

Basic Concepts In Computer Networking

Antonio Carzaniga

Faculty of Informatics
University of Lugano

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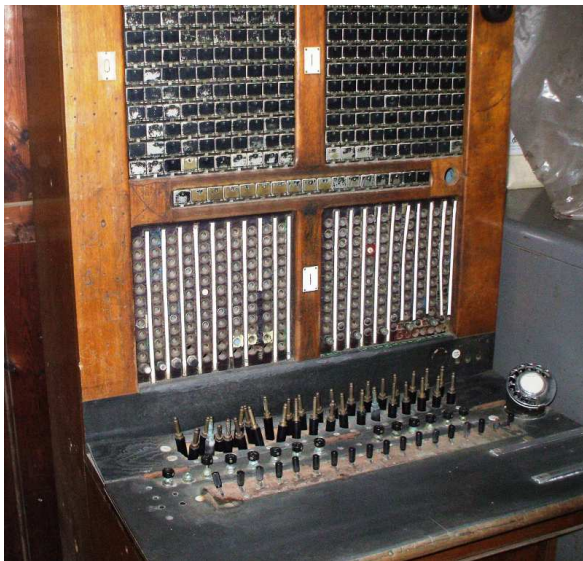
Goal of this Lecture

- Understand what *packet switching* is
- Understand what *circuit switching* is
- Understand their differences
- Understand what a *protocol* is

- What is the Internet?
- Types of network
- Types of service
- Protocols
- The Internet protocol stack

History

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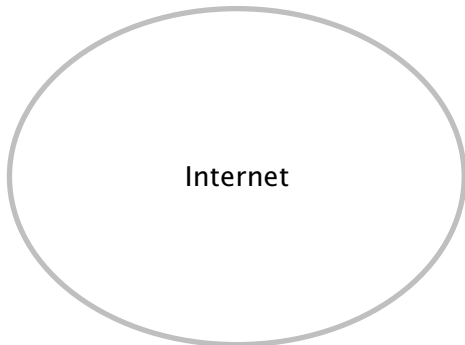


History

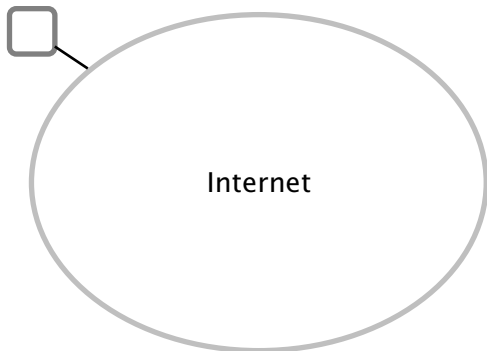
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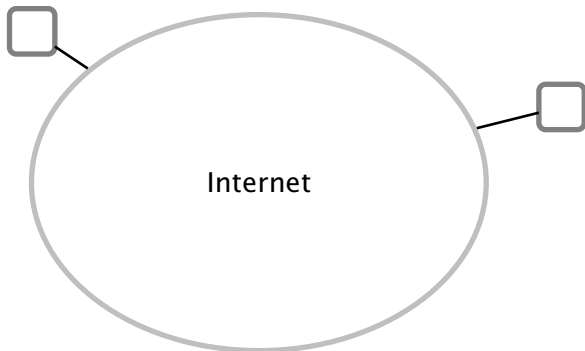
What is the Internet?



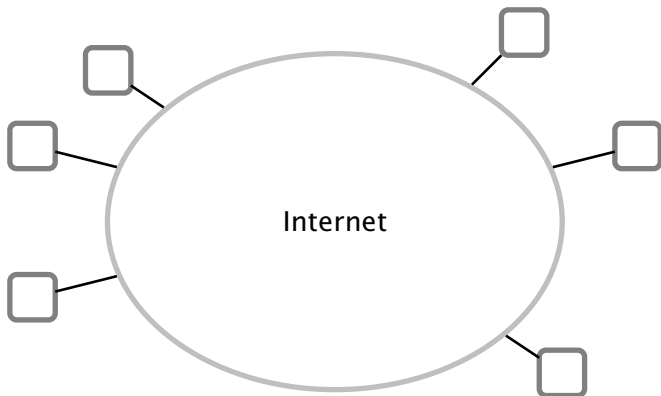
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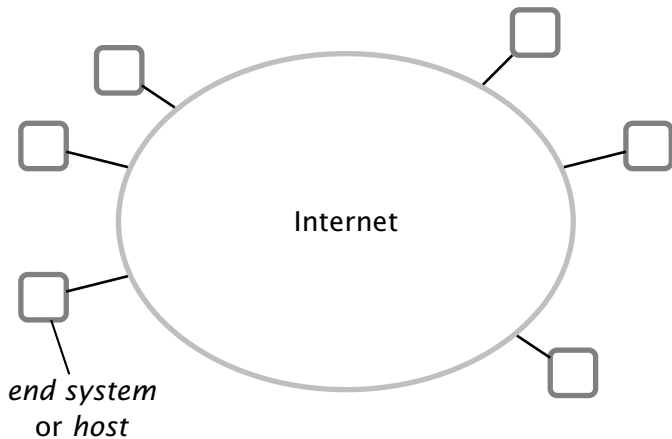
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End Systems

- *End system* or *host* (□)

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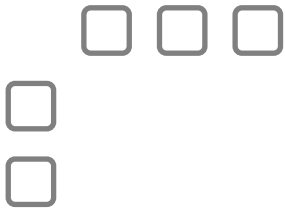
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- ▶ a picture frame
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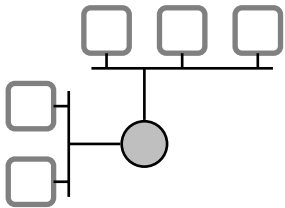
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- ▶ a toilet seat?
- ▶ a toothpick?
- ▶ ...

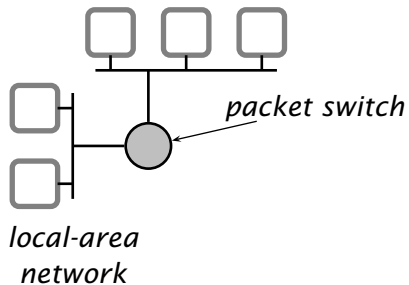
What is *Inside* the Internet?



