Basic Concepts
In Computer Networking

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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

Outline

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

History

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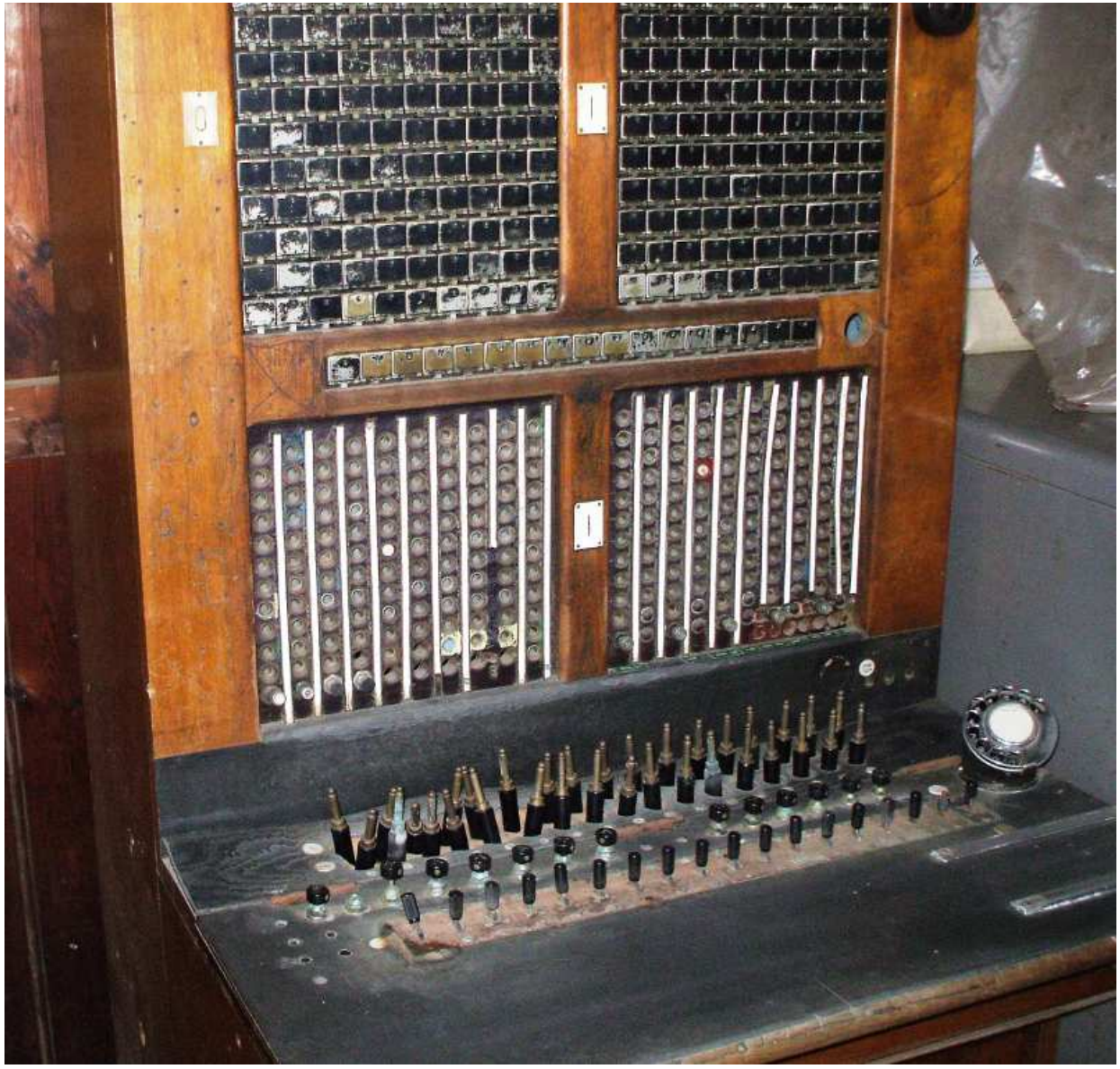

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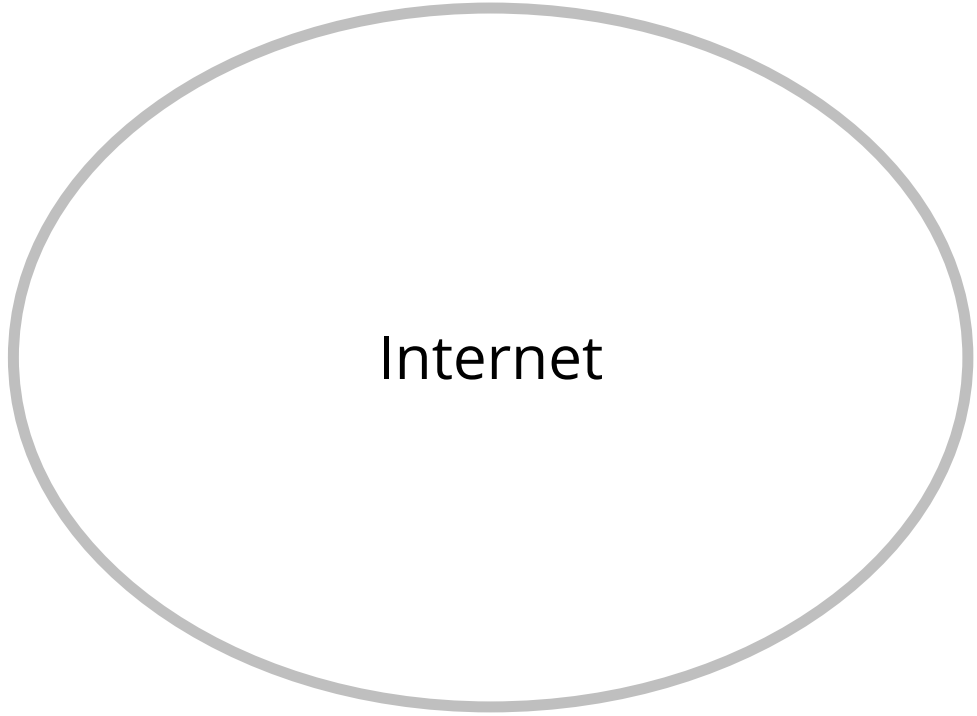

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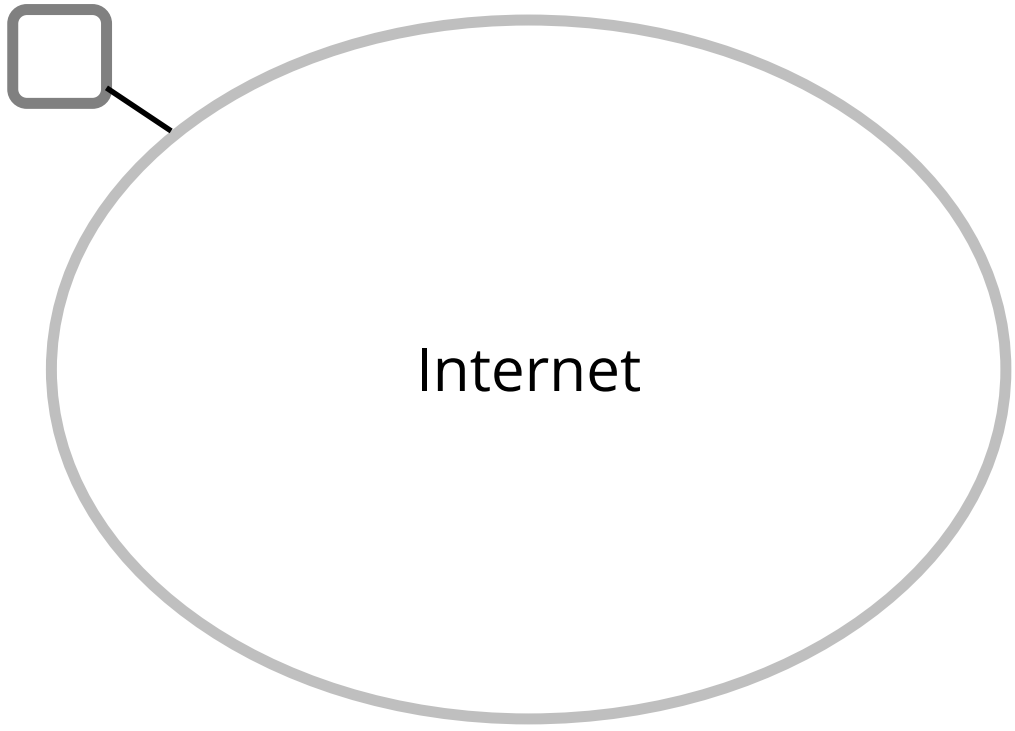

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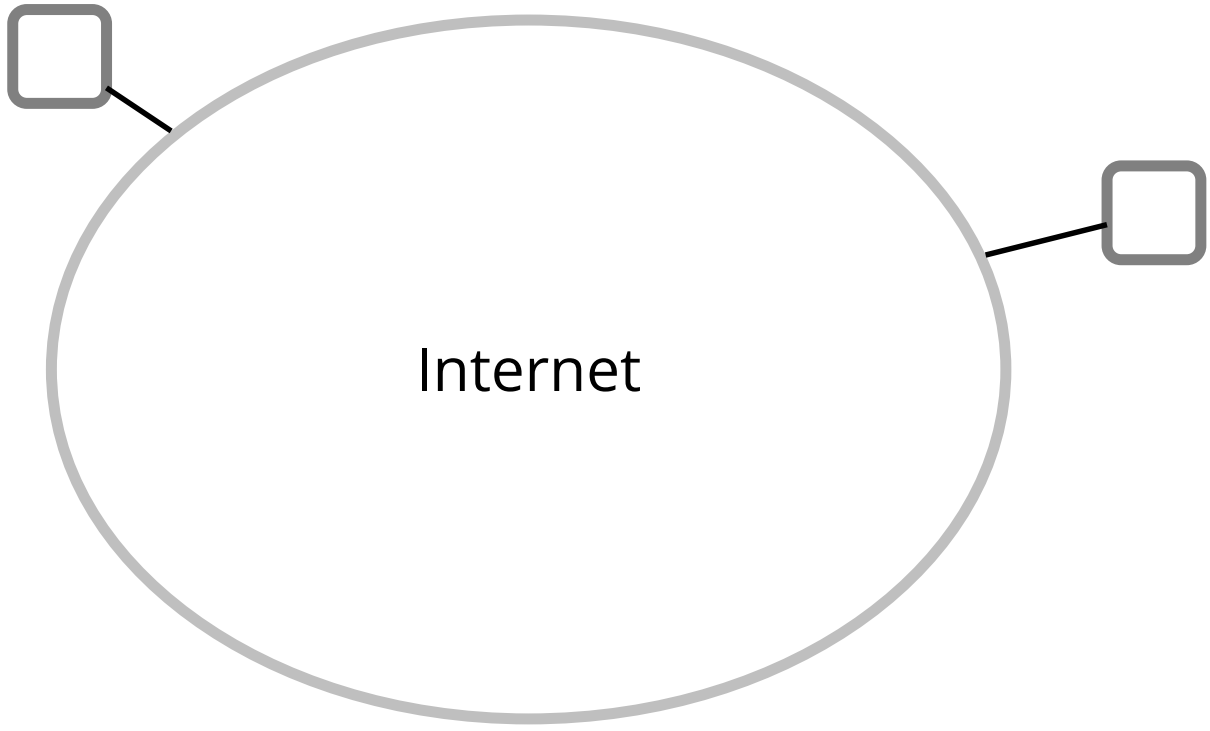

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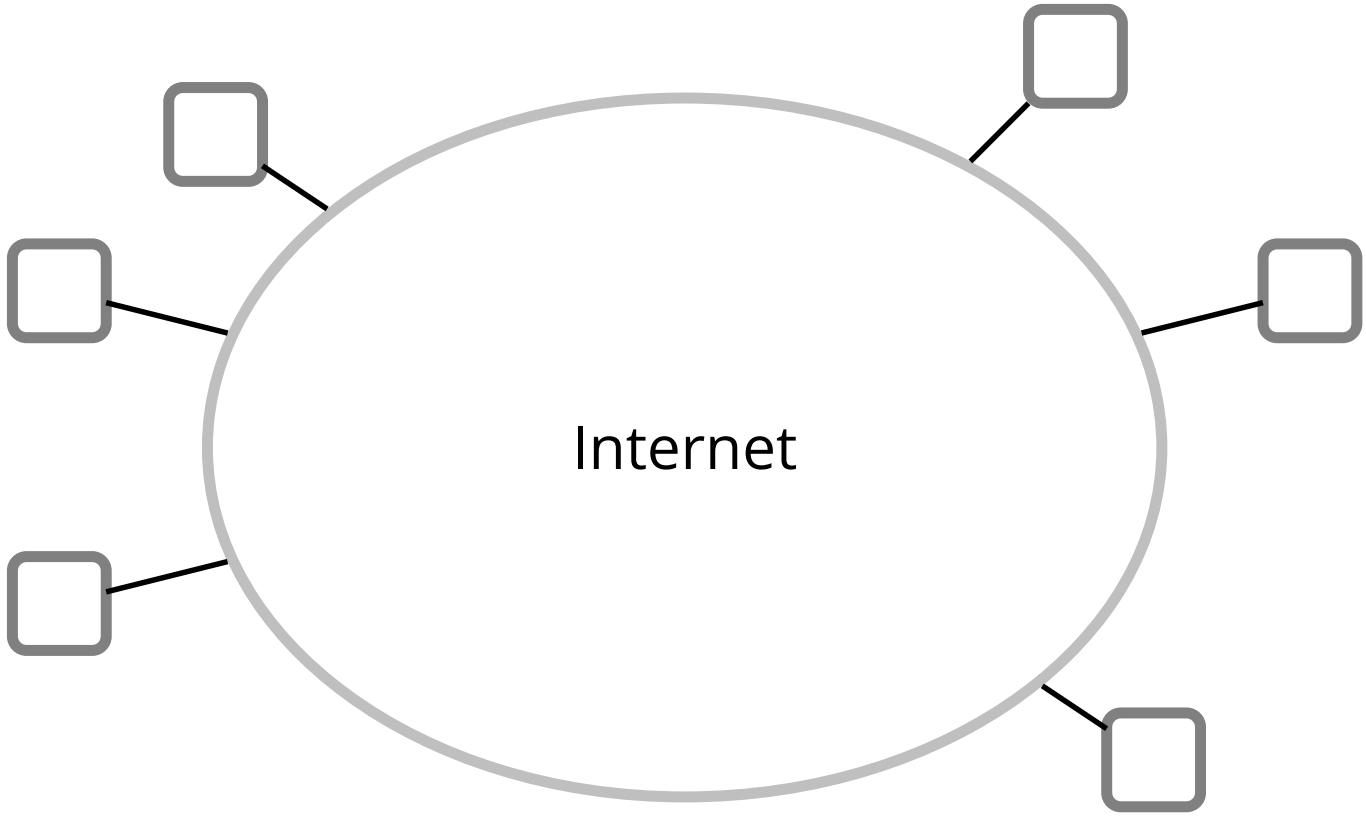

