
  - Physical topology (mesh, star, ring or bus)
  - Transmission mode (simplex, half-duplex or duplex)
  - Representation of bits
  - Data rate
  - Synchronization of bits



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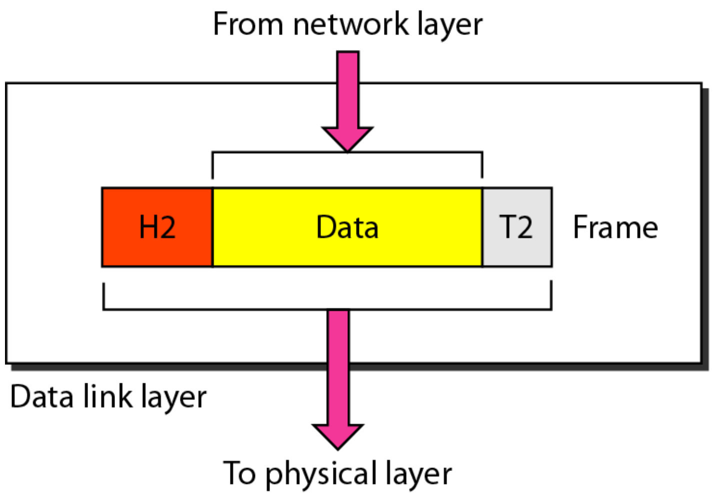
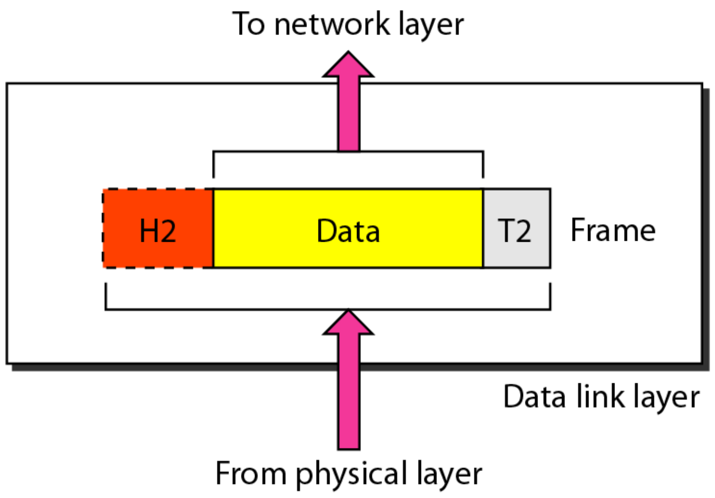
OSI Model: 2. Data Link Layer

- The **data link layer** is responsible for moving frames from one hop (node) to the next (segment).
  - Works on frames (portion of data, typically few hundreds of bytes)
  - Flow and error control (frame control sequences)
  - Access control





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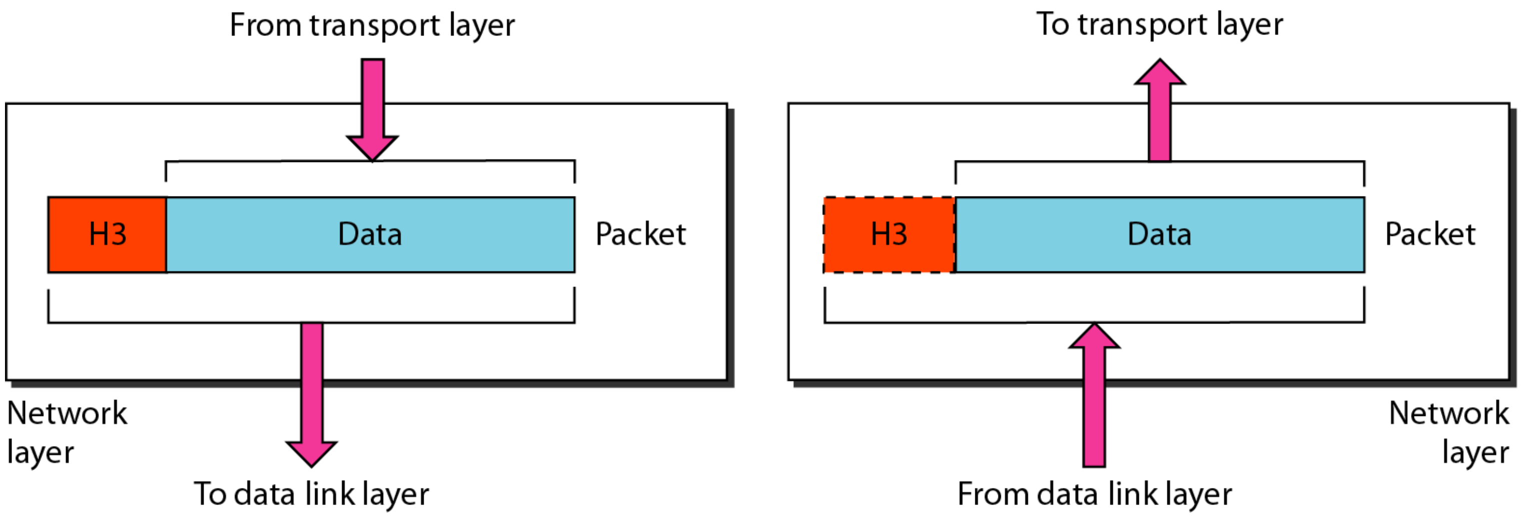
OSI Model: 3. Network Layer