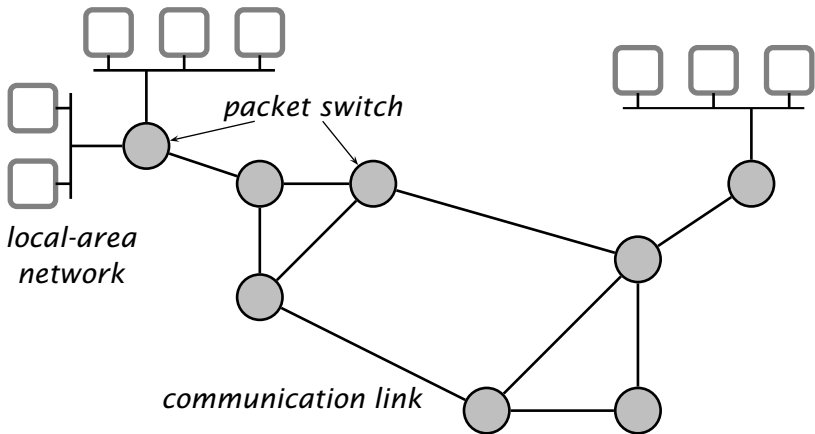
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- *Packet switch*: a *link-layer switch* or a *router*
- *Communication link*: a connection between packet switches and/or end systems
- *Route*: sequence of switches that a packet goes through (a.k.a. *path*)
- *Protocol*: control the sending and receiving of information to and from end systems and packet switches

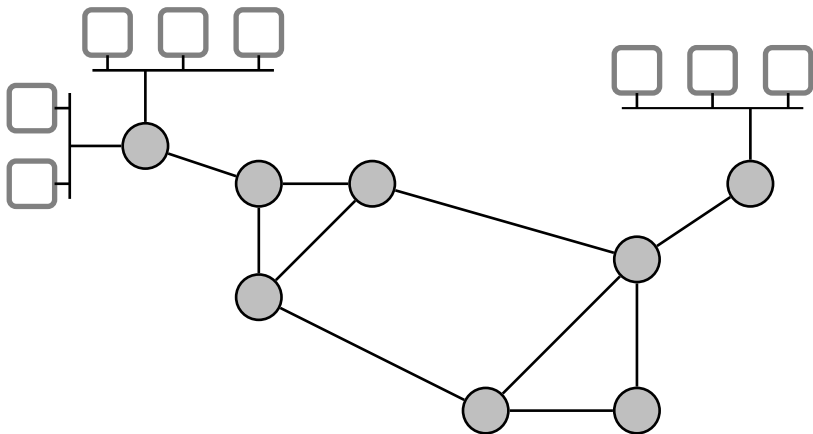
Communication Links

- Various types and forms of medium

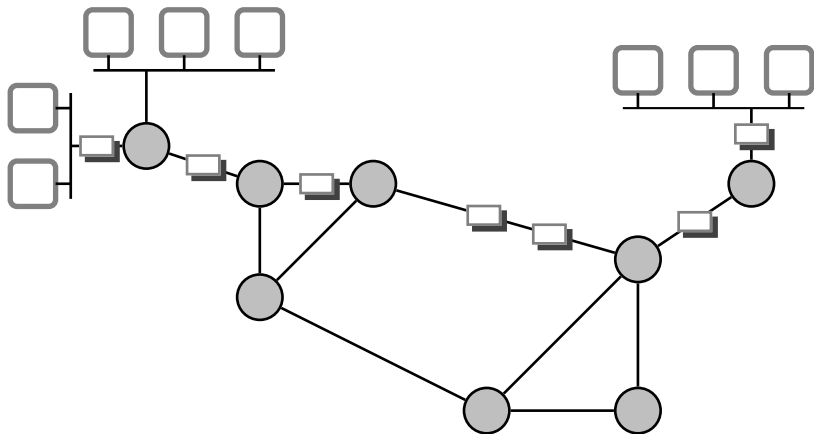
Communication Links

- Various types and forms of medium
 - ▶ Fiber-optic cable
 - ▶ Twisted-pair copper wire
 - ▶ Coaxial cable
 - ▶ Wireless local-area links (e.g., 802.11, Bluetooth)
 - ▶ Satellite channel
 - ▶ ...

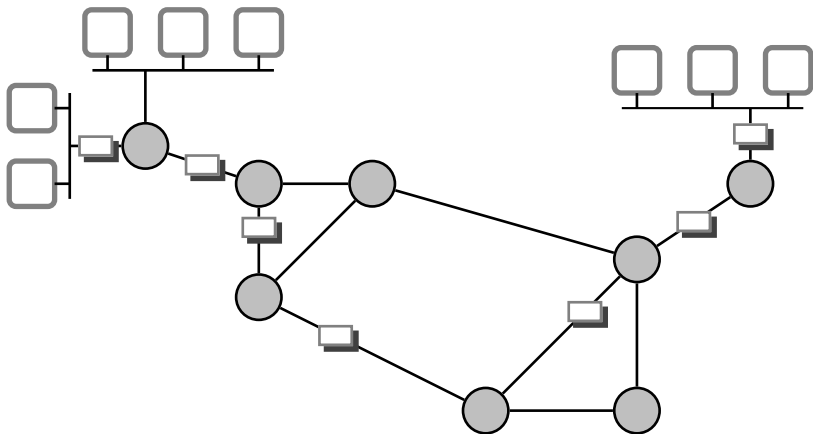
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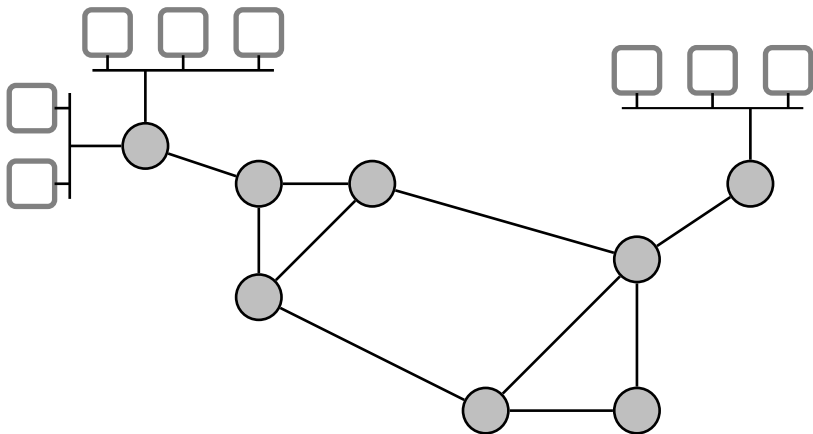
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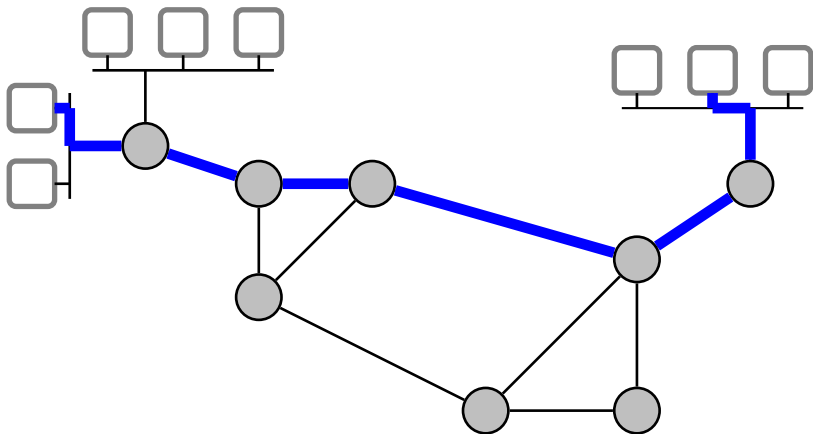
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- Every forwarding decision is taken on the basis of the information contained in the packet