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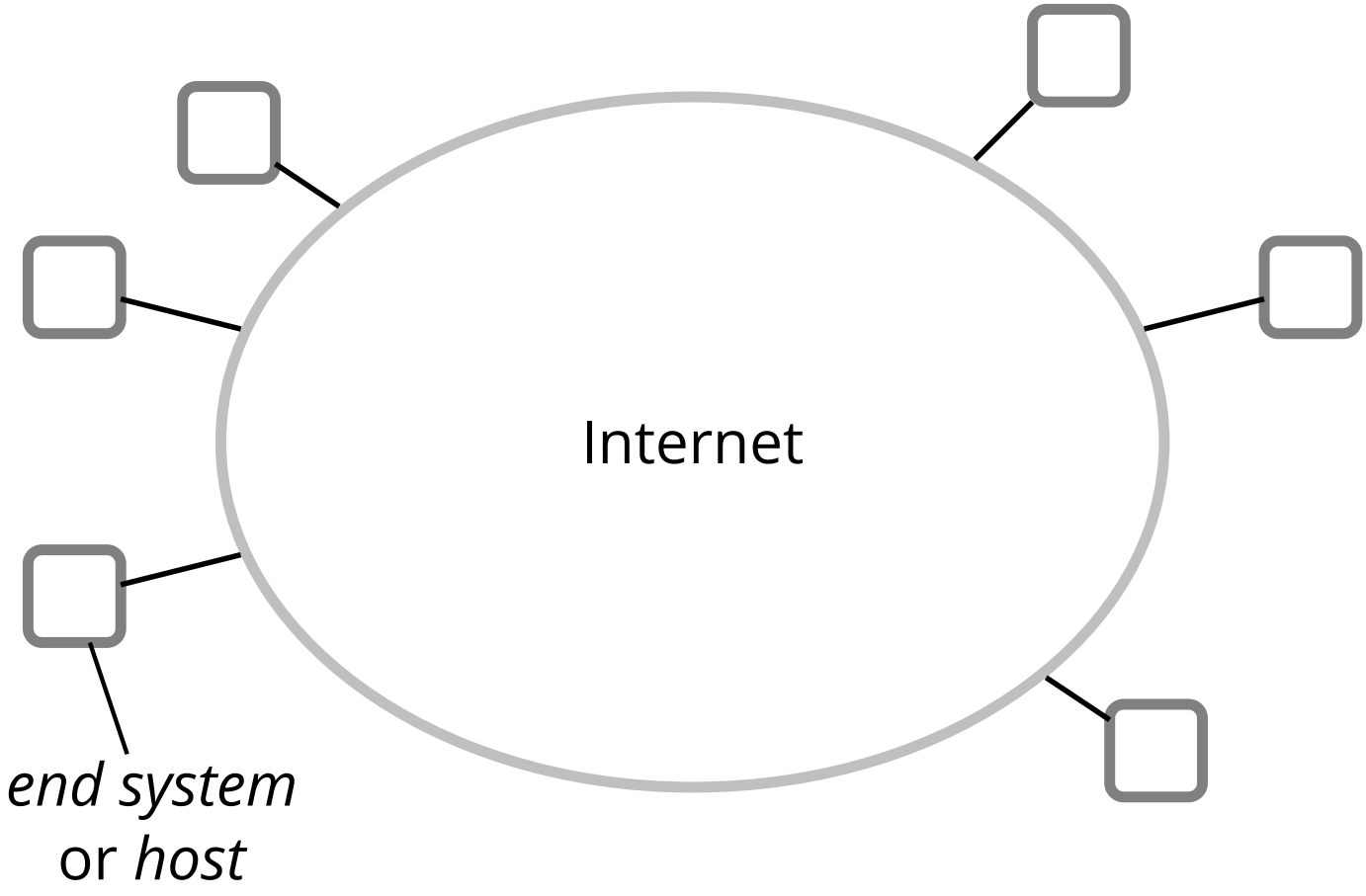

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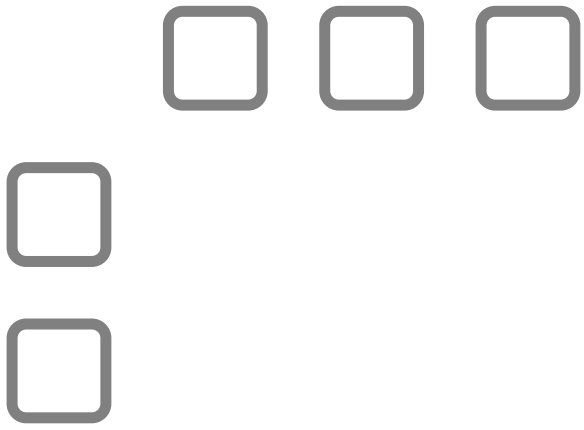

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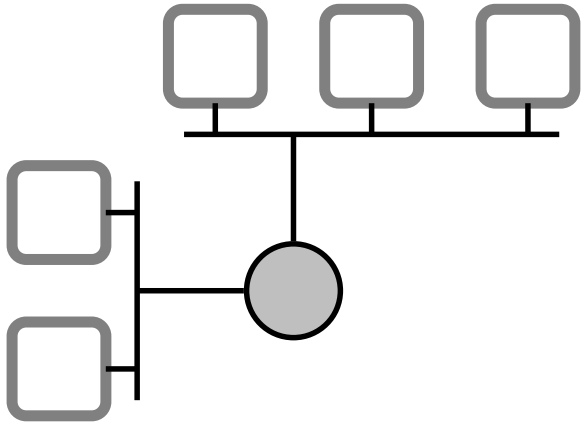

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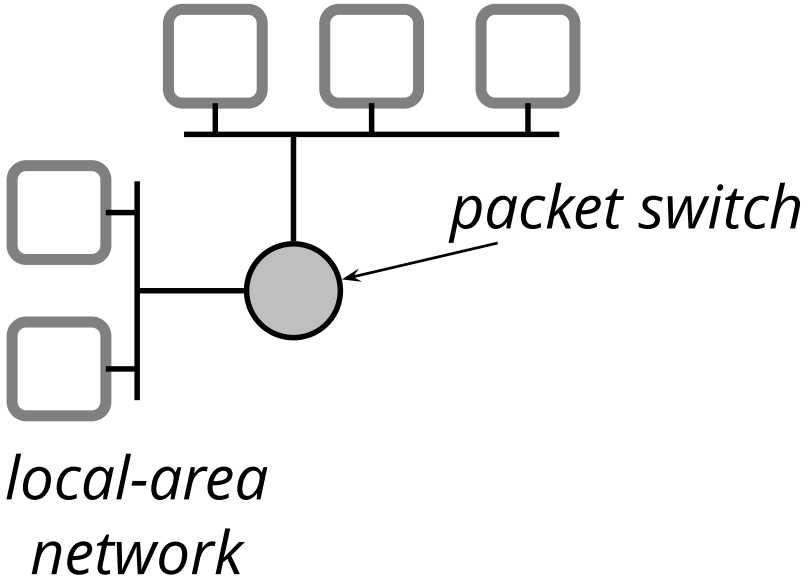

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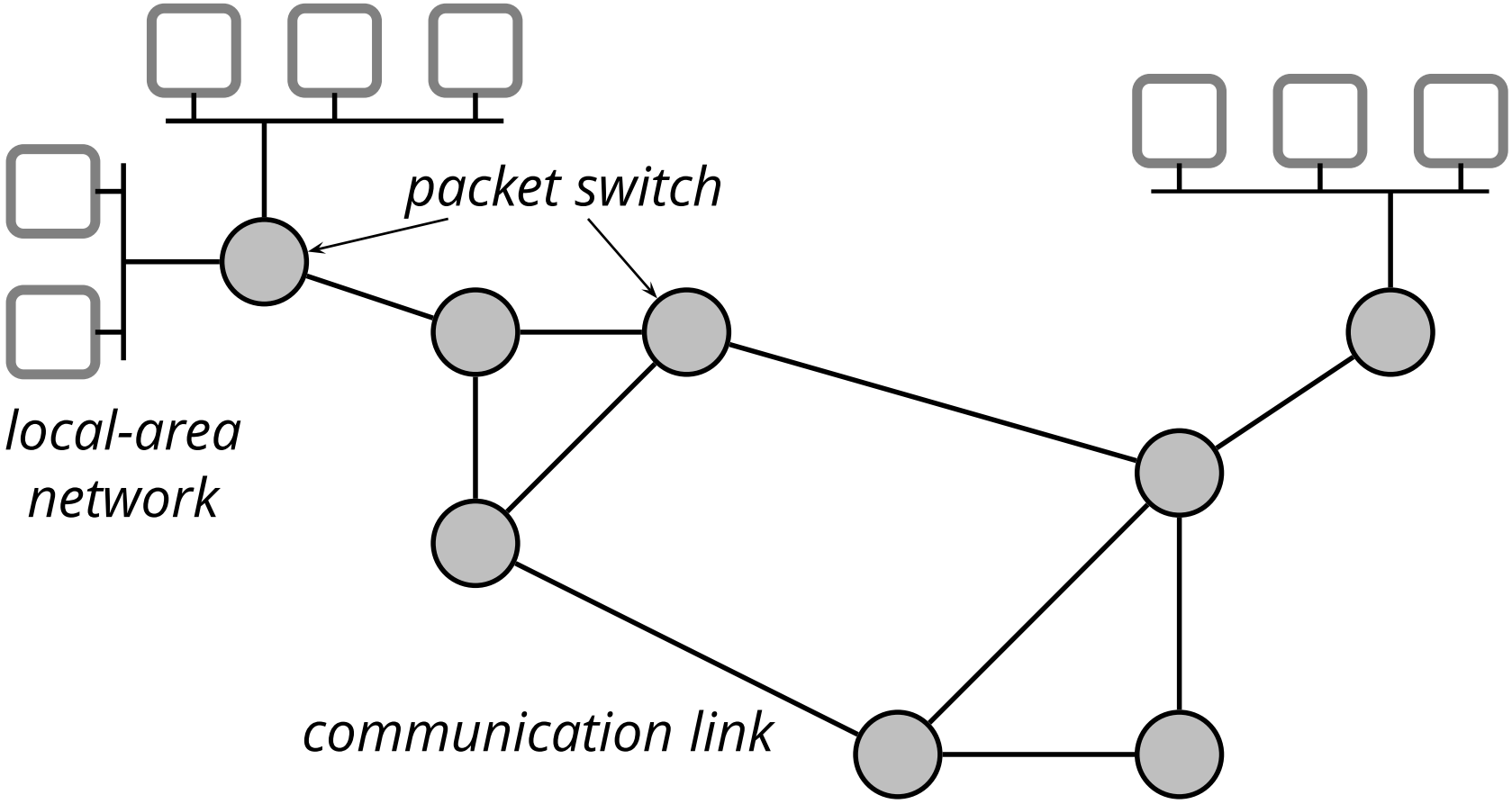

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- ***Communication link:*** a connection between packet switches and/or end systems
- ***Route:*** sequence of switches that a packet goes through (a.k.a. *path*)
- ***Protocol:*** control the sending and receiving of information to and from end systems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

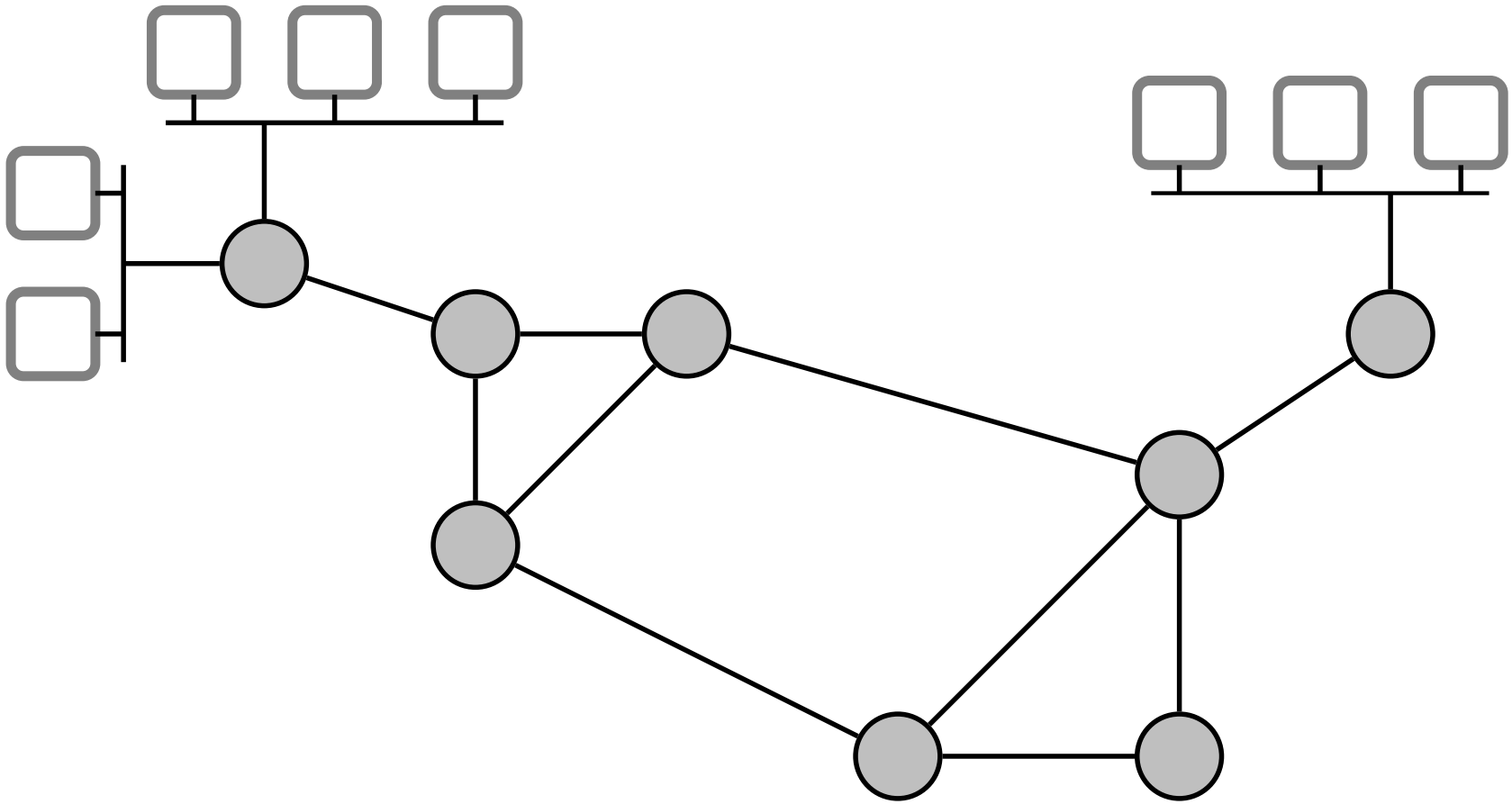
Communication Links

- 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
  - . . .