- The **network layer** is responsible for the delivery of individual packets from the source host to the destination host (path).
  - Works on packets (typically larger and more complex than frames)
  - Source-to-destination delivery: packets from the source to the destination.
  - Logical addressing
  - Routing (routing tables)



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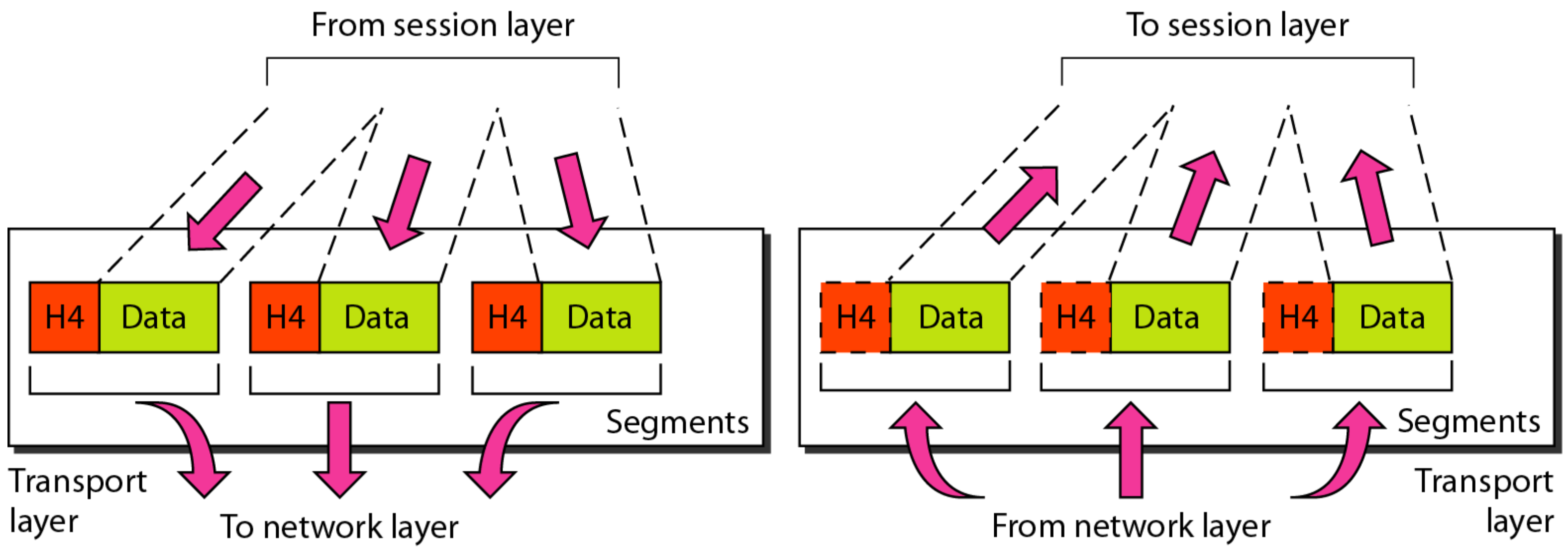
OSI Model: 4. Transport Layer

