

Lecture 2: Network Protocols and Layering

Prof. Mohammed Hawa
Electrical Engineering Department
University of Jordan

EE426: Communication Networks

What is a *Network Protocol*?

- A protocol is the set of rules that specify:
 - Format of **messages** exchanged in the network.
 - Appropriate **actions** required for each message.
- A protocol is executed by running distributed service scripts on remote communicating entities.
- The service scripts within communicating entities are typically **Layered**.
- Protocols are typically written in **standards** and implemented by software and/or hardware.

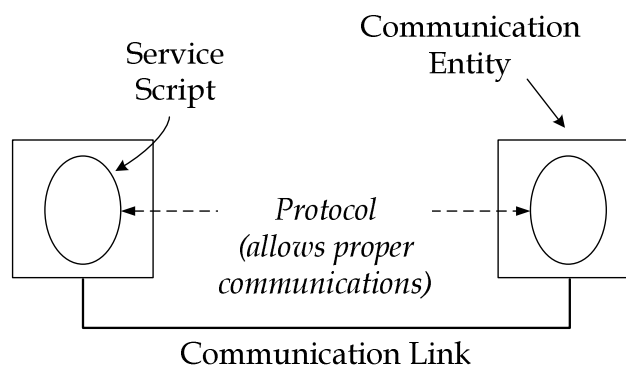


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What is a Network Protocol?



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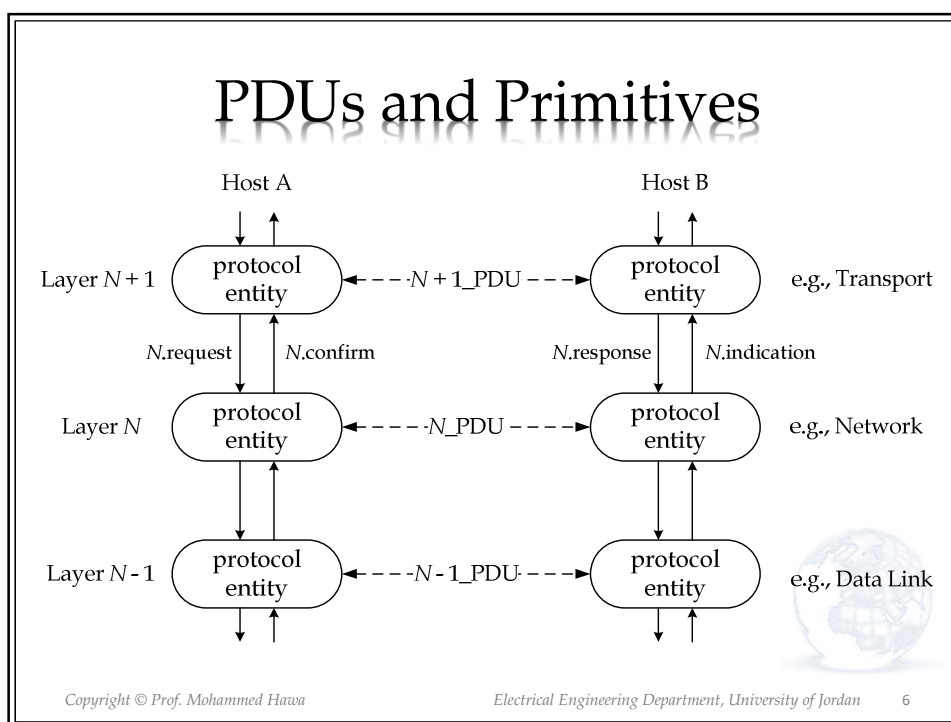
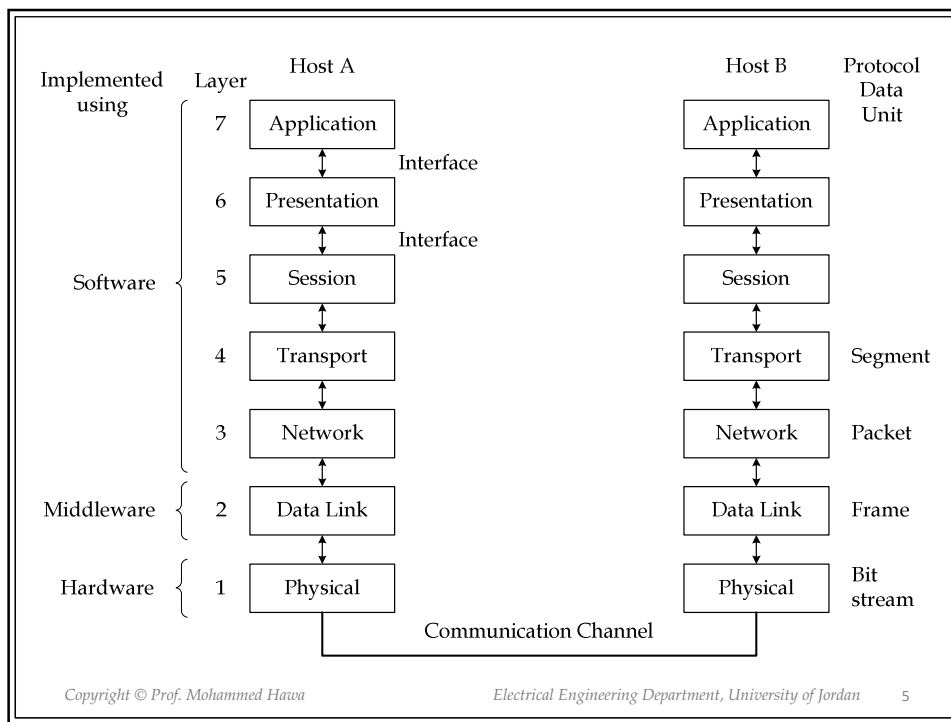
The OSI Model