Packet Switching



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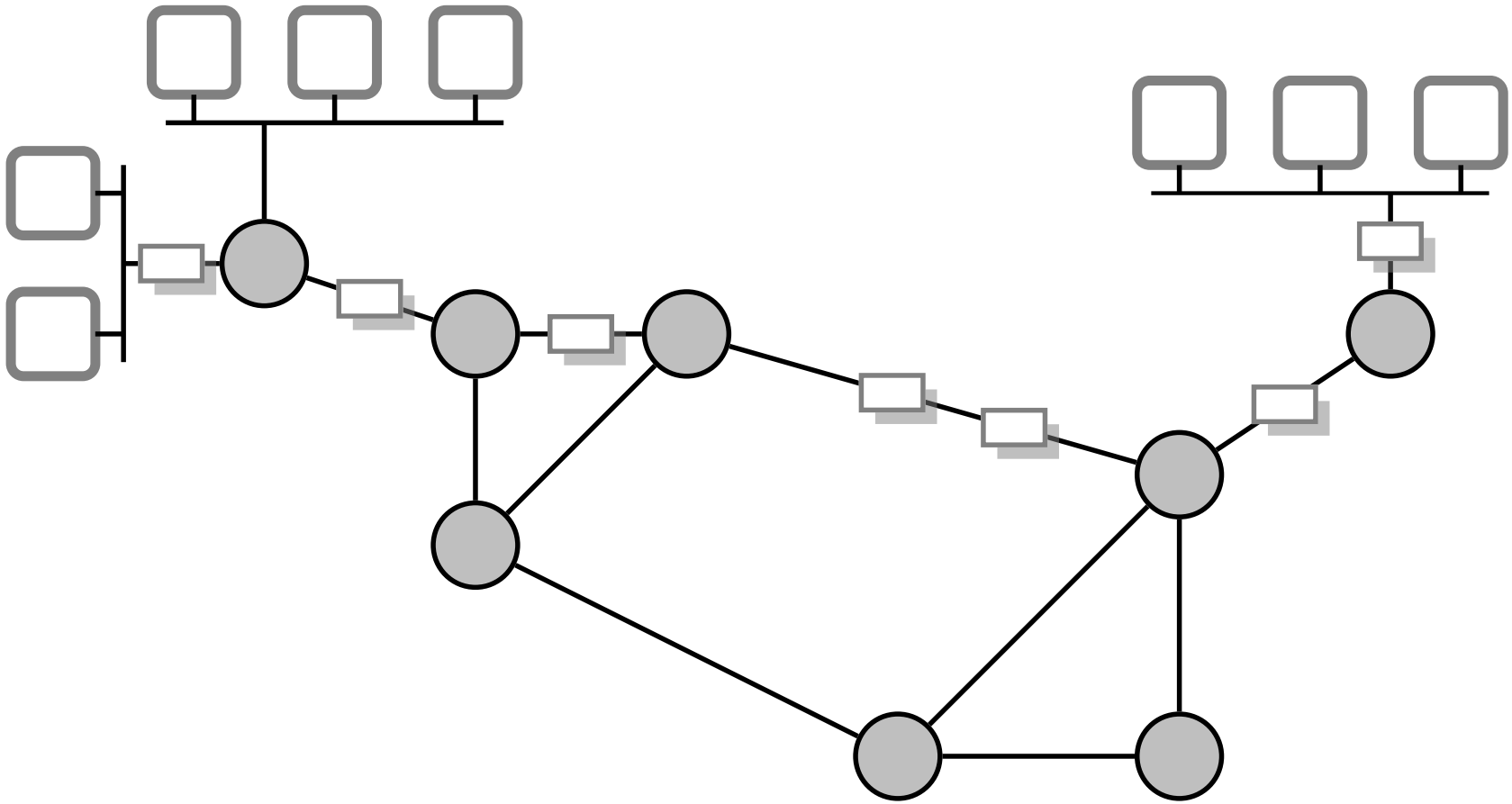

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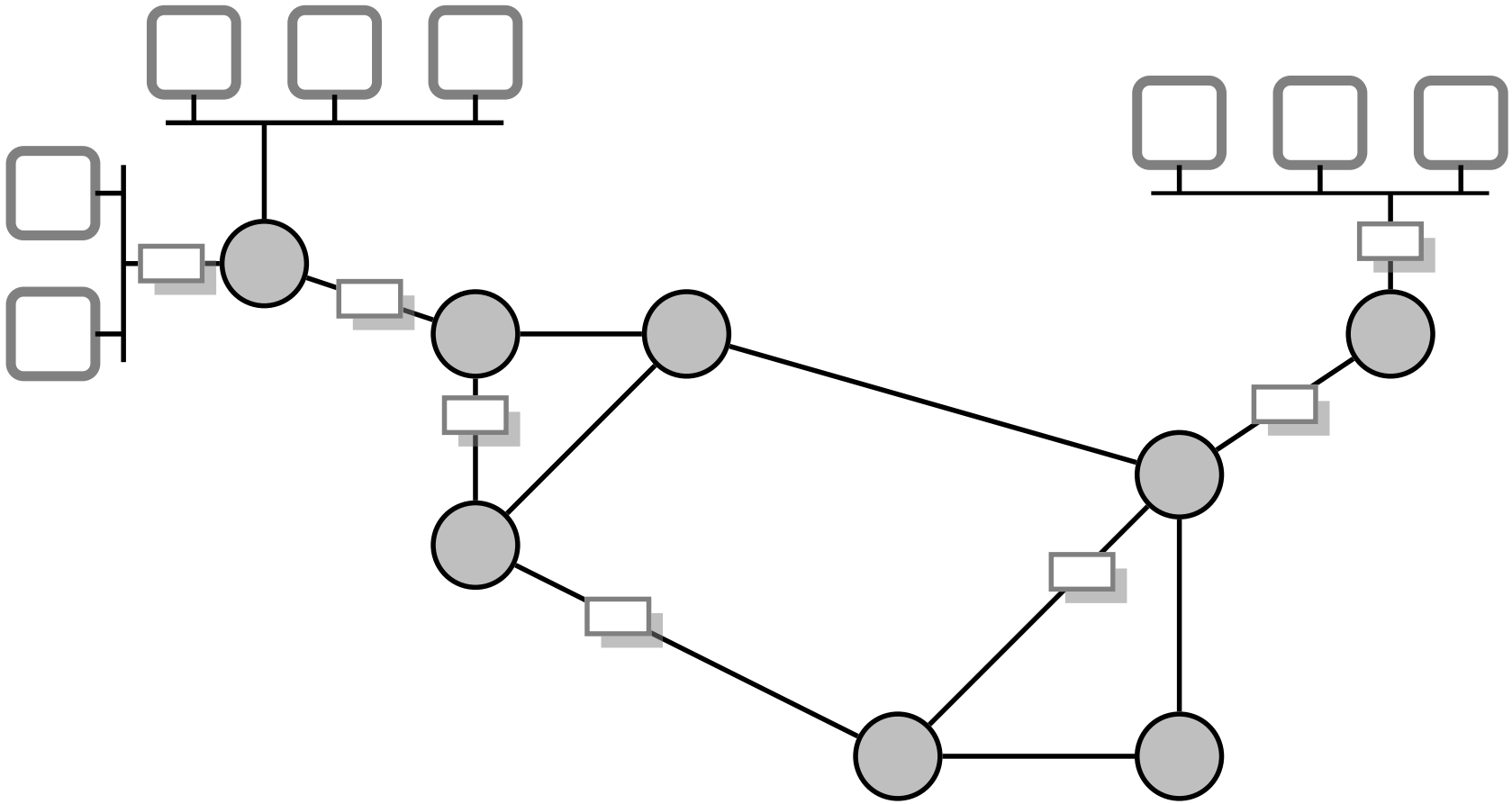

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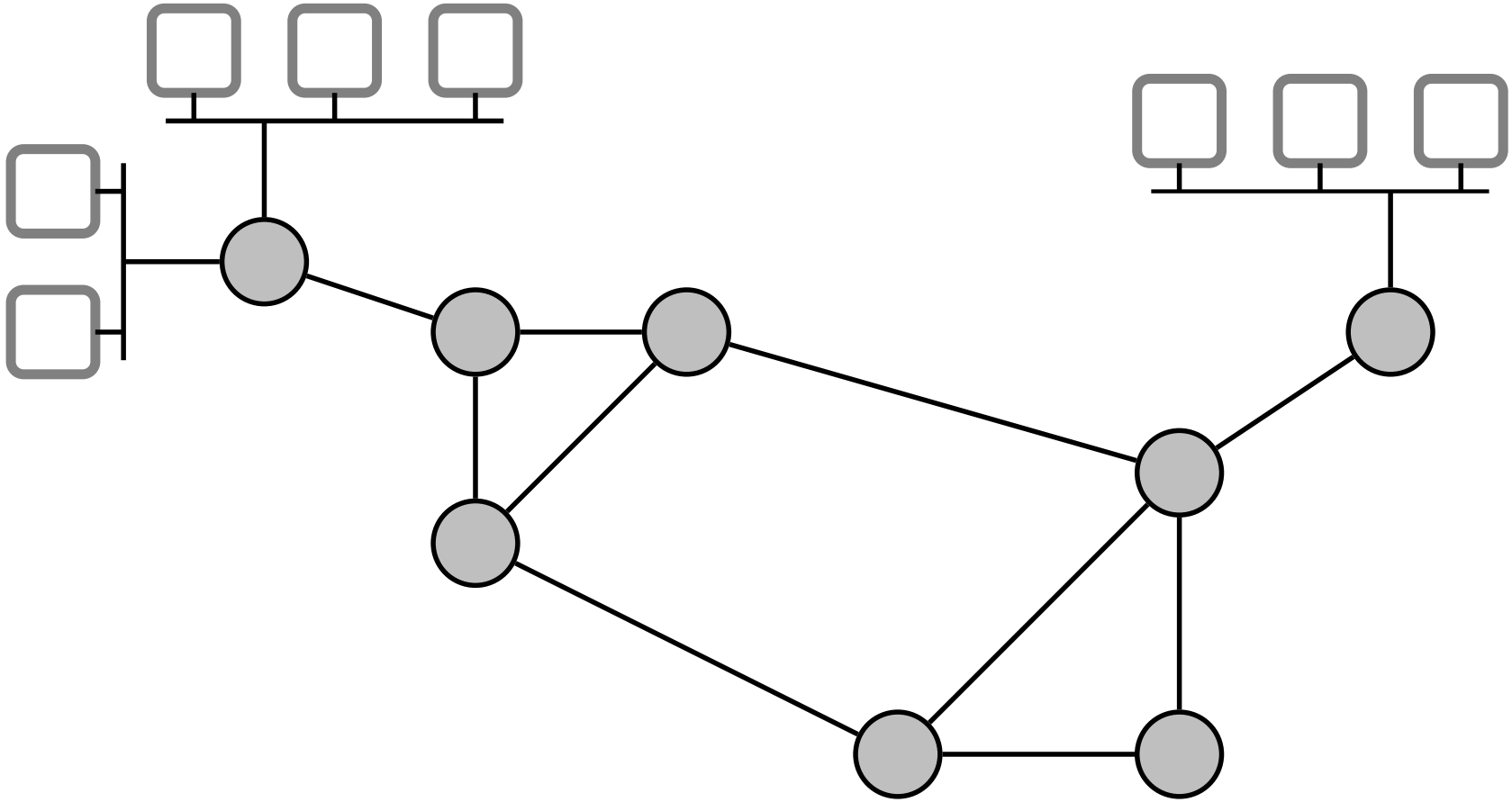
- A switch (router) receives packets and *forwards* them along to other switches or to end systems
- Every forwarding decision is taken on the basis of the information contained in the packet

Circuit Switching



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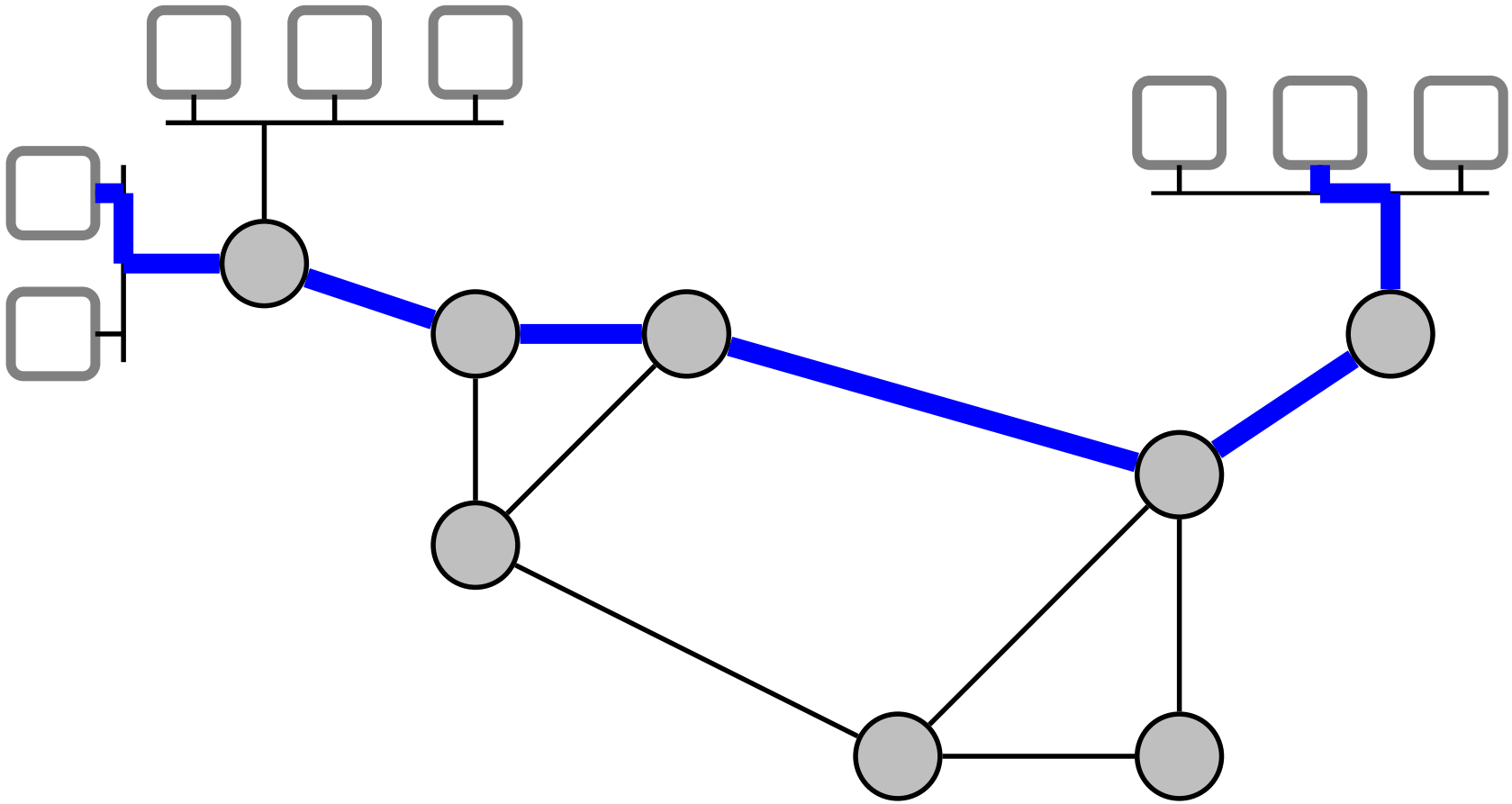

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- After a successful setup, the communicating systems are connected by ***a set of links dedicated to the connection*** for the entire duration of their conversation
- When the conversation ends, the network tears down the connection, freeing the corresponding 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

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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)

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  - i.e., circuit switching is an inefficient way to use the network

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  - 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

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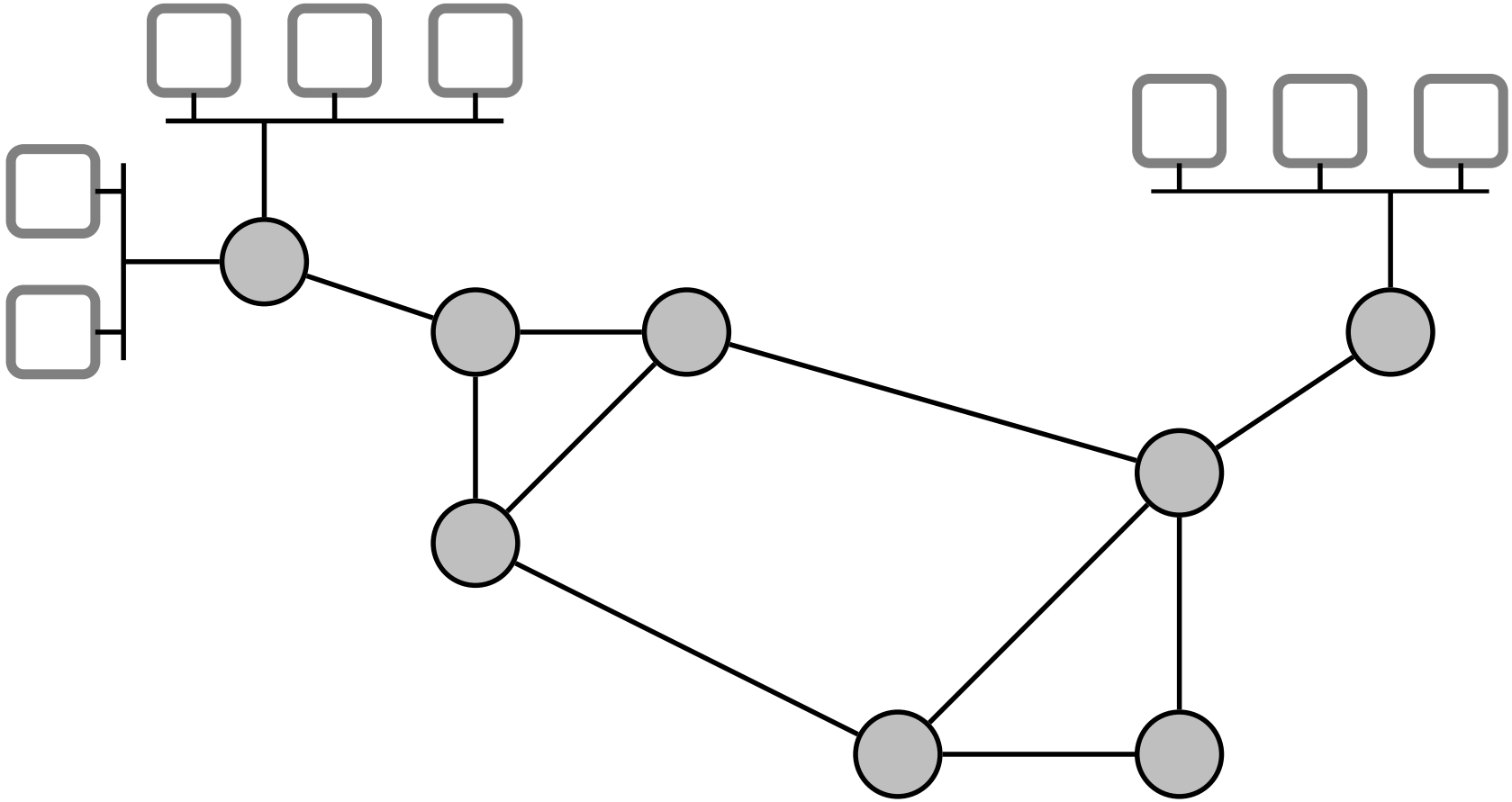
- The connection does not create a physical circuit, but rather a "virtual circuit"
- Information is sent in packets, so links can be shared more effectively
- Packets carry a *virtual circuit identifier* instead of the destination address
  - *Important observation:* at any given time there are much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