- The **transport layer** is responsible for the delivery of a message from one end to another (message is received by the right program).
  - End-to-end delivery
  - Connection control (Connection-oriented or connection-less)
  - Segmentation/reassembly (to/from packets of layer 3)
  - Port addressing
  - Flow and error control



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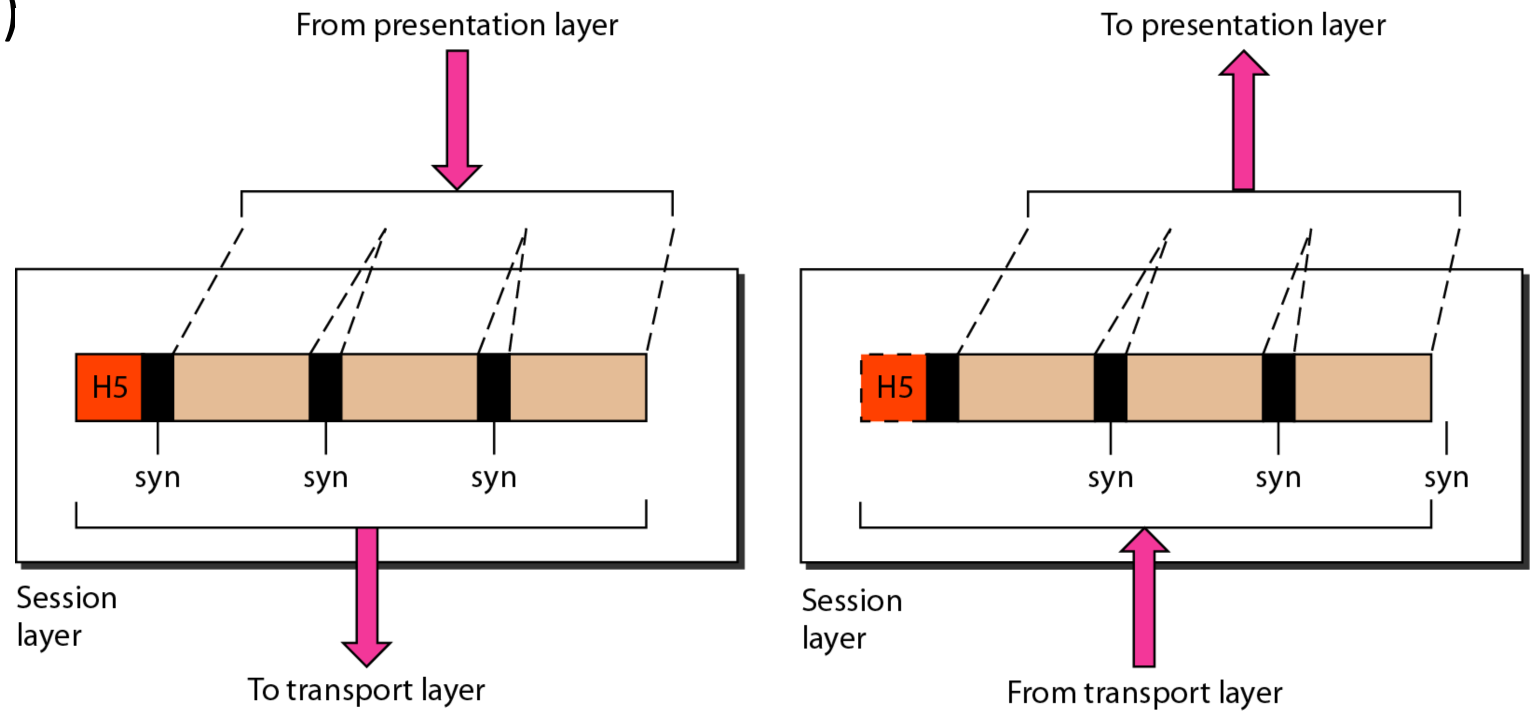
OSI Model: 5. Session Layer

- The **session layer** is responsible for dialog control and synchronization of request/response.
  - It establishes, maintains and synchronize the interaction between communicating system (communication session).
  - Dialog control and management
  - Synchronization (checkpoints)