- One of the main layered models in computer networks is the “Open Systems Interconnection Reference Model” (OSI Model).
- It was developed by the International Organization for Standardization (ISO) in the late 1970s.
- The OSI model contains 7 layers.
- In a layered architecture, layer N uses only the services of layer N – 1 (so communication is valid only between adjacent layers, called *Interface*).

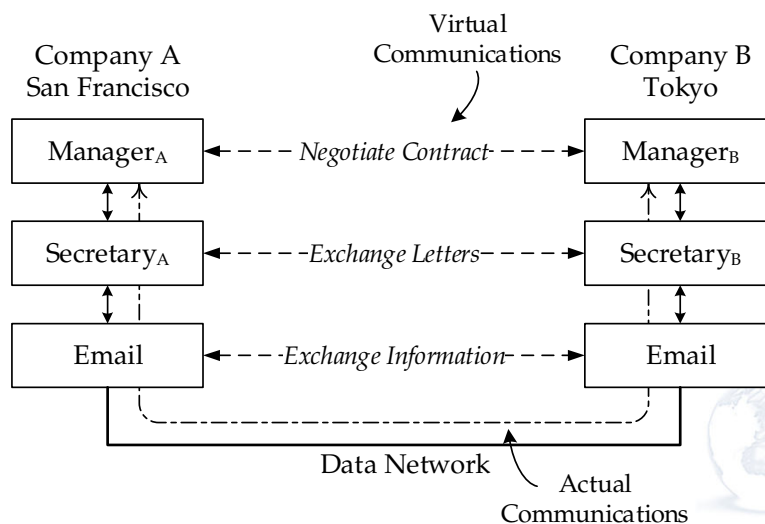
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Analogy...