Virtual Circuit



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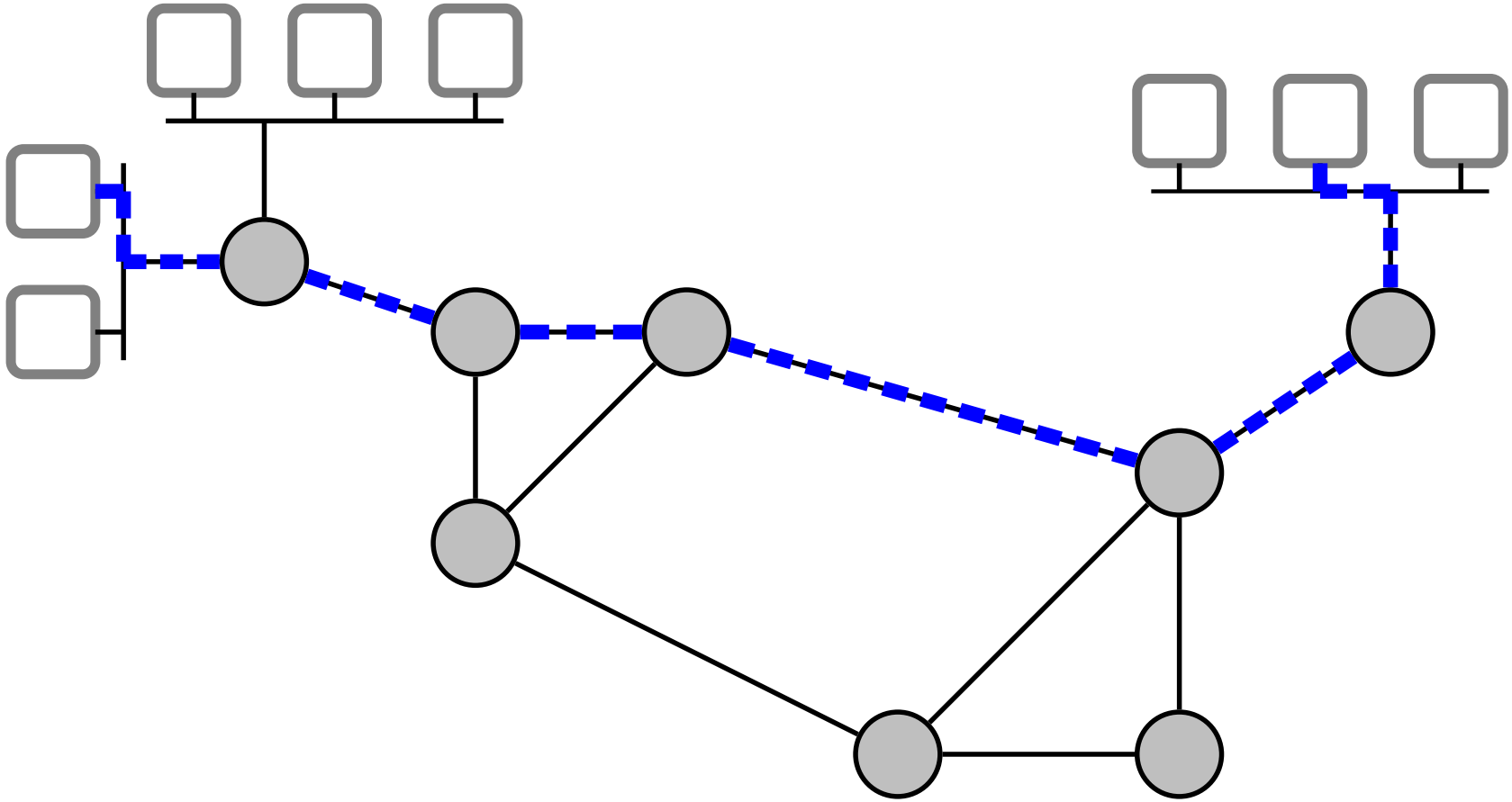

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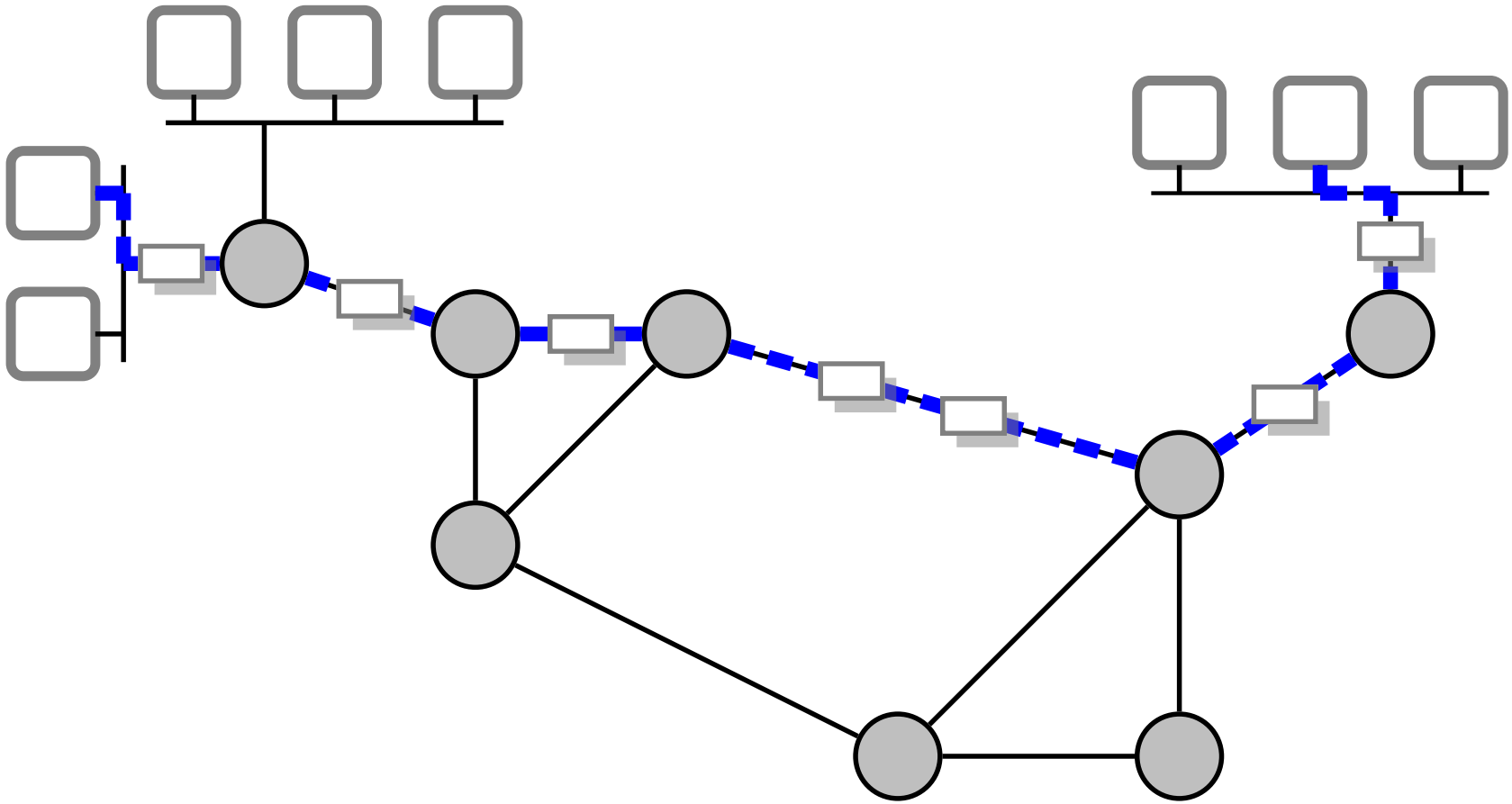

Taxonomy of Networks

communication
network

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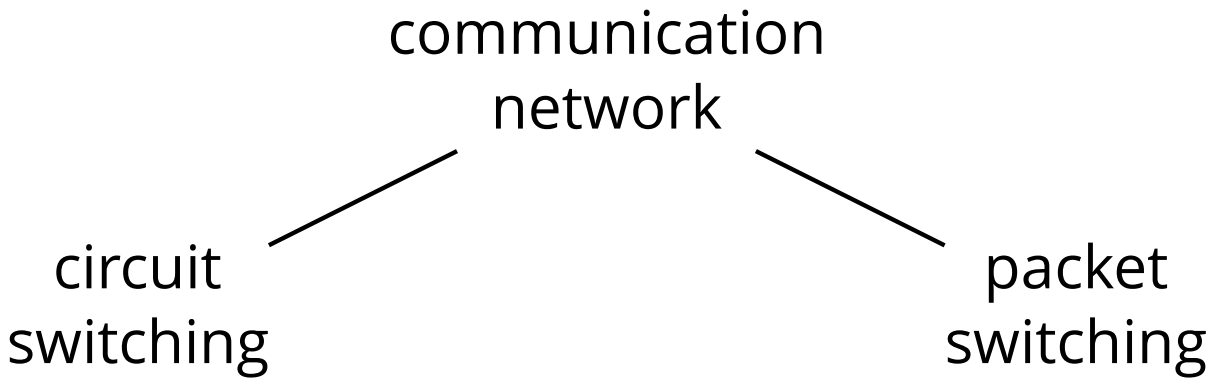

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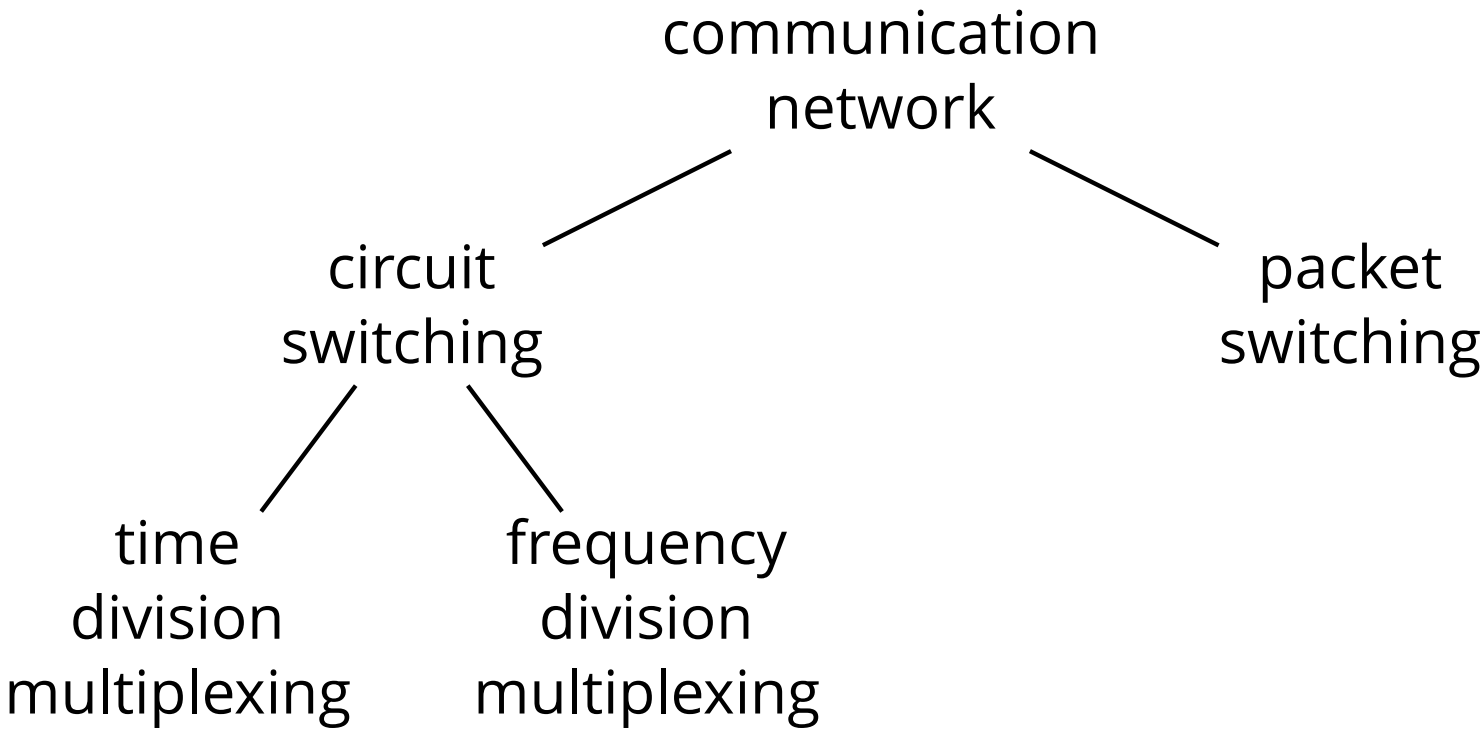

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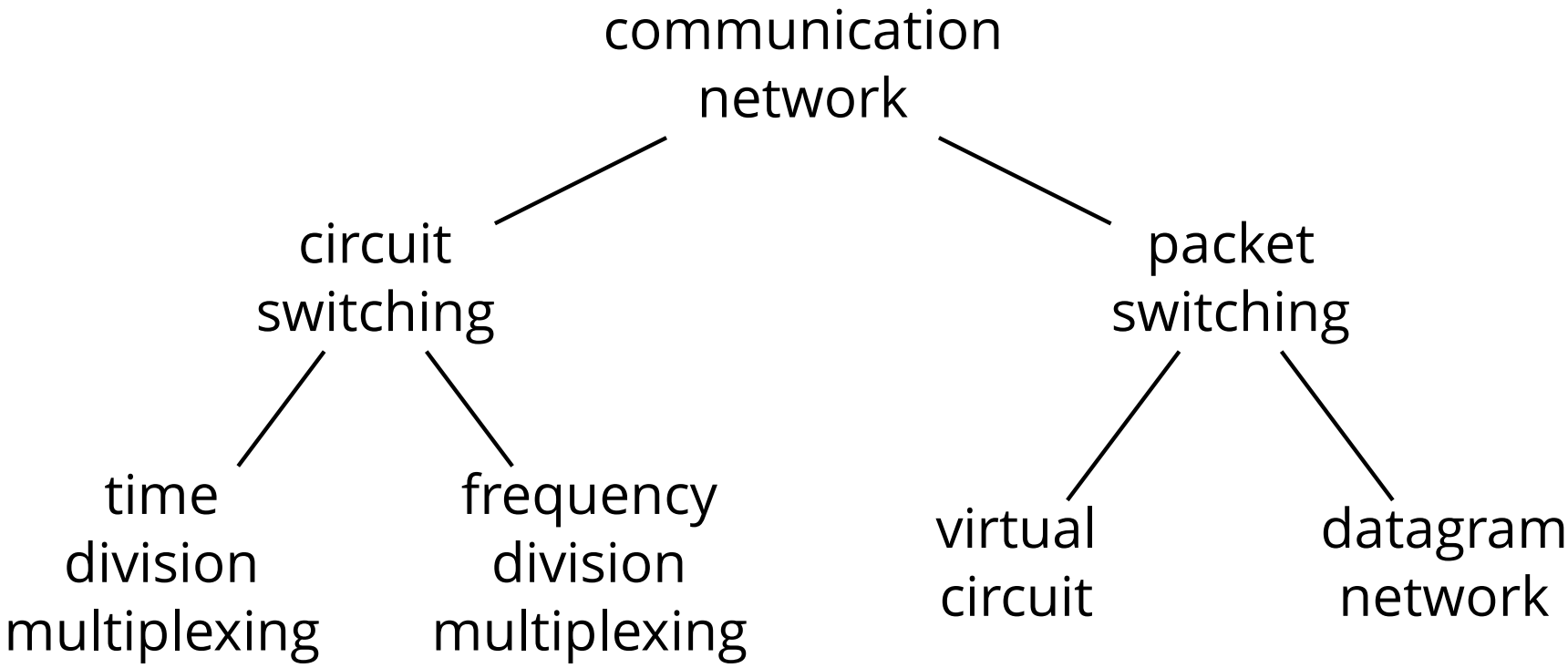