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- After a successful setup, the communicating systems are connected by a set of links that are dedicated to their connection for the entire duration of their conversation
- When the conversation ends, the network tears down the connection, freeing the corresponding resources (links, buffers, etc.) for other connections

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- Circuit switching requires an expensive setup phase
 - ▶ however, once the connection is established, little or no processing is required
- Packet switching does not incur any setup cost
 - ▶ however, it always incurs a significant processing and space overhead, on a per-packet basis
 - ▶ *processing cost* for forwarding
 - ▶ *space overhead* because every packet must be self-contained

Circuit vs. Packet Switching (2)

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- Circuit switching admits a straightforward implementation of quality-of-service guarantees
 - ▶ network resources are reserved at connection setup time
- Guaranteeing any quality of service with packet switching is very difficult
 - ▶ no concept of a “connection”
 - ▶ and again, processing, space overhead, etc.

Circuit vs. Packet Switching (3)

- Circuit switching allows only a limited sharing of communication resources
 - ▶ once a connection is established, the resources are blocked even though there might be long silence periods
 - ▶ i.e., circuit switching is an inefficient way to use the network

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 - ▶ once a connection is established, the resources are blocked even though there might be long silence periods
 - ▶ i.e., circuit switching is an inefficient way to use the network
- Packet switching achieves a much better utilization of network resources
 - ▶ it is designed specifically to share links

Virtual Circuits

- Idea: combine the advantages of circuit switching and packet switching

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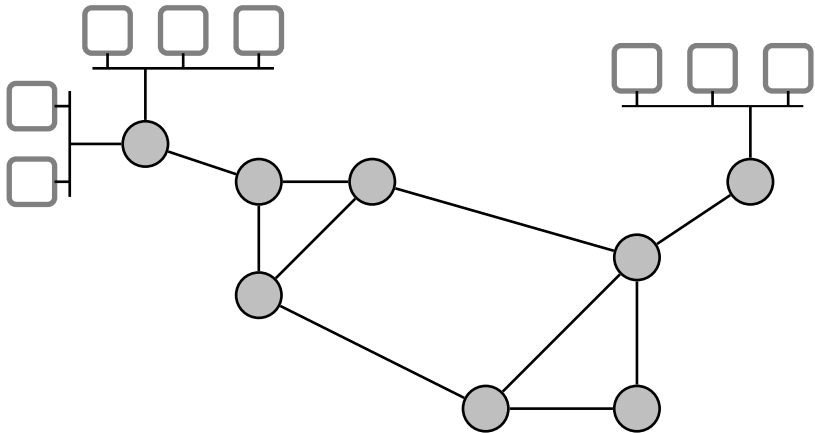
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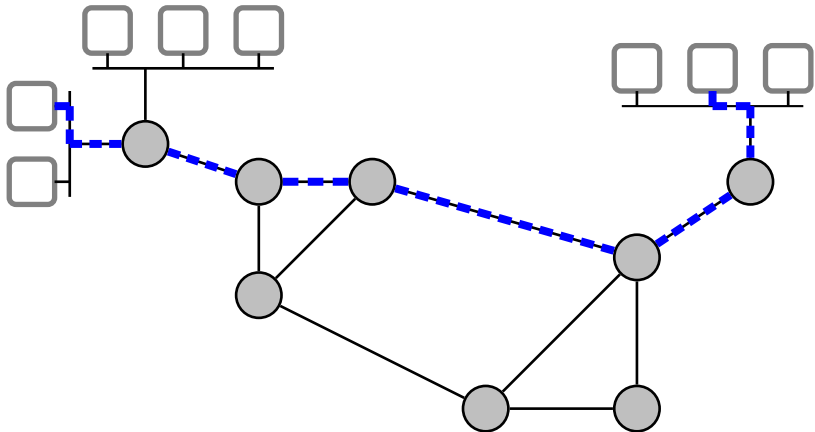
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- The connection does not create a physical circuit, but rather a “virtual circuit”
- Information is sent in packets, so links can be shared more effectively
- Packets carry a *virtual circuit identifier* instead of the destination address
 - ▶ *Important observation:* at any given time there are much fewer *connections* than *destinations*
 - ▶ much faster per-packet processing (forwarding)
 - ▶ lower per-packet space overhead