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OSI Layers

- 1. Physical Layer:** Transmits bits (1's and 0's) as appropriate electrical or optical signals on the transmission medium (physical link) between two adjacent nodes. The functions of this layer include modulation/demodulation, encoding/decoding, clock synchronization, etc. It is usually implemented in hardware.
- 2. Data Link Layer:** Handles transmission of frames (sequence of bits) on one given physical link between two adjacent nodes. The data link layer makes sure this sequence of bits arrives correctly (and intact) at the receiving end, and supervises the retransmission of frames that arrive incorrectly (*Old*). Part of the data link layer (called *Medium Access Control* sublayer or **MAC**) is responsible for controlling access to the shared medium, if one is used.

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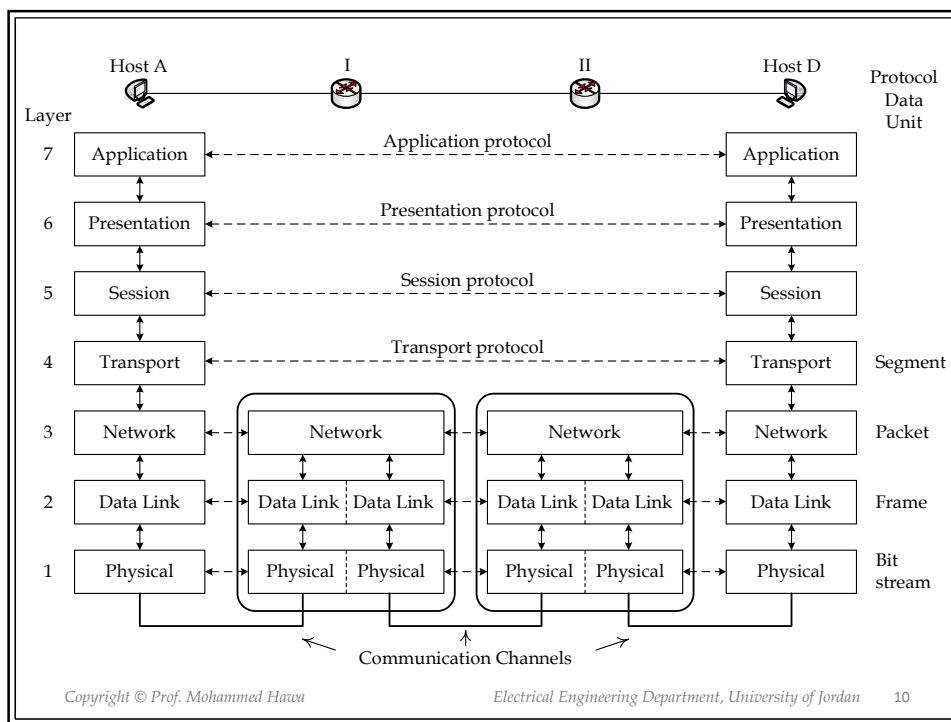
OSI Layers

3. **Network Layer:** Handles proper *end-to-end* transmission of packets. To do that, this layer collects information about the intermediate nodes in the network to find the *best path* through the network for packets to follow. It also deals with *global address assignment* of different nodes and controls the quality of service (QoS) issues (e.g., delay, jitter, bandwidth reservation, etc).
4. **Transport Layer:** Ensures the *reliable transfer* of messages between end nodes. It handles *dividing* the message into smaller segments, and uses *acknowledgements* (ACKs) to verify that the segments are received correctly by the destination. It supervises the *retransmission* of segments that arrive incorrectly. It also handles *numbering* of the transmitted segments and *rearranges out-of-order* segments at the receiving end. This layer also controls the *rate* at which segments are transmitted. It also allows end nodes to react to ease *congestion* in the network.