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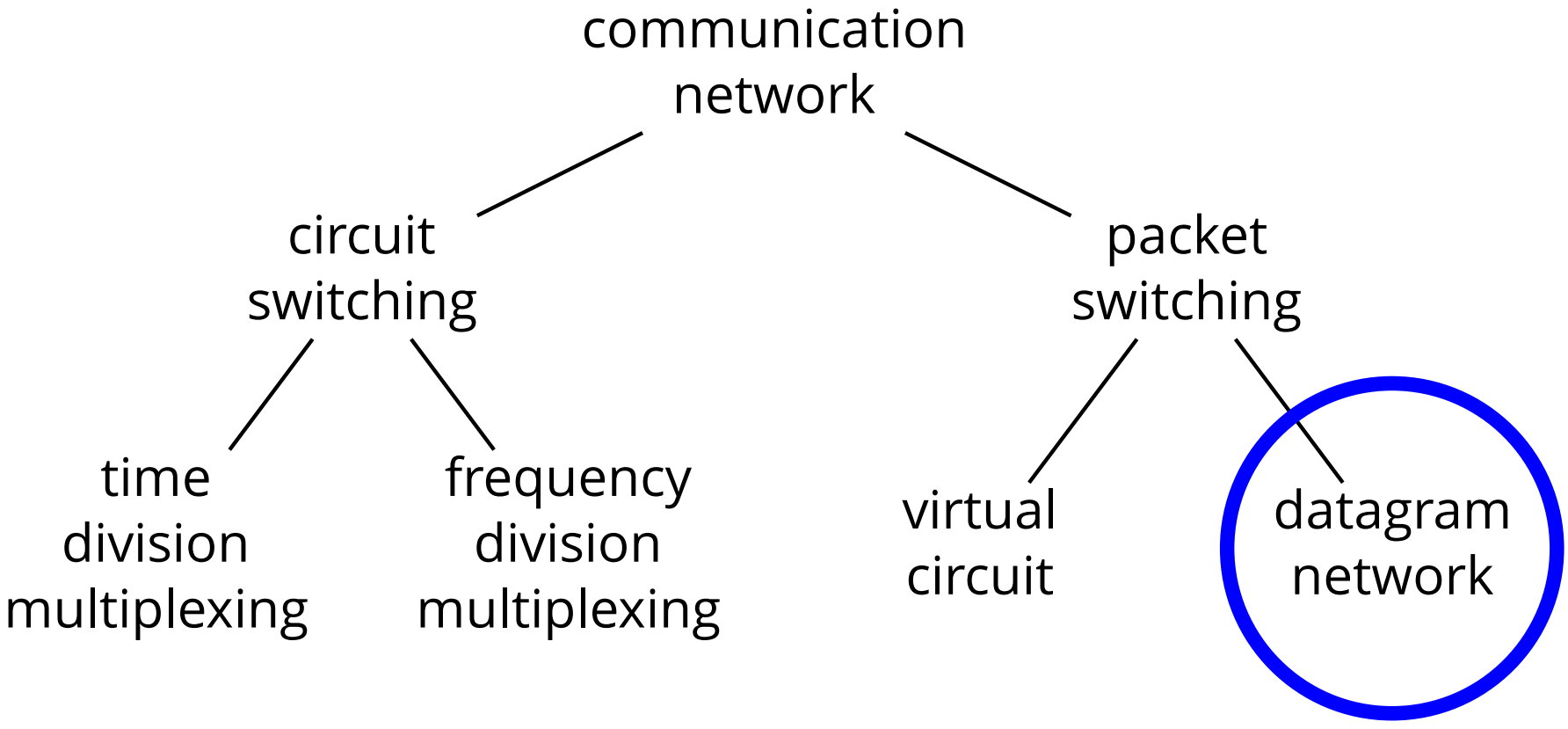

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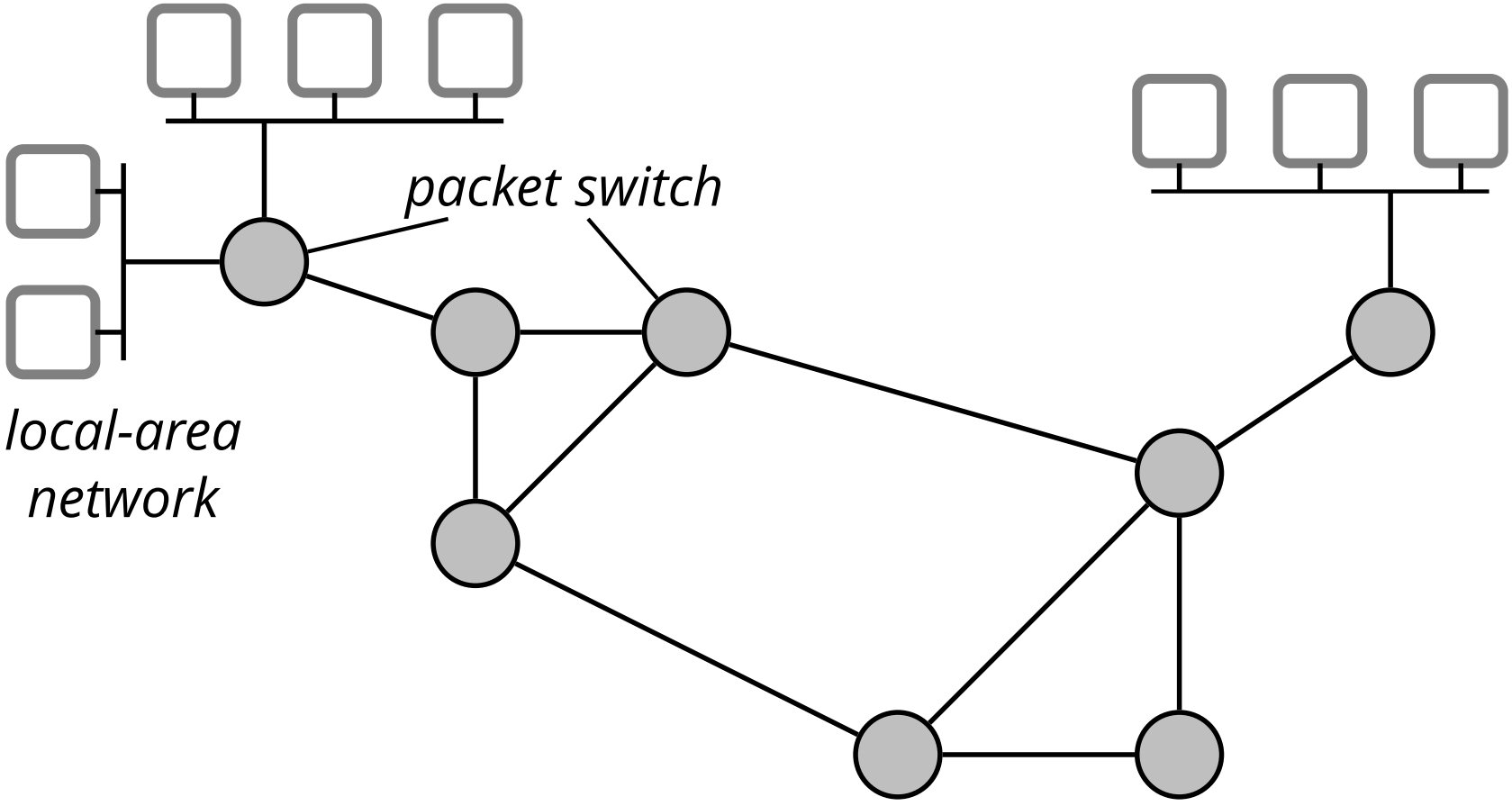

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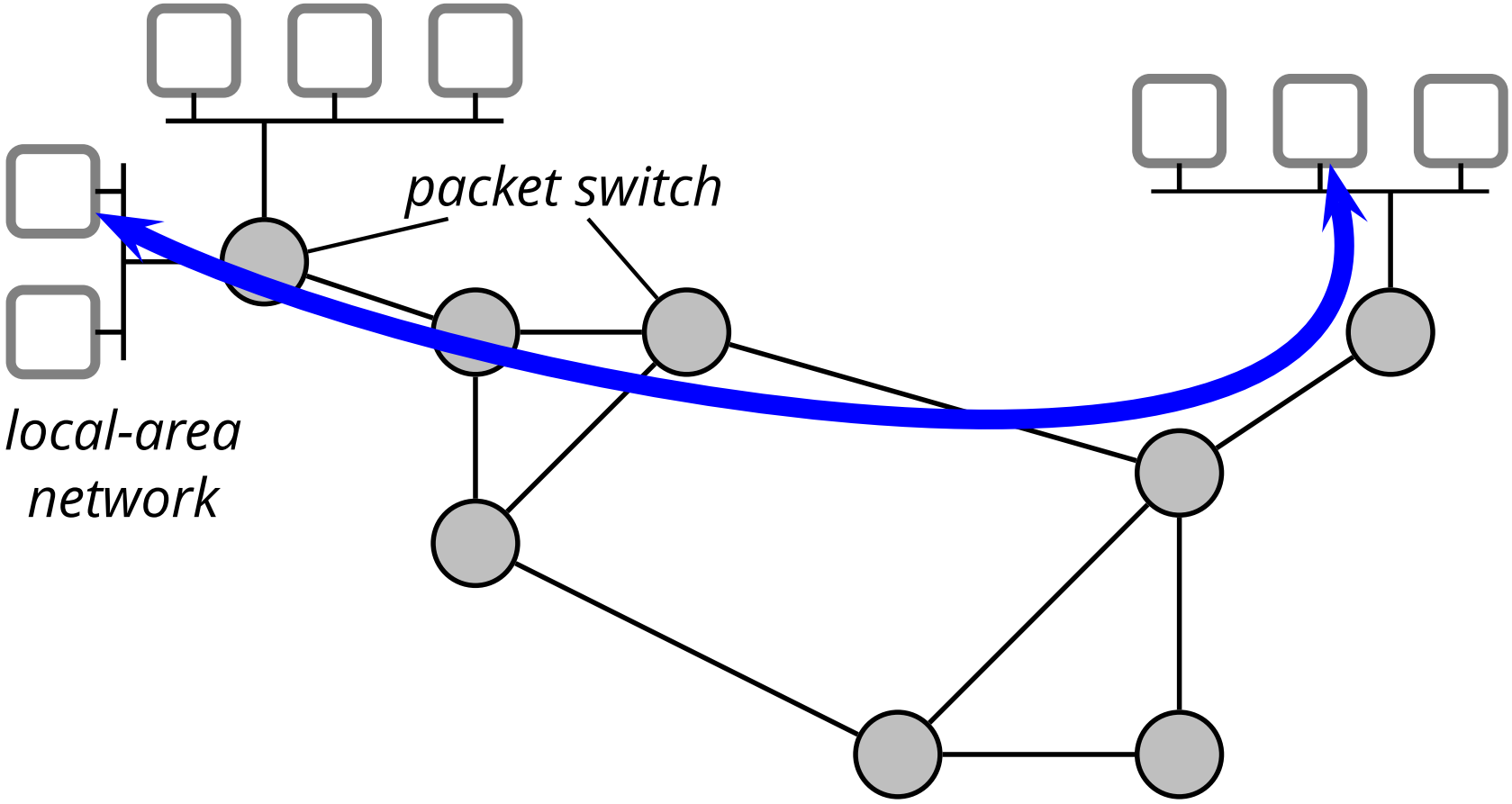

- What kind of ***service*** does the Internet offer to end systems?

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  - "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

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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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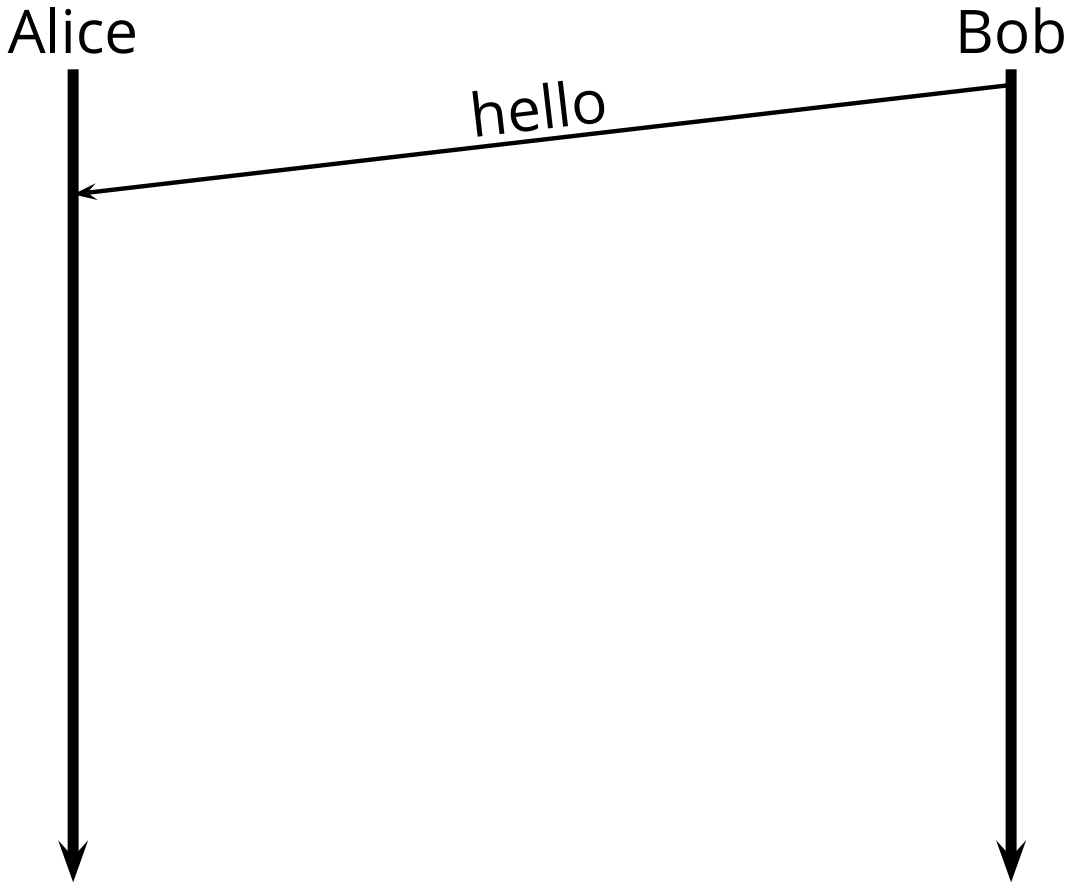