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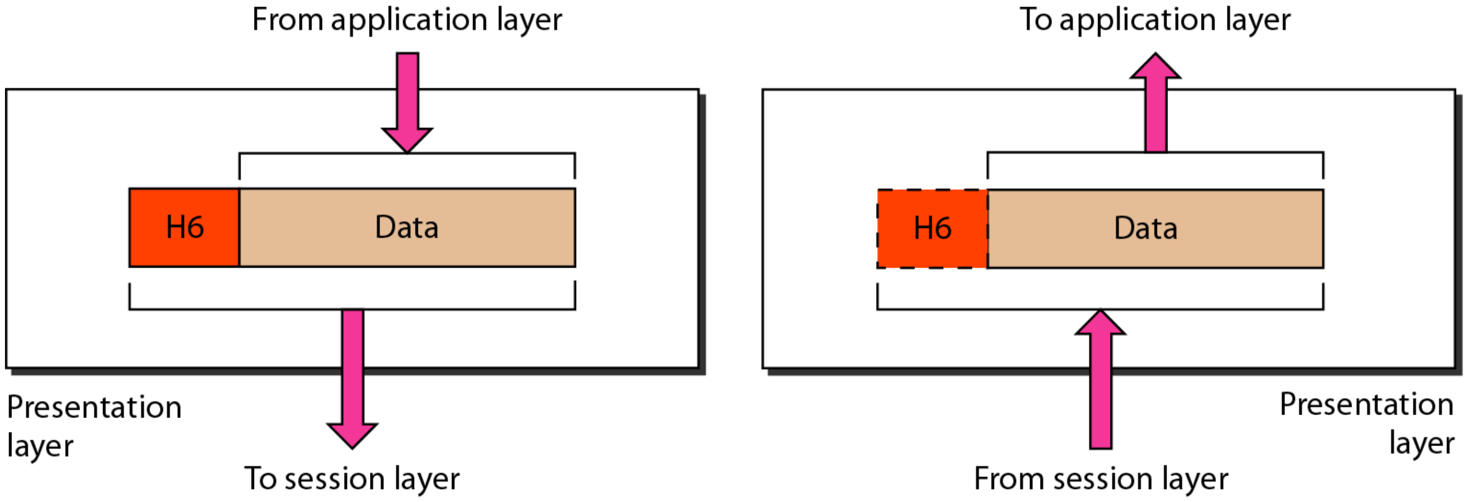
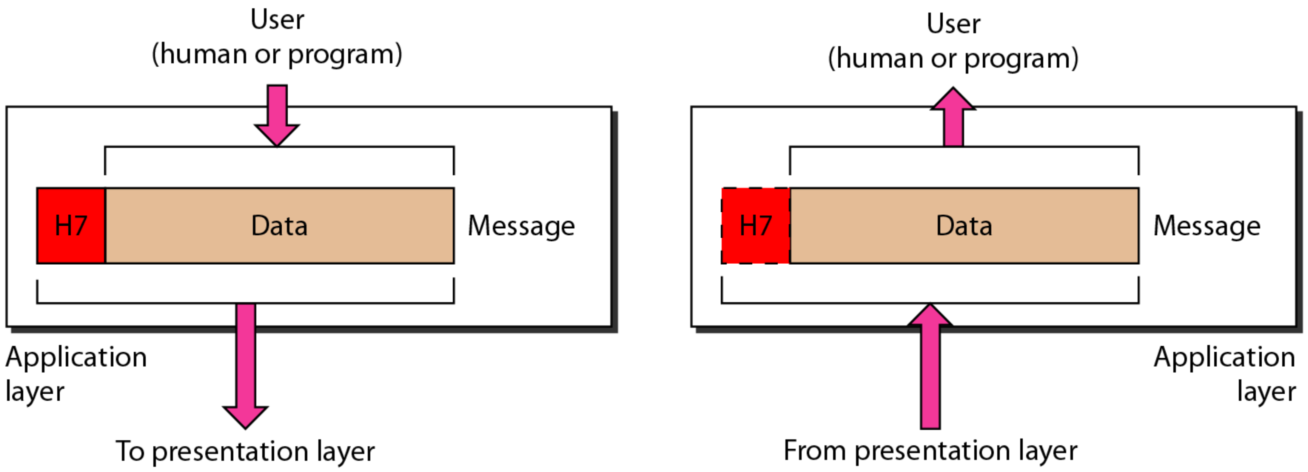
OSI Model: 6. Presentation Layer