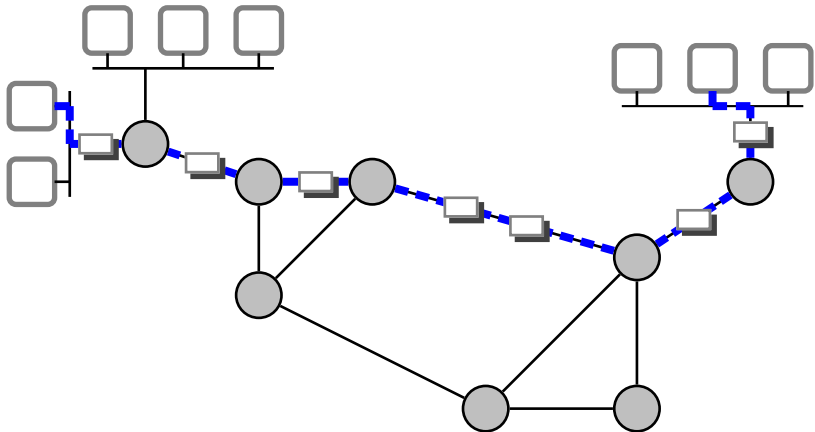
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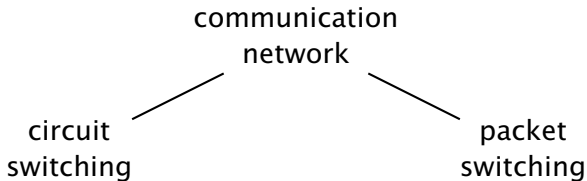
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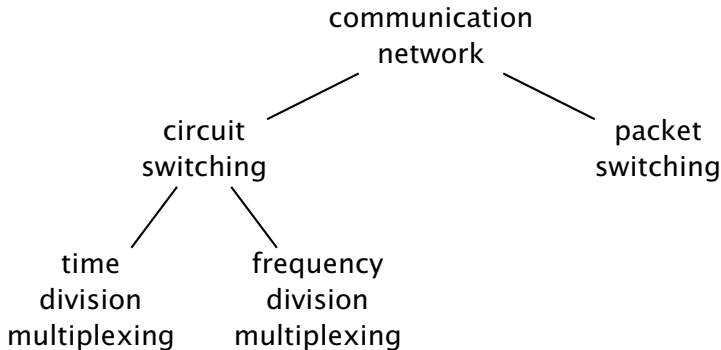
Taxonomy of Networks

communication
network

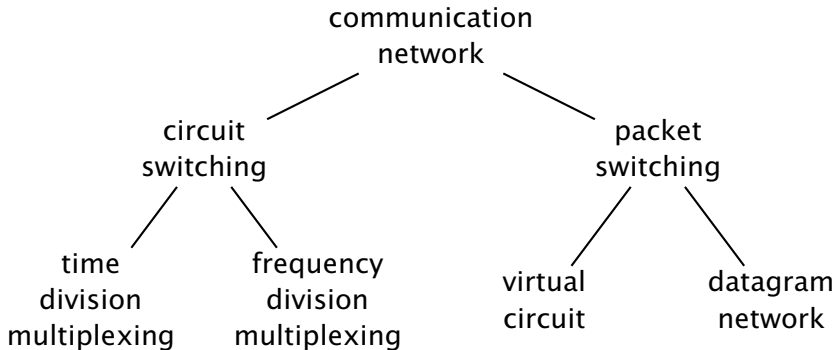
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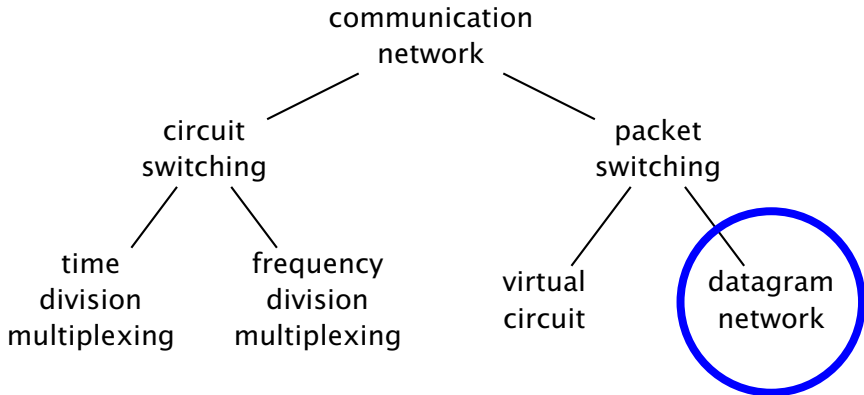
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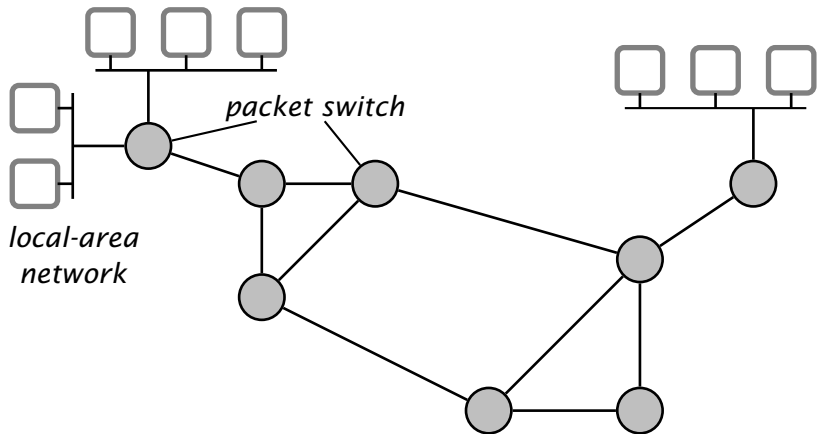
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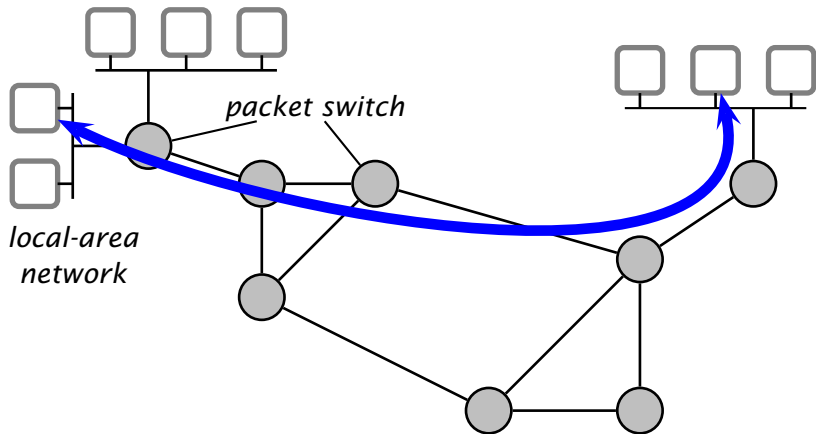
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Service Perspective



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- What kind of *service* does the Internet offer to end systems?