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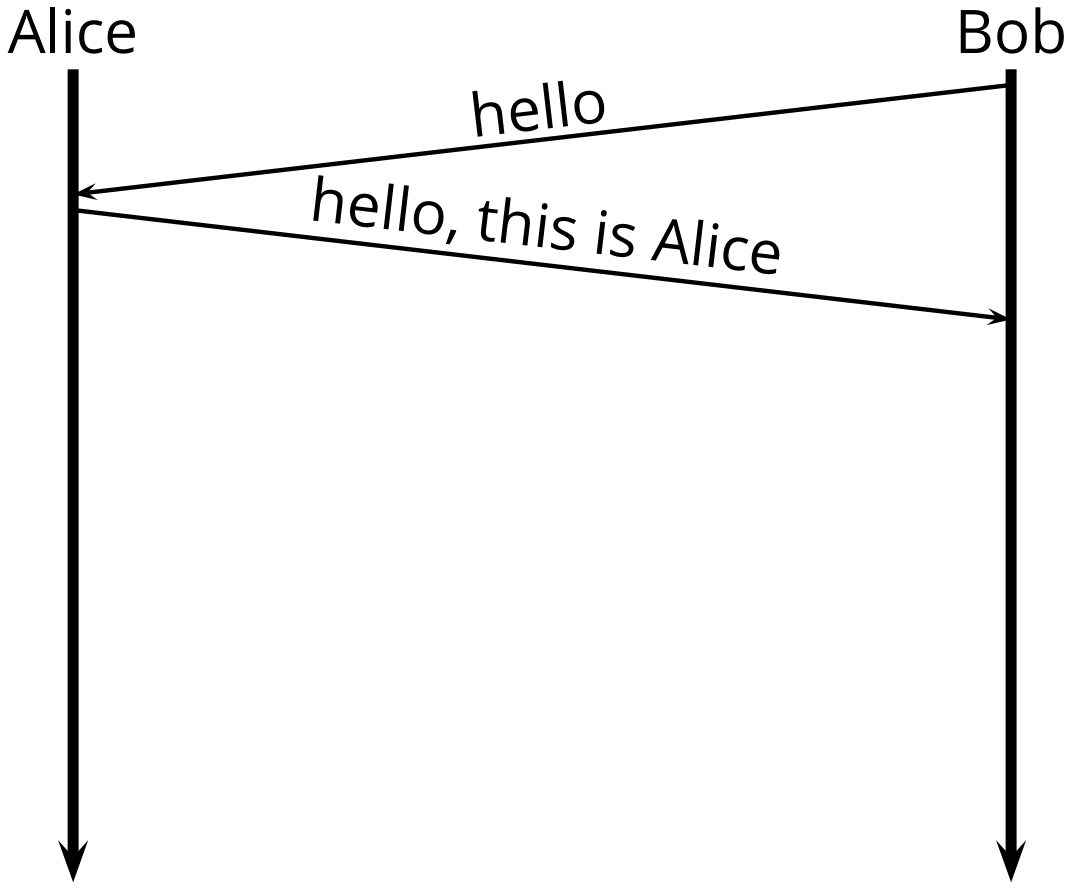

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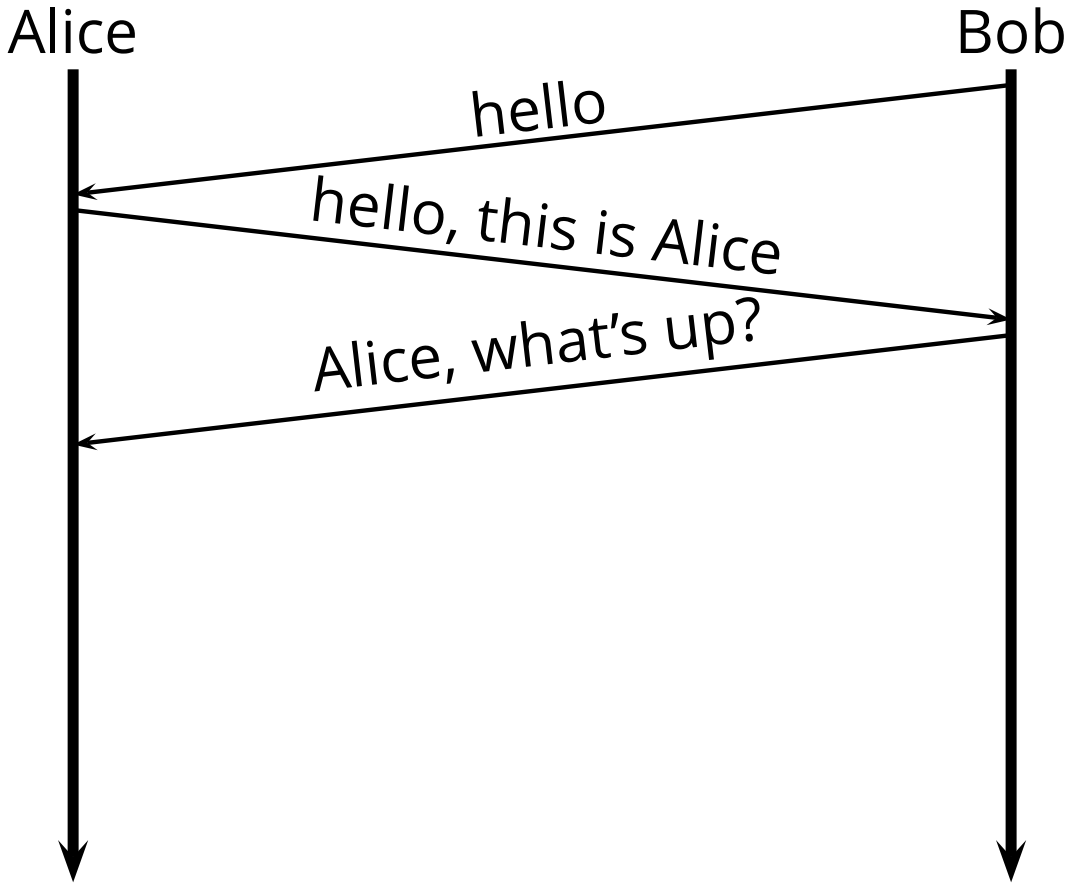

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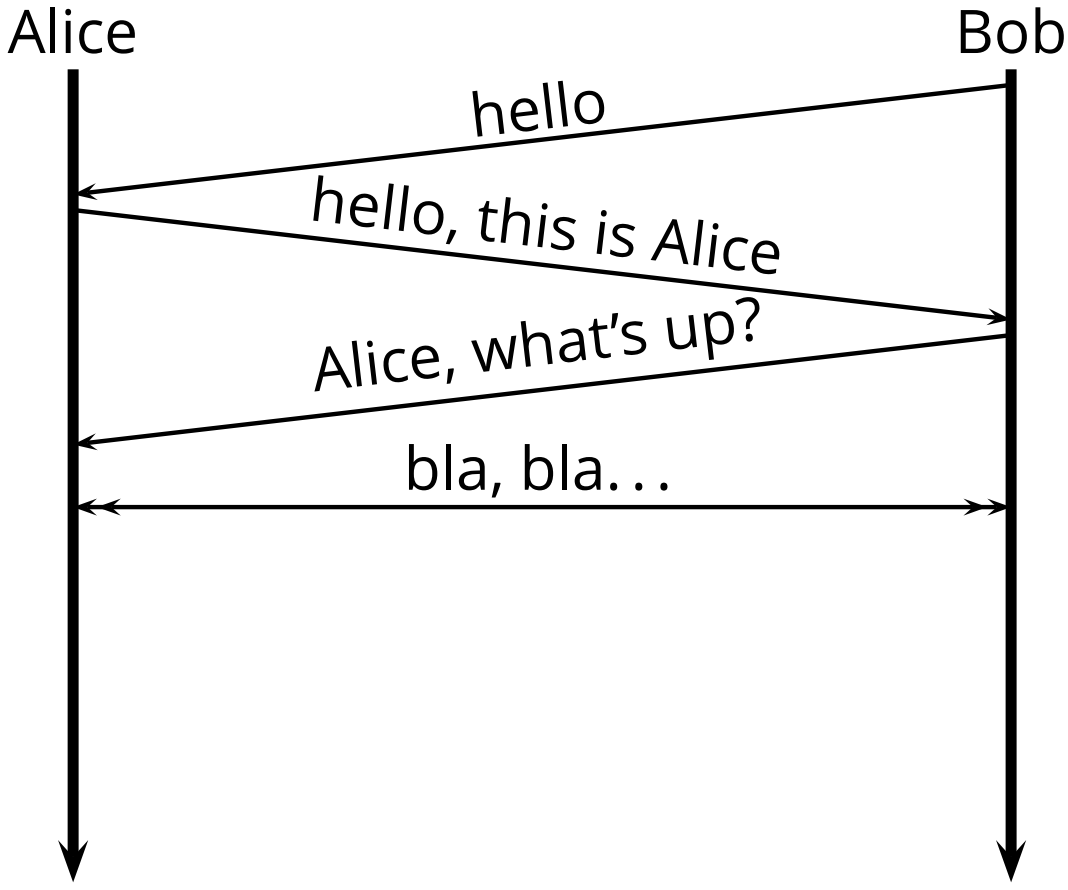

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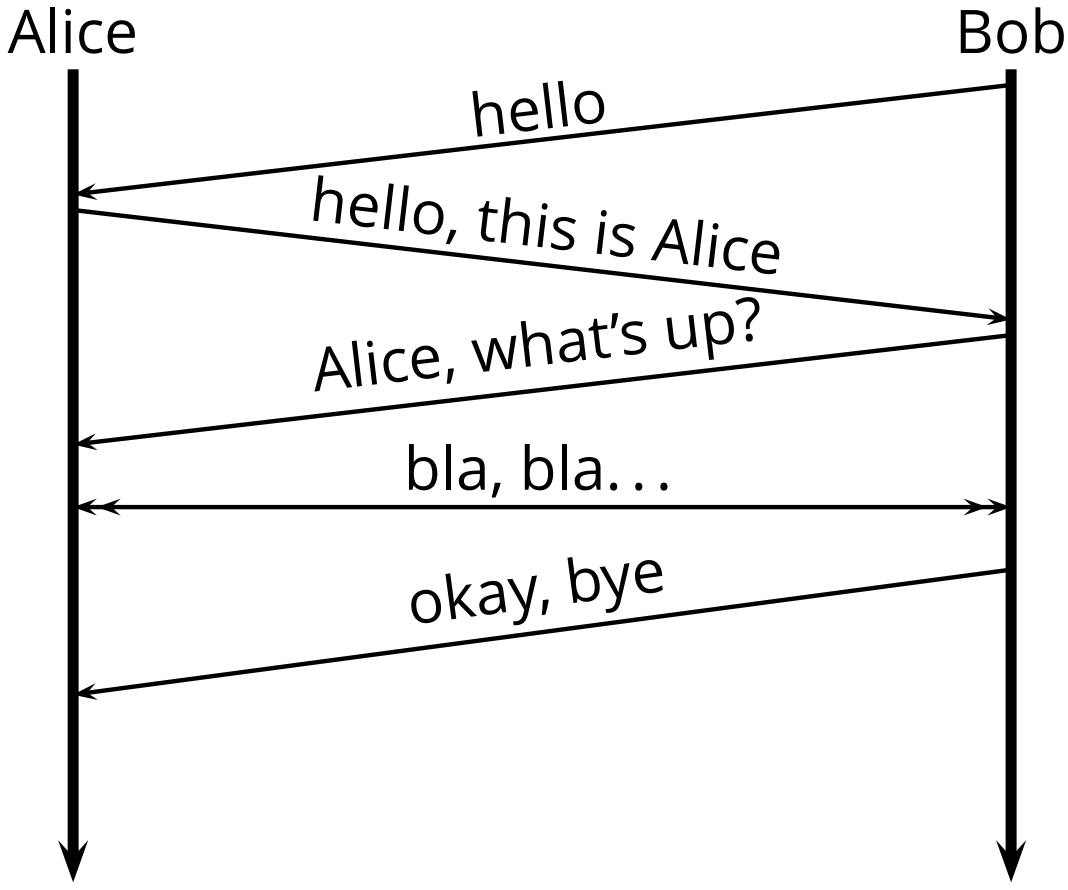

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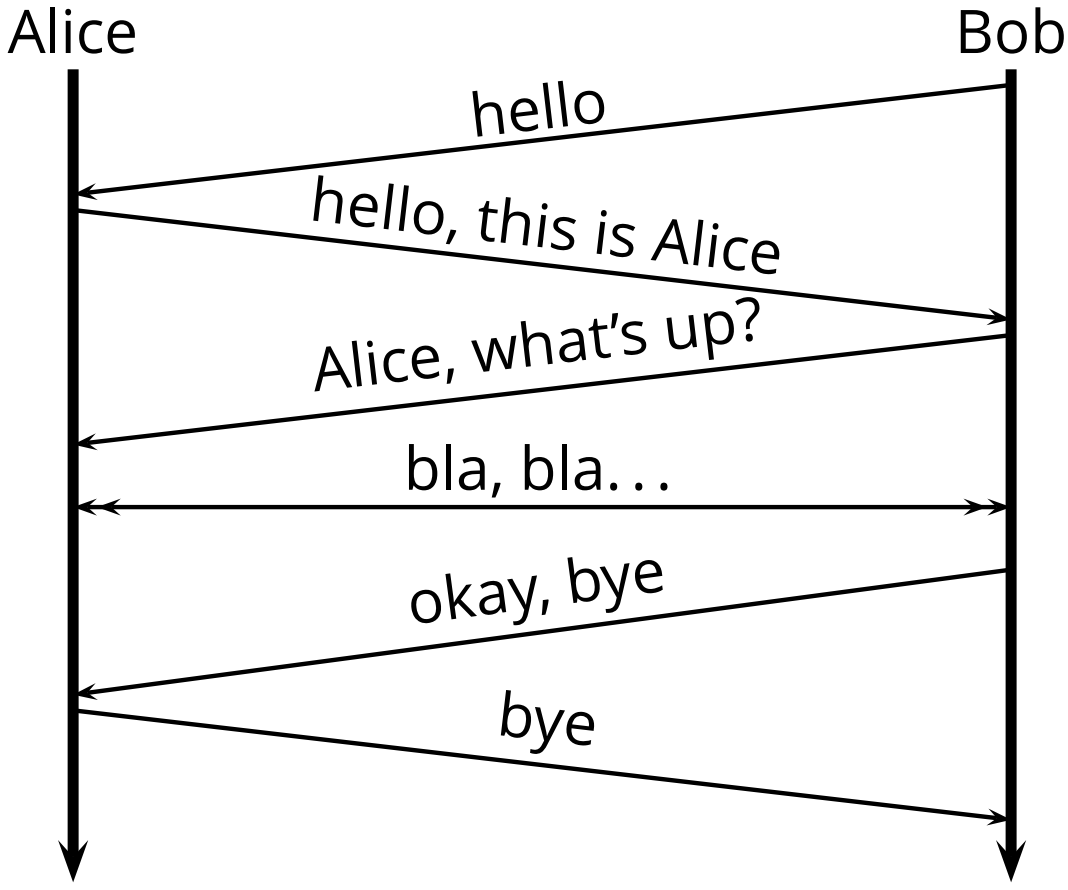

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  - *handshake:* establishes the identities and/or the context
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- This protocol assumes a connection-oriented medium
- The protocol involves two parties (Alice and Bob)
- ...