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OSI Layers

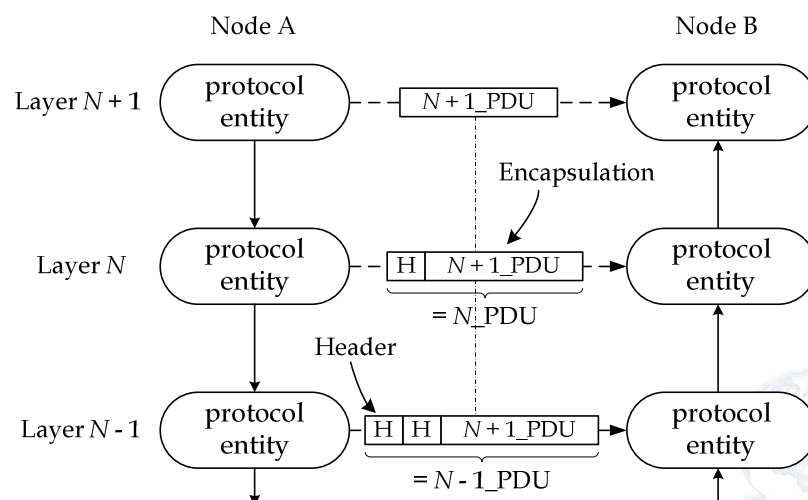
5. **Session Layer:** Handles the *setup* and *management* of end-to-end sessions (or conversations). It handles *negotiating connection parameters* plus *authentication of users* using passwords.
6. **Presentation Layer:** Handles any necessary *formatting* to translate from the representation on one computer to the representation on another (e.g., ASCII vs. EBCDIC). This layer also handles any necessary *encryption* (for security) and *compression* of data (for faster transfer).
7. **Application Layer:** Those are the applications or services running on top of the network, such as file transfer, web browsing, VoIP and email. Part of the application layer program runs in node A and the other part runs in node B.

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Encapsulation

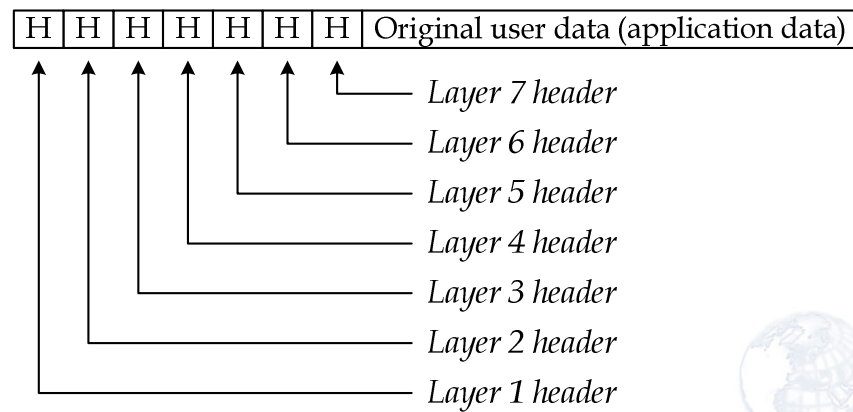


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Encapsulation (Headers)

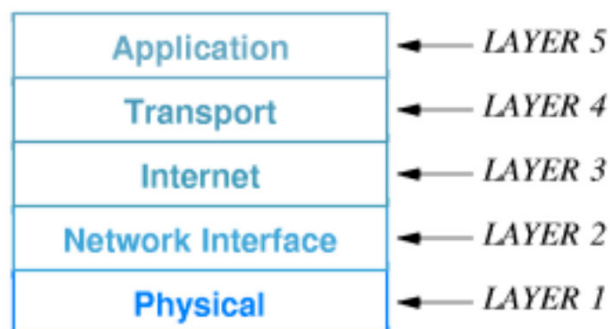


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TCP/IP Stack



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Standards & Standardization Bodies

- **ITU-T** (International Telecommunication Union – Telecommunications Sector), formerly CCITT: Mainly physical layer.
- **IEEE** (Institute of Electrical and Electronics Engineers): Mainly layer 2 such as Ethernet (IEEE 802.3) and Wi-Fi (IEEE 802.11).
- **IETF** (Internet Engineering Task Force): Mainly layer 3 and layer 4 such as IPv4 (RFC 791) and TCP (RFC 793).

