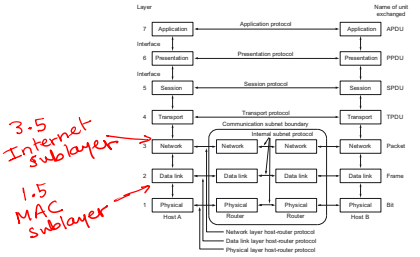
The OSI Reference Model



- A ***protocol*** defines message types and associated actions
- MAC sublayer to handle multi-access (shared) links
- Internetwork sublayer to connect networks

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ISO/OSI Architecture (cont'd)

- Seven layers with following typical functions:
  - ***application***: user interface
  - ***presentation***: code conversion, encryption, compression
  - ***session***: organizes and synchronizes the data exchange
  - ***transport***: multiplexing/demultiplexing, fragmentation/reassembly, end-to-end flow control, congestion control and error control
  - ***network***: addressing and routing
  - ***data link***: link-level flow and error control
  - ***physical***: physical and electrical interfaces (normally 100% hardware)

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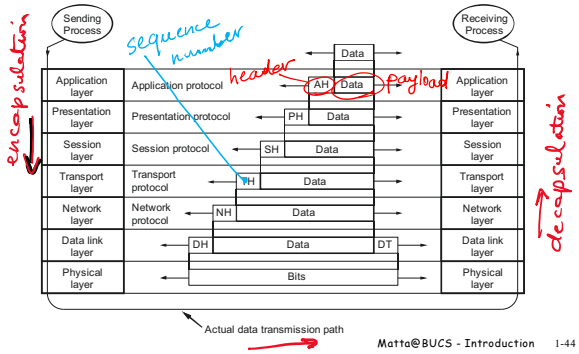
How is the OSI Model used?



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Service Offered by a Layer

- Connection-oriented:
  - Before data exchange takes place, a logical (virtual) connection has to be first established
  - Usually reliable; delivery is in-order, error- and loss-free, no duplication
- Connection-less: data is sent directly in a best-effort way; data can arrive out-of-order, be lost, corrupted, duplicated

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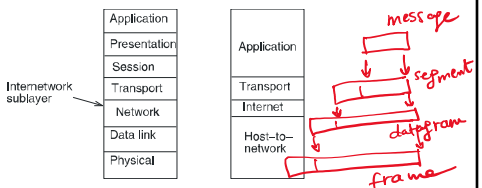
TCP/IP (Internet) Architecture

- An industry / de facto standard
- Four layers (application, transport, internet, network interface)
- Data units: messages, segments, datagrams, frames
- Many intranets also use TCP/IP



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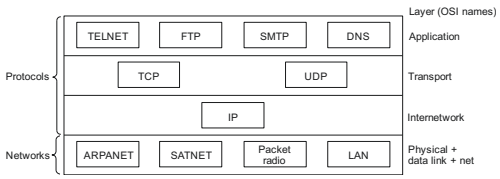
Initial Protocols & Networks in the TCP/IP model



- TCP (Transmission Control Protocol):
  - offers ***connection-oriented reliable*** service
- UDP (User Datagram Protocol):
  - offers ***connection-less unreliable*** service

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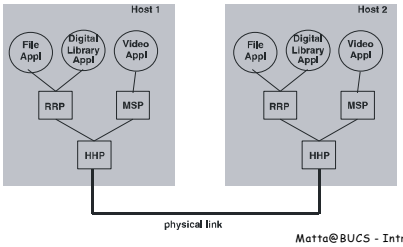
Protocol Graph

- collection of protocols and their dependencies
- most peer-to-peer communication is indirect
- peer-to-peer is direct only at hardware level



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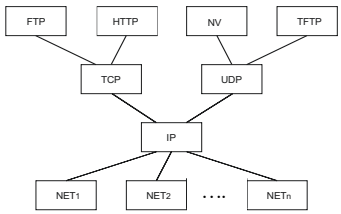
Protocol Graph for the Internet



- IP provides a connection-less "best-effort" ***datagram state-less*** service

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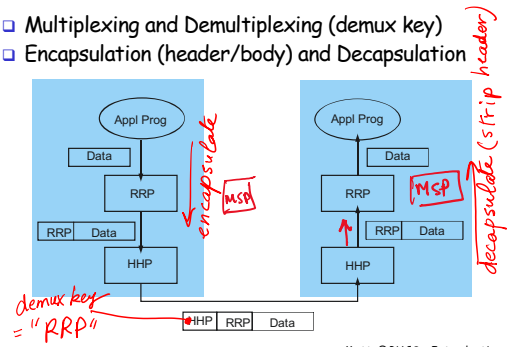
Protocol Stack

- Multiplexing and Demultiplexing (demux key)
- Encapsulation (header/body) and Decapsulation



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We will cover …

- In a top-down Internet-centric fashion …
- Applications
  - Socket programming
- Transport Services
  - Error, flow and congestion control
- Internetworking
  - Addressing and Routing
  - Scalability/heterogeneity
- LANs, point-to-point links
  - Access control, data communication
- Wireless (WiFi LAN), mobility
- As time permits: wide-area wireless, real-time, management, operational security, …