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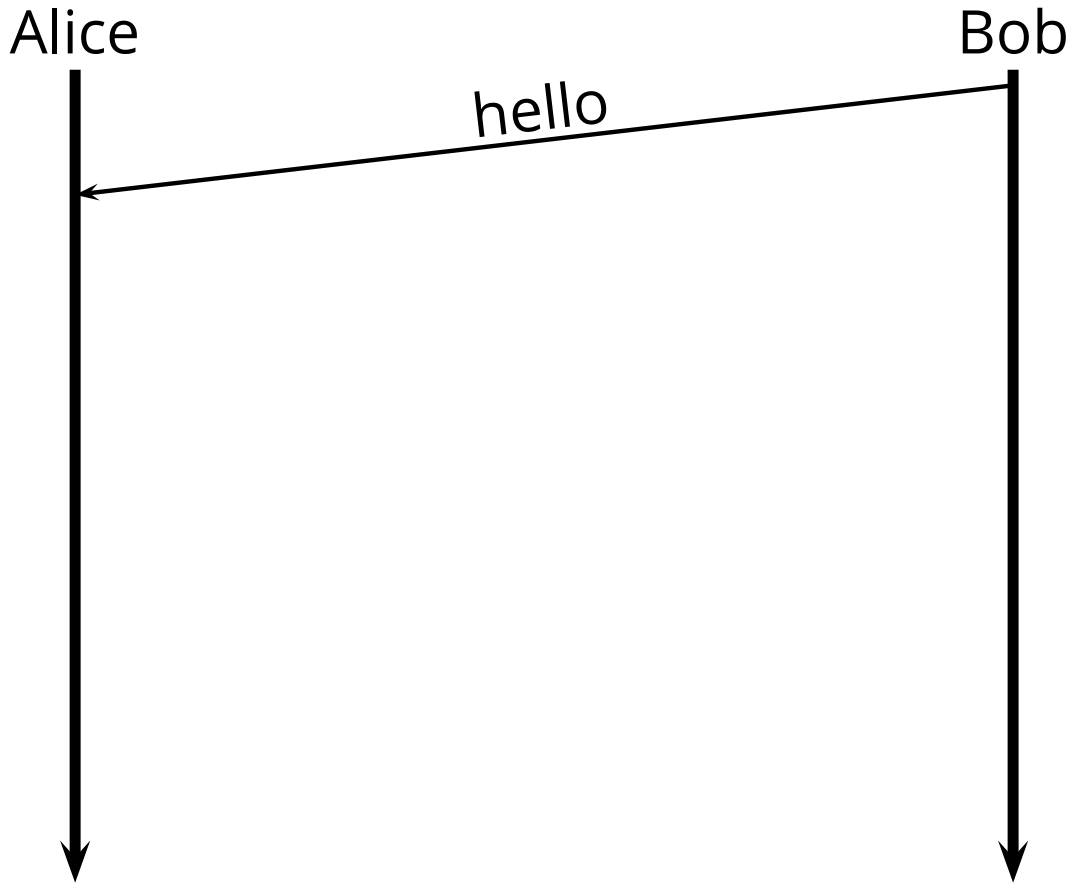

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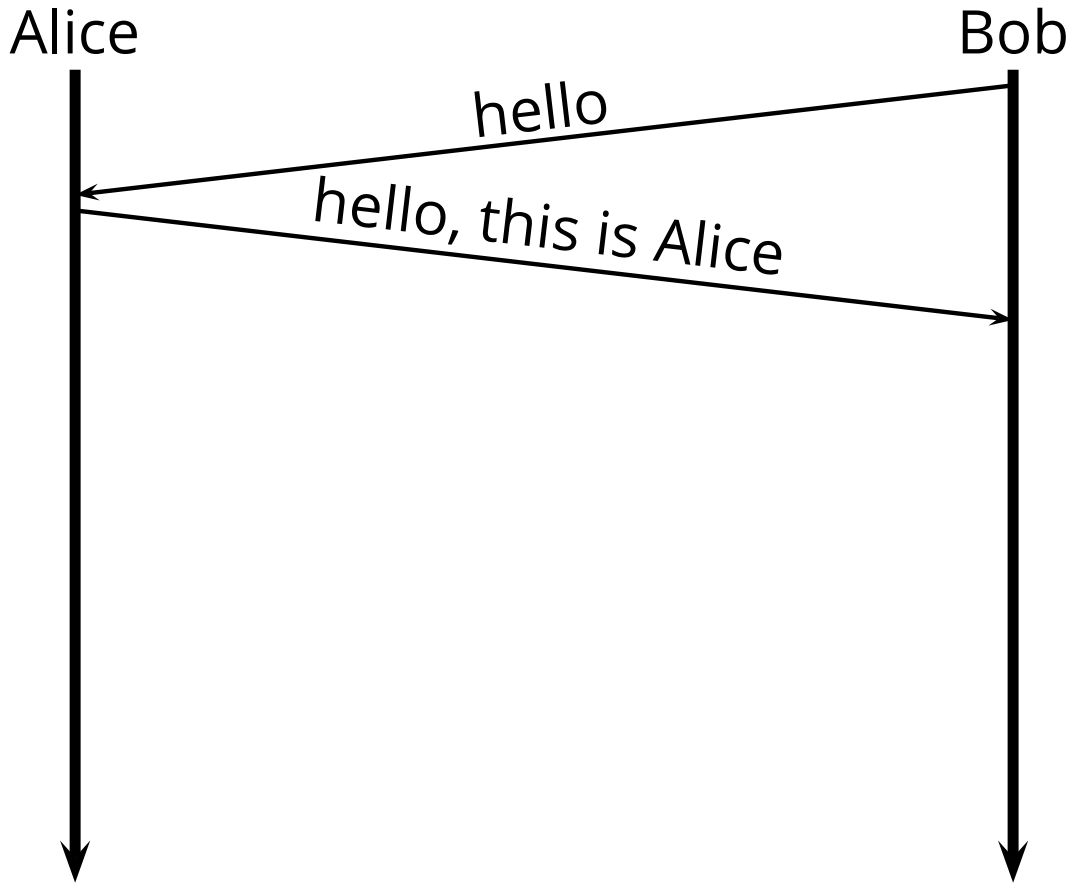

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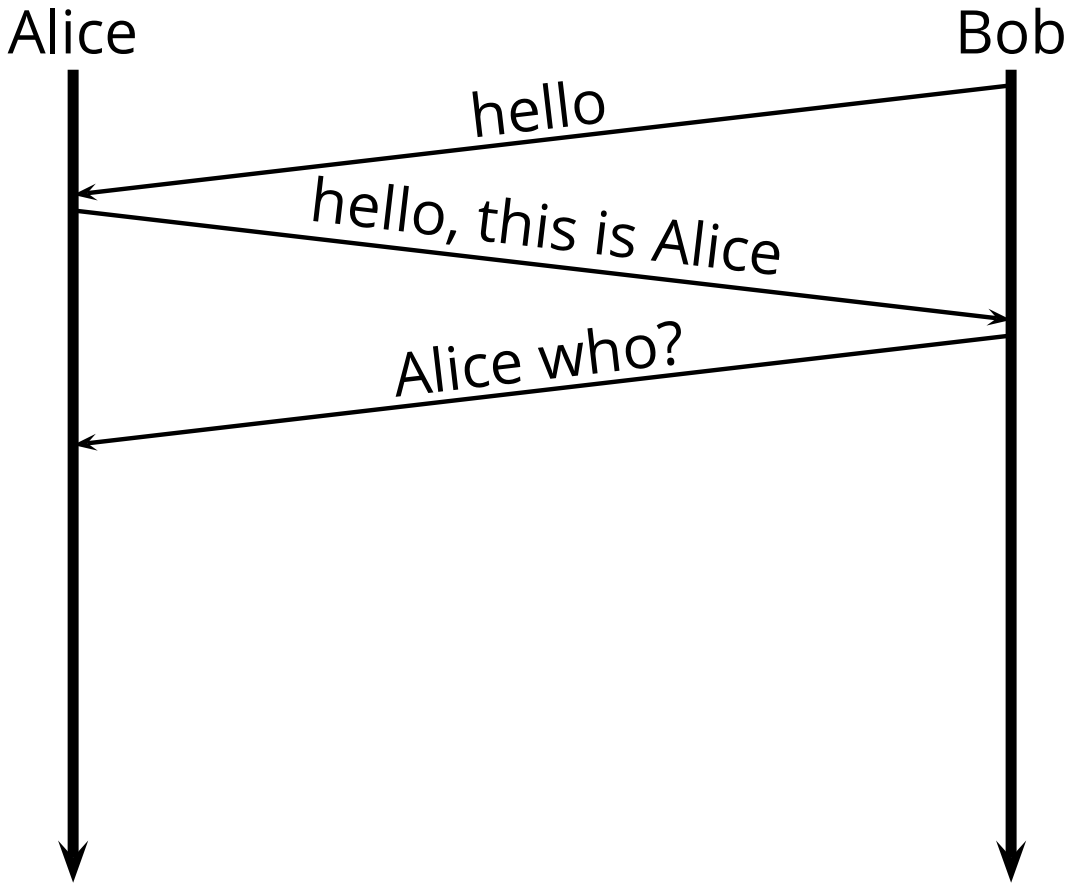

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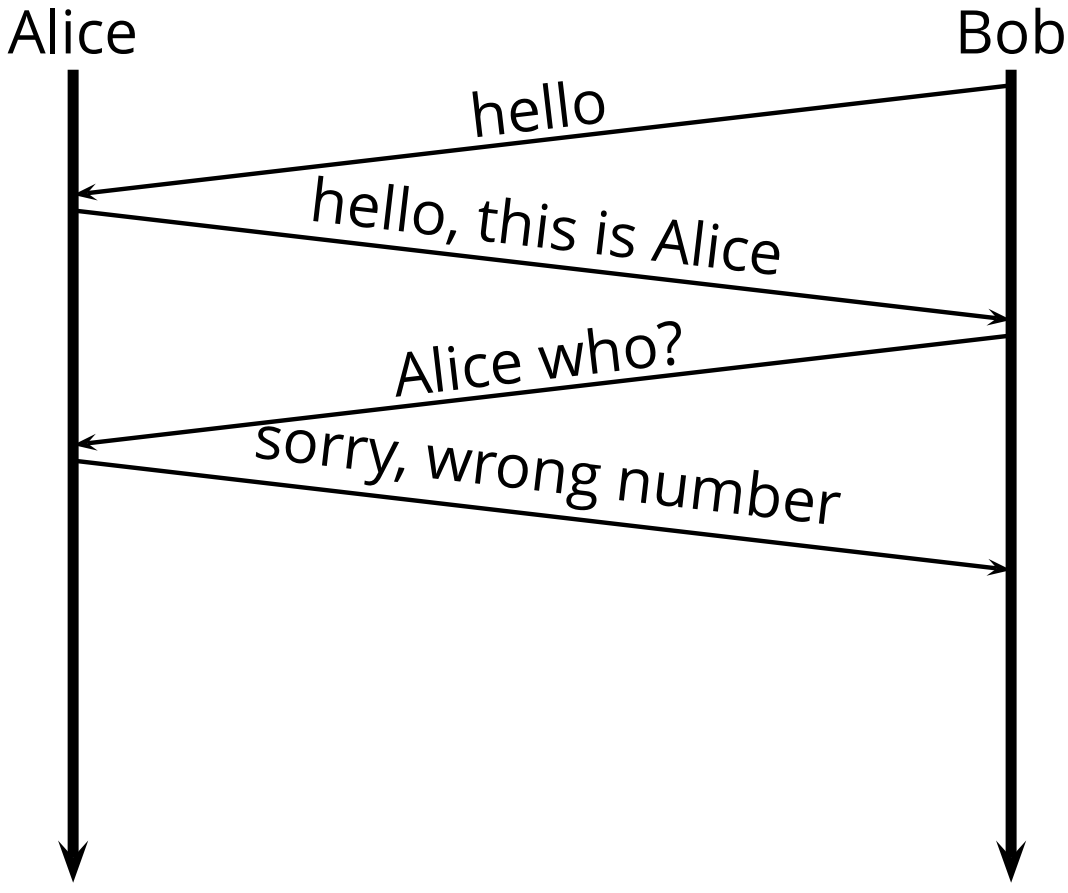

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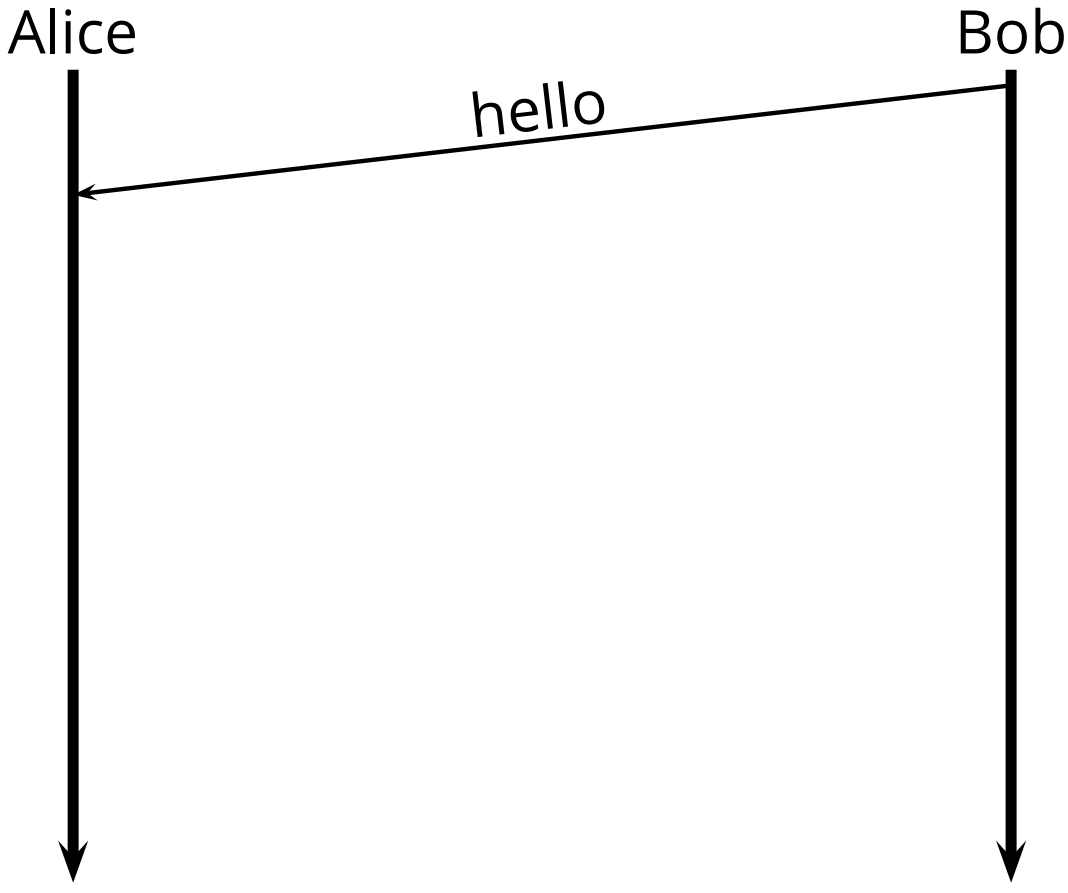

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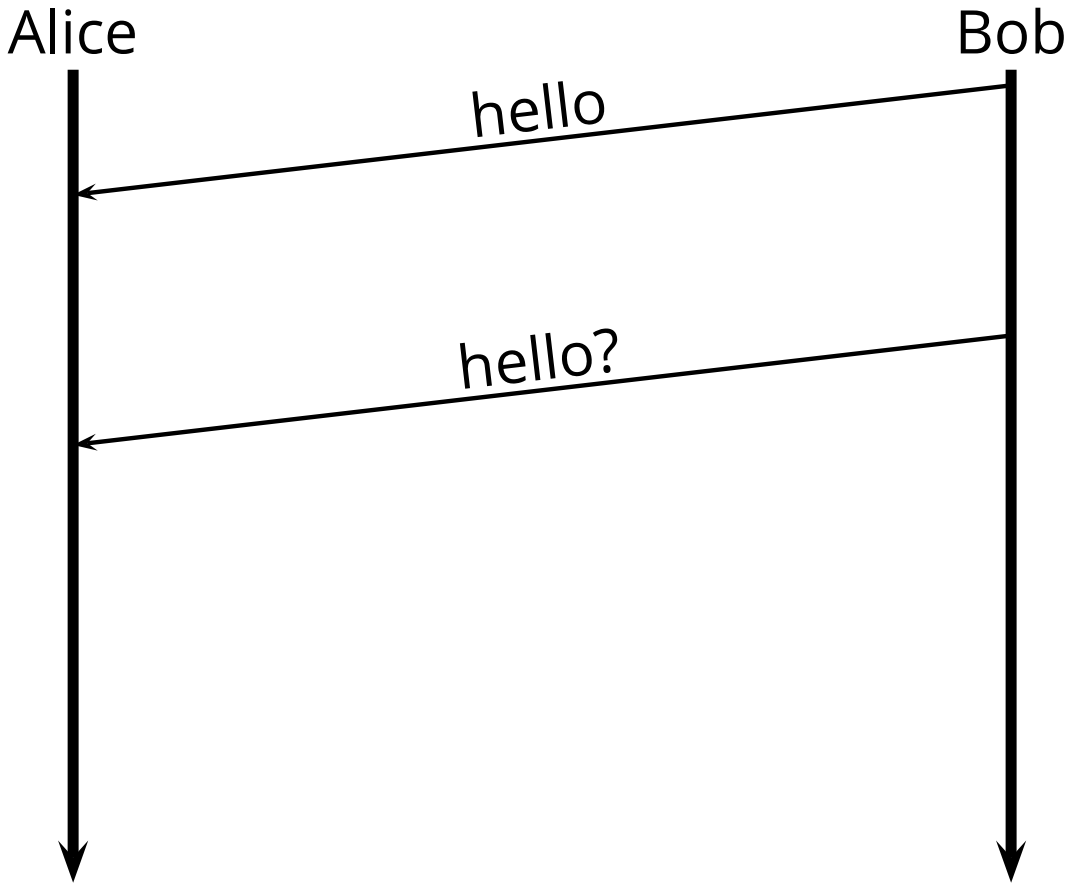