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 - ▶ the network accepts “datagrams” for delivery—this is conceptually similar to the postal service
 - ▶ “best effort” really means *unreliable* though not malicious
- *Connection-oriented, reliable*
 - ▶ virtual duplex communication channel ($A \leftrightarrow B$)—conceptually similar to a telephone service
 - ▶ information is transmitted “reliably” and in order

Type of Service (2)

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- The term “reliable” means that information will eventually reach its destination if a route is viable within a certain amount of time
- The network makes absolutely no guarantees on *latency* (i.e., the time it takes to transmit some information from a source to a destination)

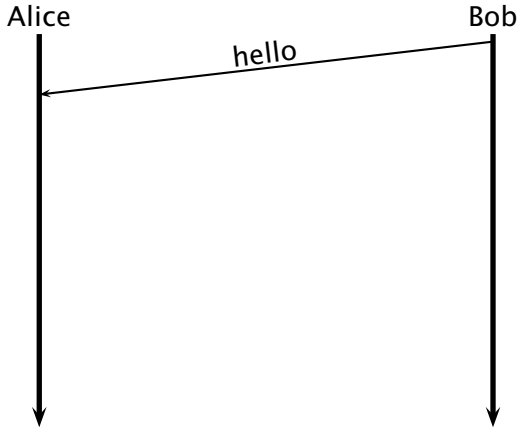
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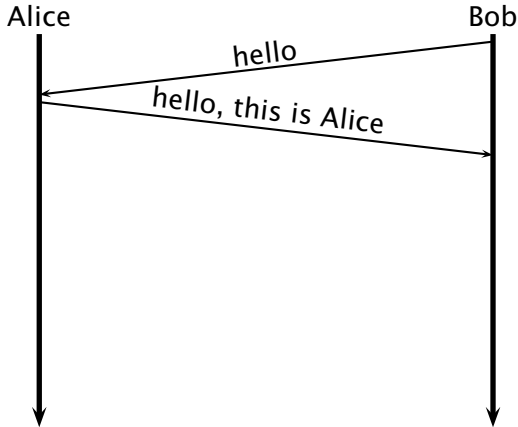
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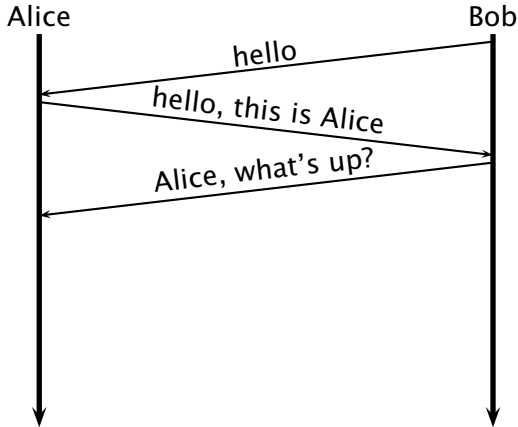
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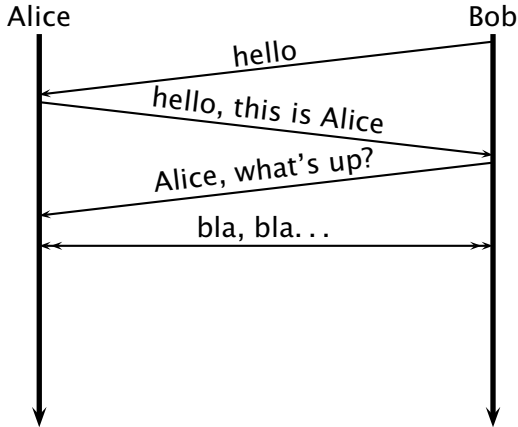
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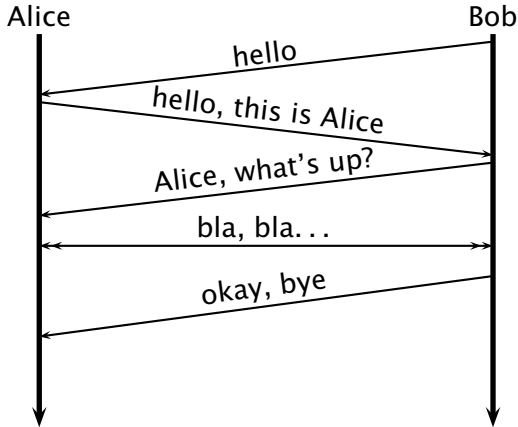
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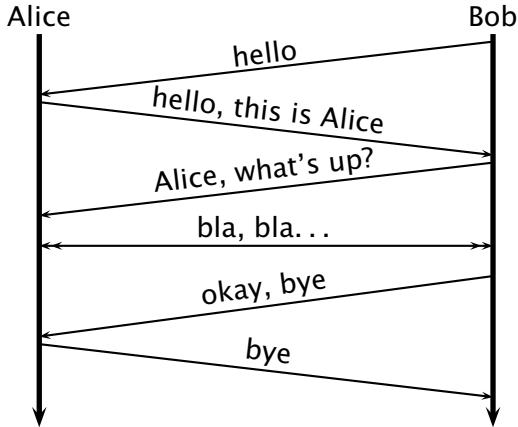
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■ Phases of the protocol

- ▶ *handshake*: establishes the identities and/or the context
- ▶ *conversation*: free-form exchange
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- Phases of the protocol
 - ▶ *handshake*: establishes the identities and/or the context
 - ▶ *conversation*: free-form exchange
 - ▶ *closing*: terminates the conversation
- This protocol assumes a connection-oriented medium
- The protocol involves two parties (Alice and Bob)
- ...