- The **presentation layer** is responsible for the representation of data, i.e., translation, compression, encryption, etc.
  - Translation (e.g., EBCDIC-coded or ASCII-coded to text)
  - Encryption and Decryption
  - Compression



Standardization
OSI Model: 7. Application Layer

- The **application layer** is responsible for providing services to the user.
  - Network virtual terminal (Remote log-in)
  - File transfer and access
  - Mail services
  - Accessing the World Wide Web
  - …



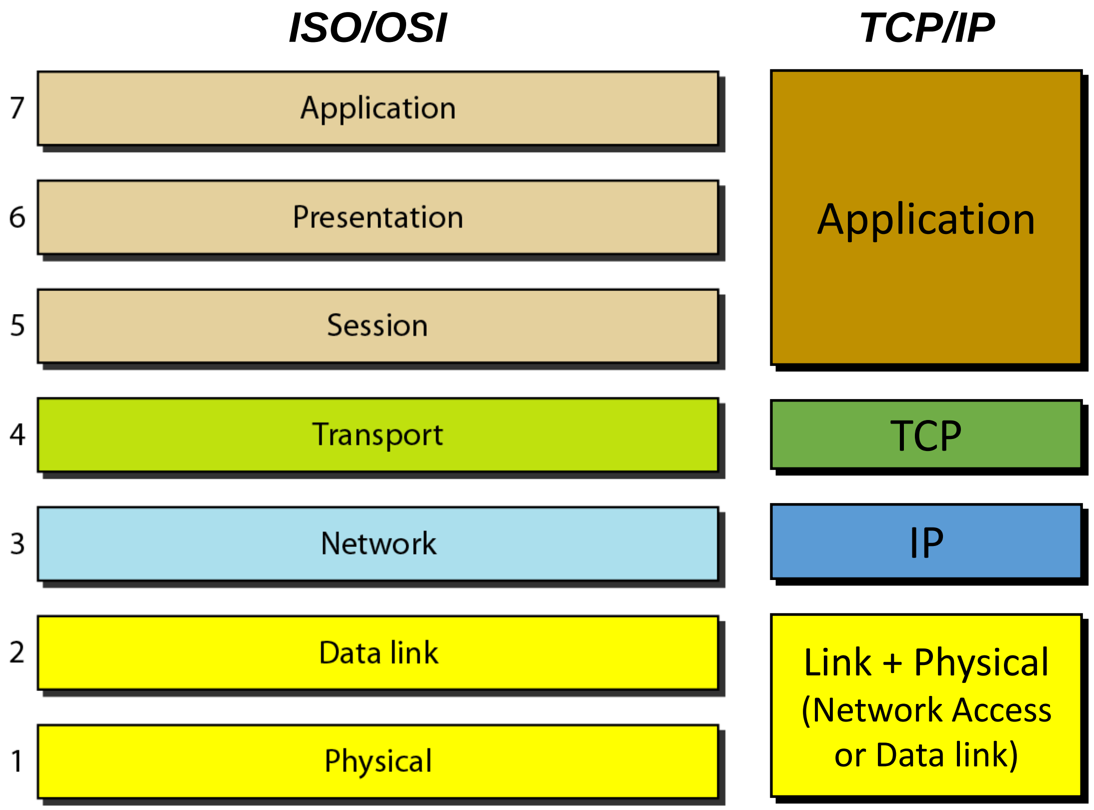
Standardization

Network Models: The TCP/IP Model

- The ISO/OSI model is *de iure* the standard stack for computer networks, but it is quite complex and detailed.

- The TCP/IP (aka Internet Protocol Suite) is the set of communication protocols **actually used** on internet and local networks.
  - TCP: Transmission Control Protocol.
  - IP: Internet Protocol.

- The TCP/IP is *de facto* the standard stack for internet communication.



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Network Models: Other Protocols

- There are different protocols for device communication, which can be used depending on the situation, that are still relying on the layered model.