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 - ▶ requesting flight level 3-5-0, Delta 800
 - ▶ Delta 800, unable at the moment

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- Medium access control (MAC) protocol
- Interleaved communication
- Acknowledgements
- Timeout and retransmission
- “Master” role

Communication Protocols (3)

- Let's revisit the phone-call protocol

Alice

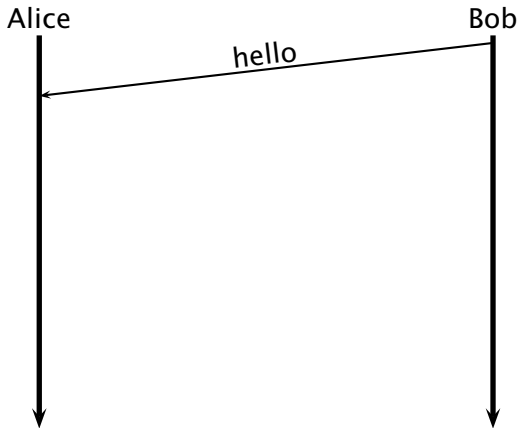


Bob



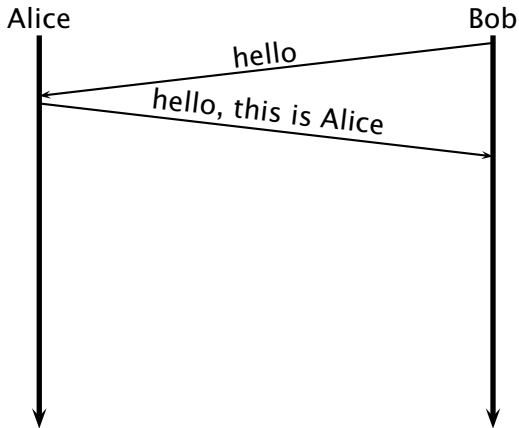
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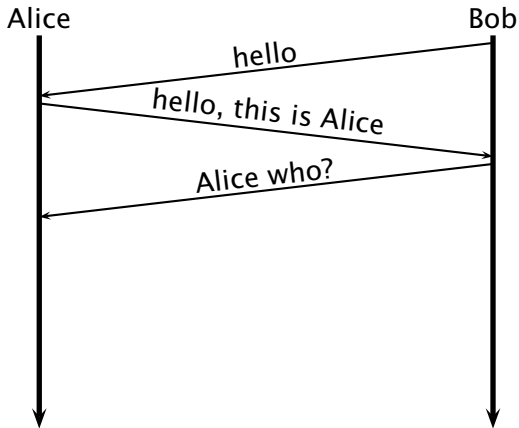
Communication Protocols (3)

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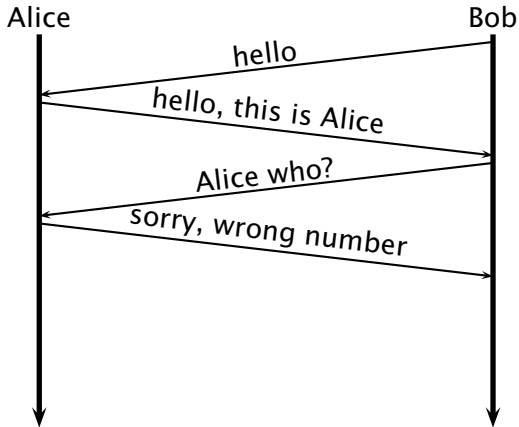
Communication Protocols (3)

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Communication Protocols (4)

- Another run of the phone-call protocol

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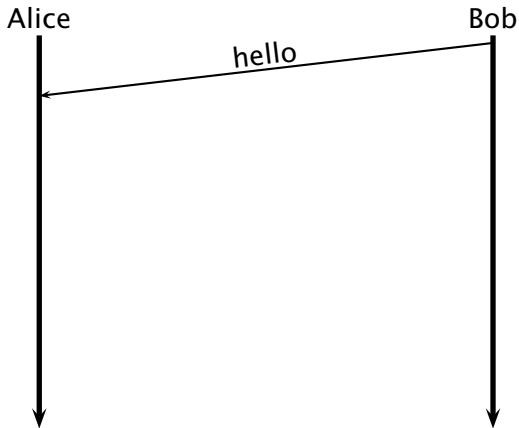


Bob



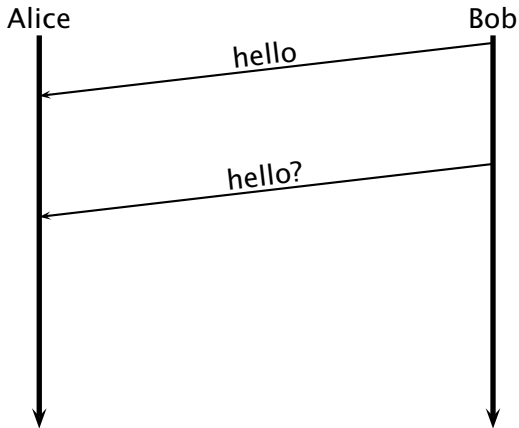
Communication Protocols (4)

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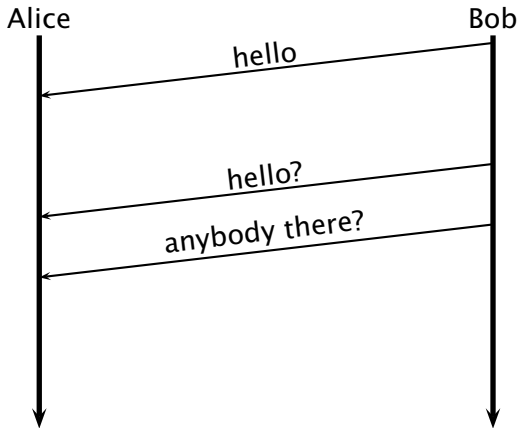
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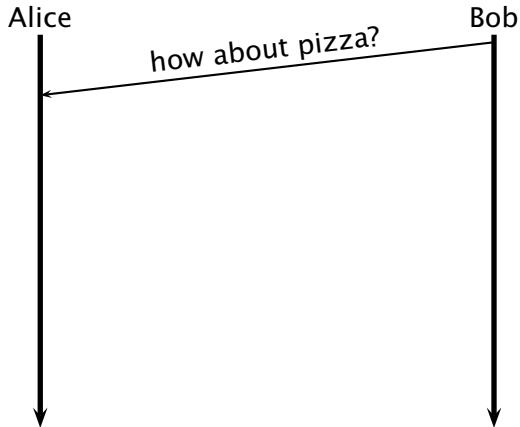
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- A network protocol must also define all the necessary *message formats*

Communication Protocols (5)

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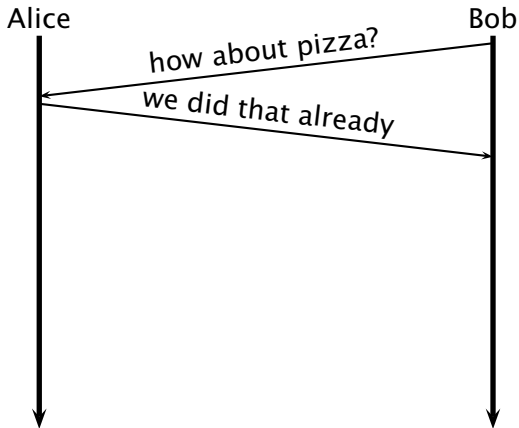
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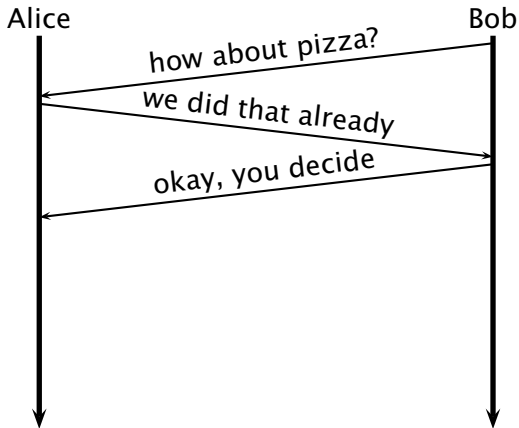
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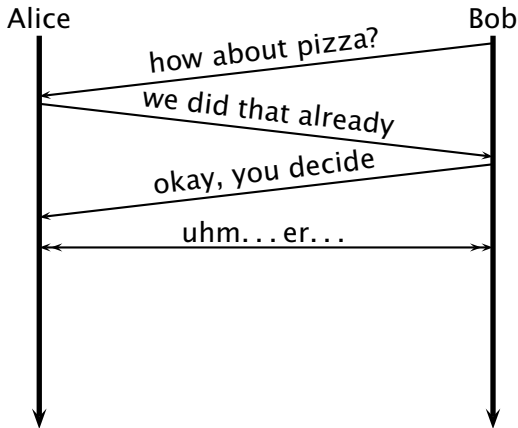
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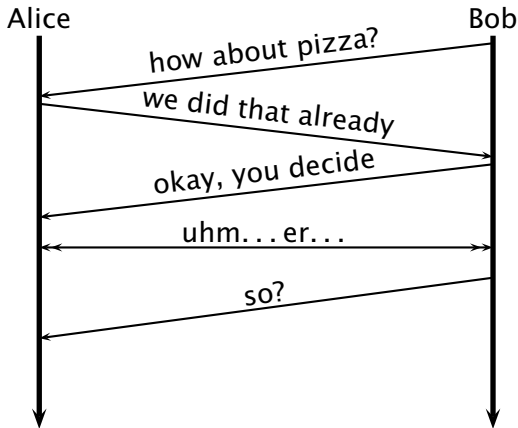
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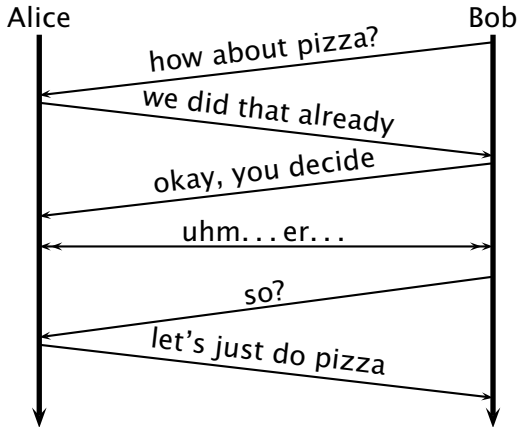
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Protocol Layering

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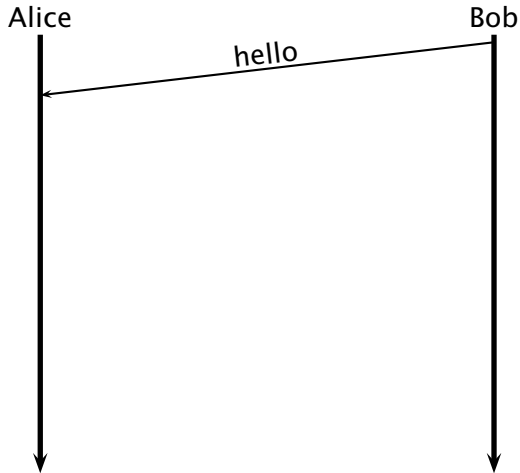


Bob



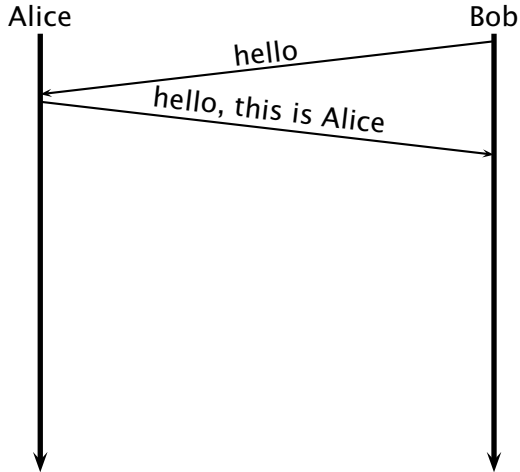
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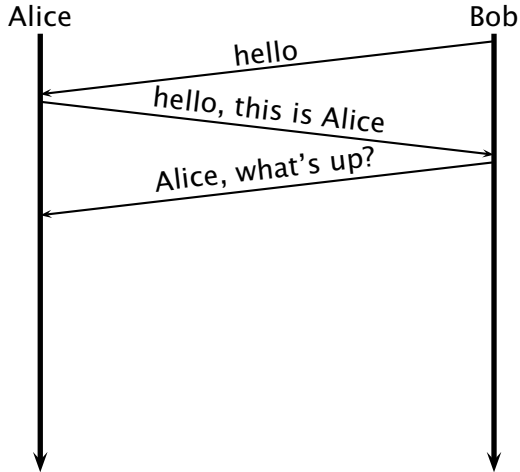
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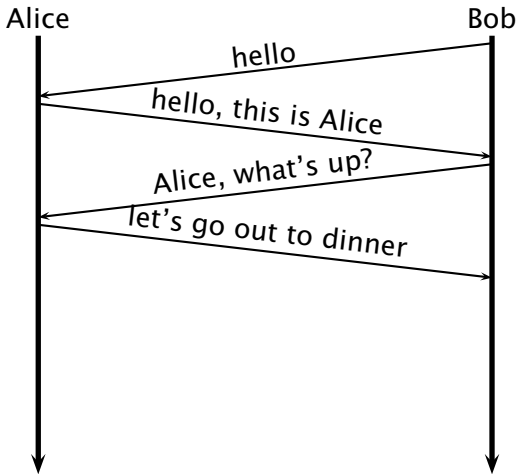
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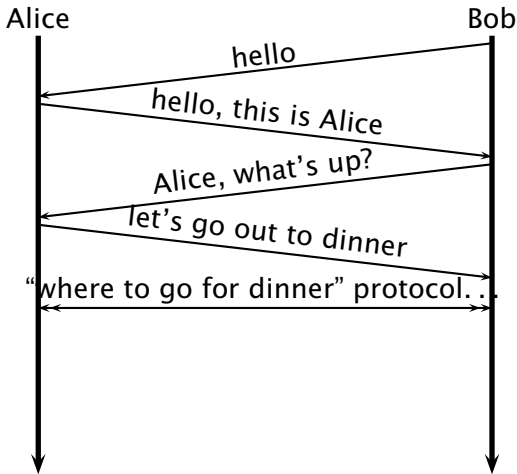
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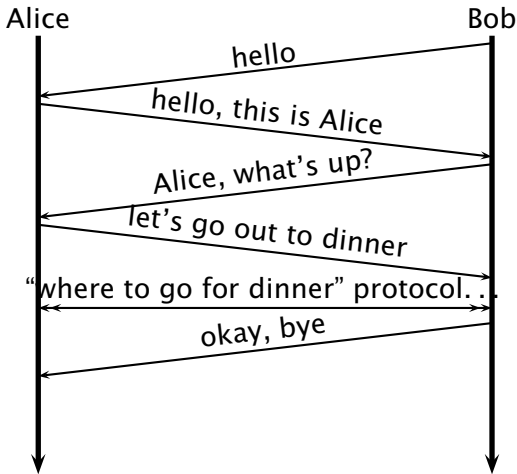
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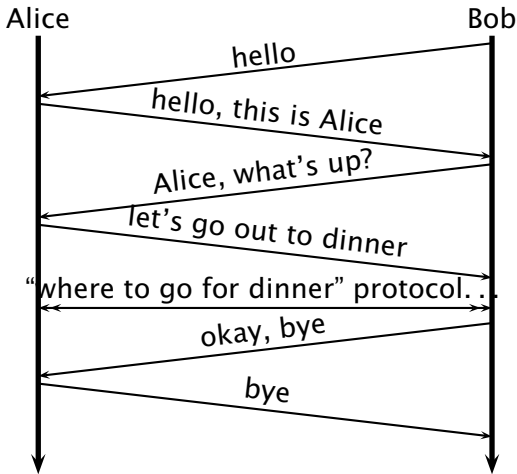
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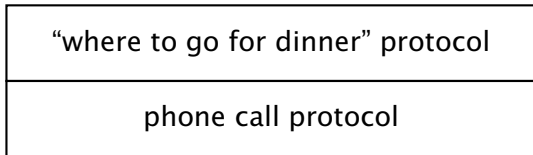
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phone call protocol

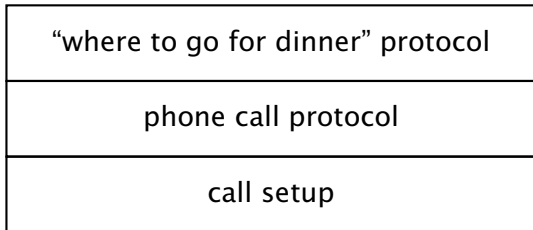
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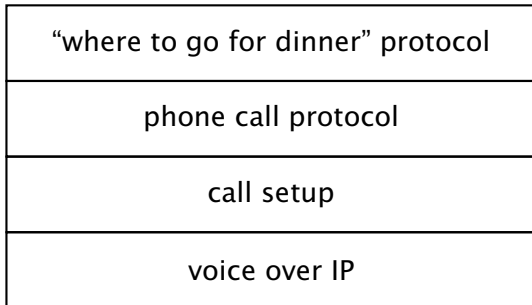
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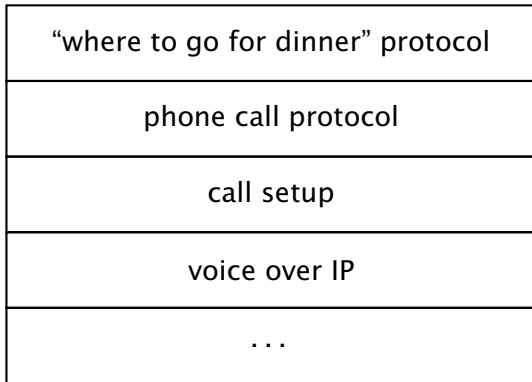
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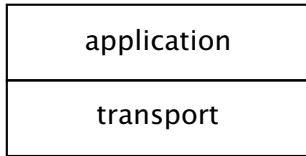
Internet Protocol Stack

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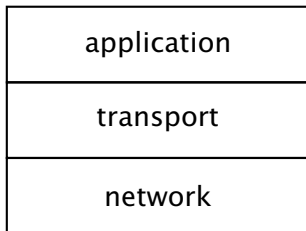


application

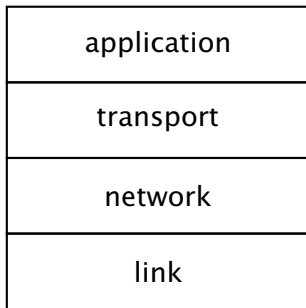
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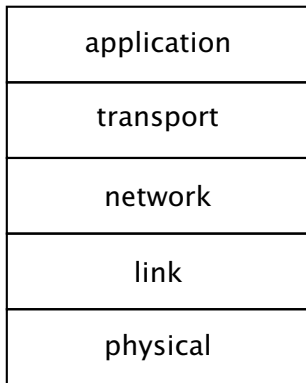
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