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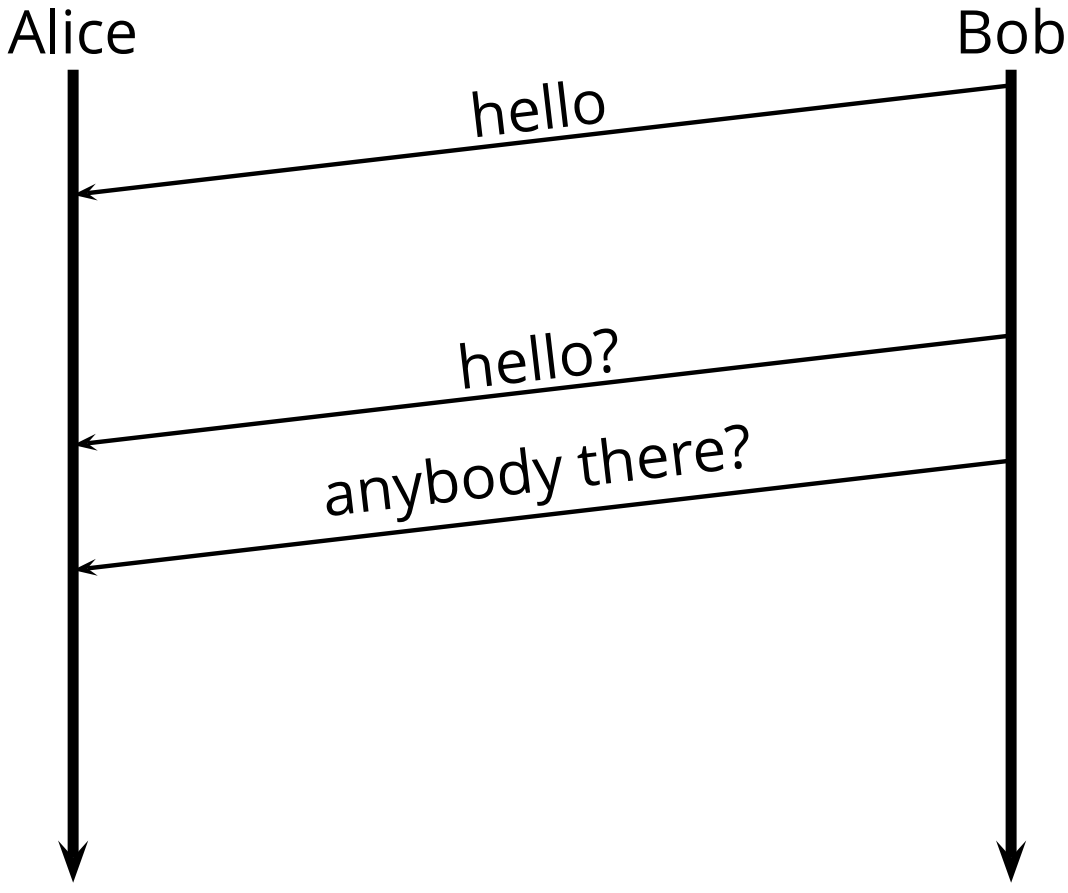

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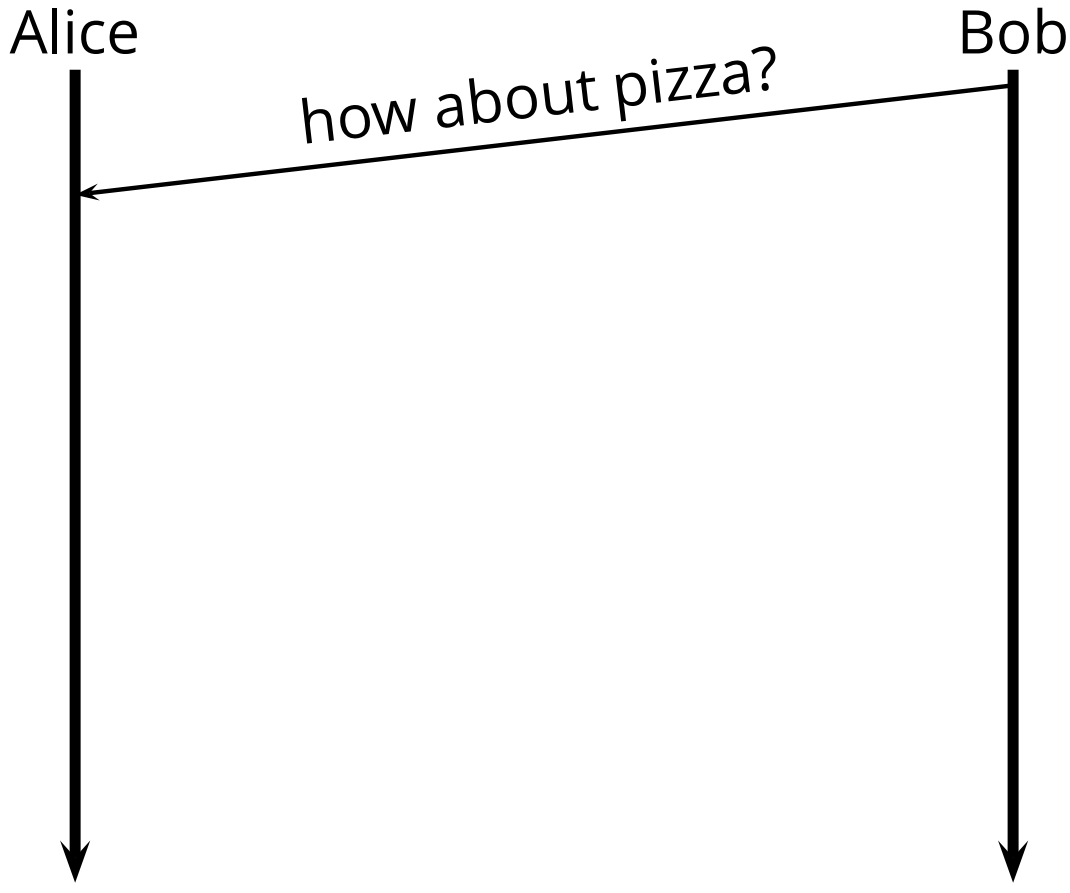

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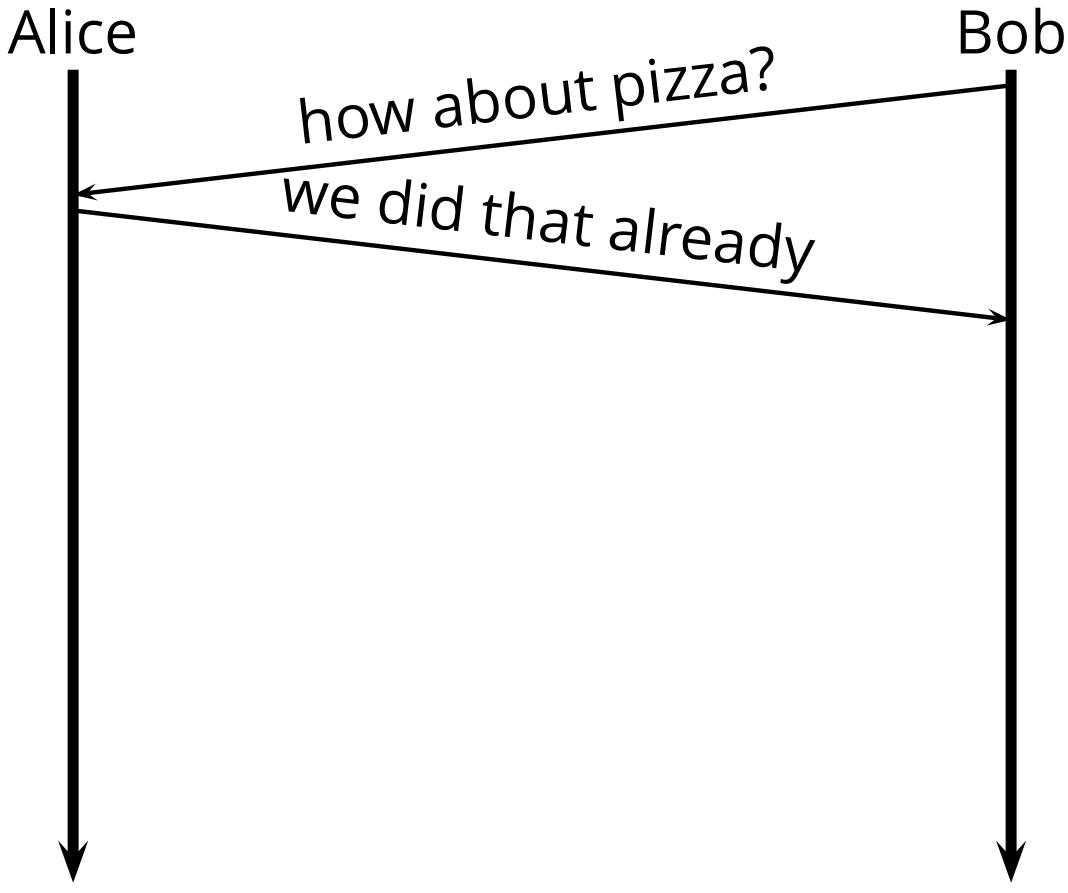

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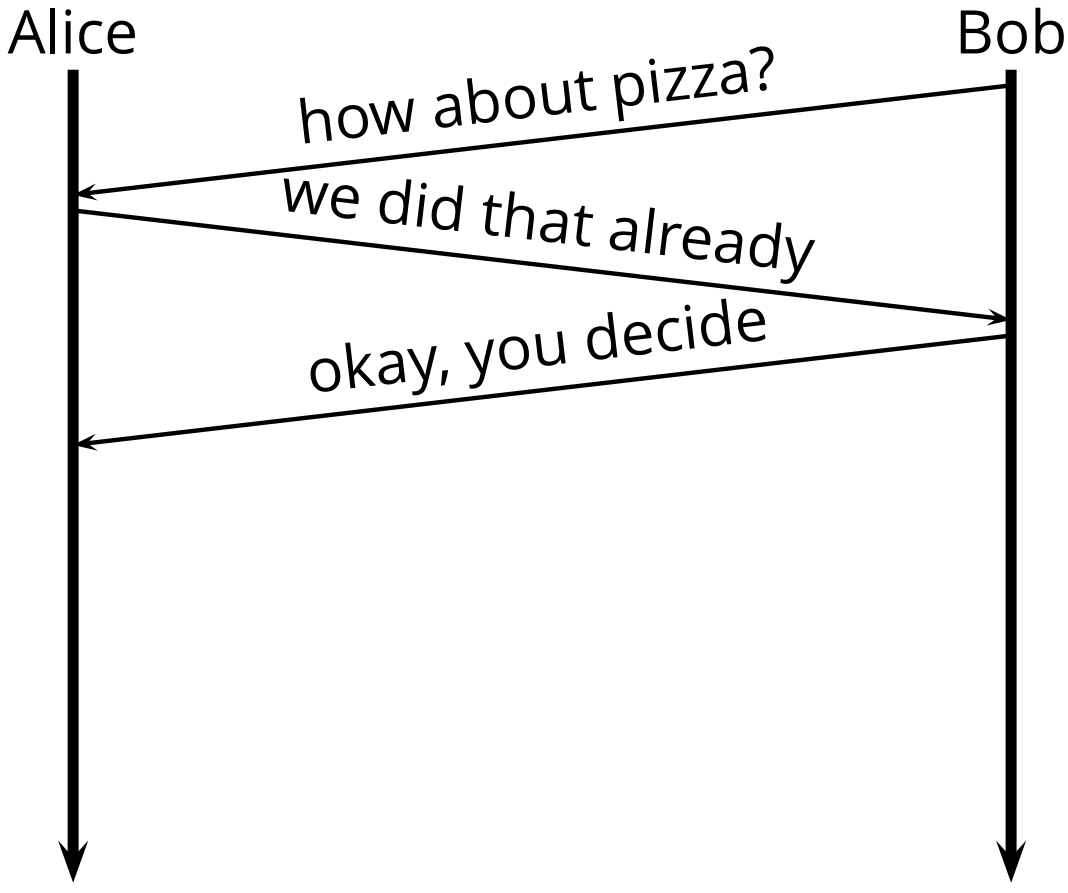

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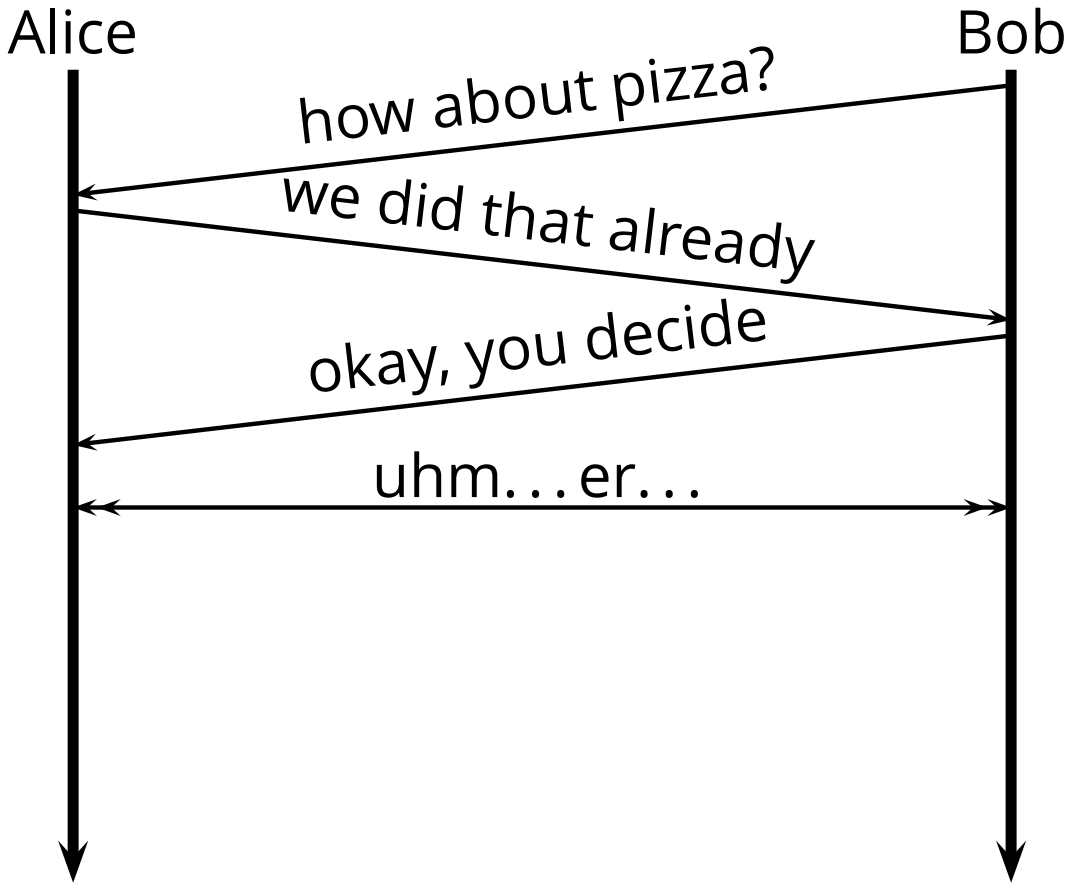

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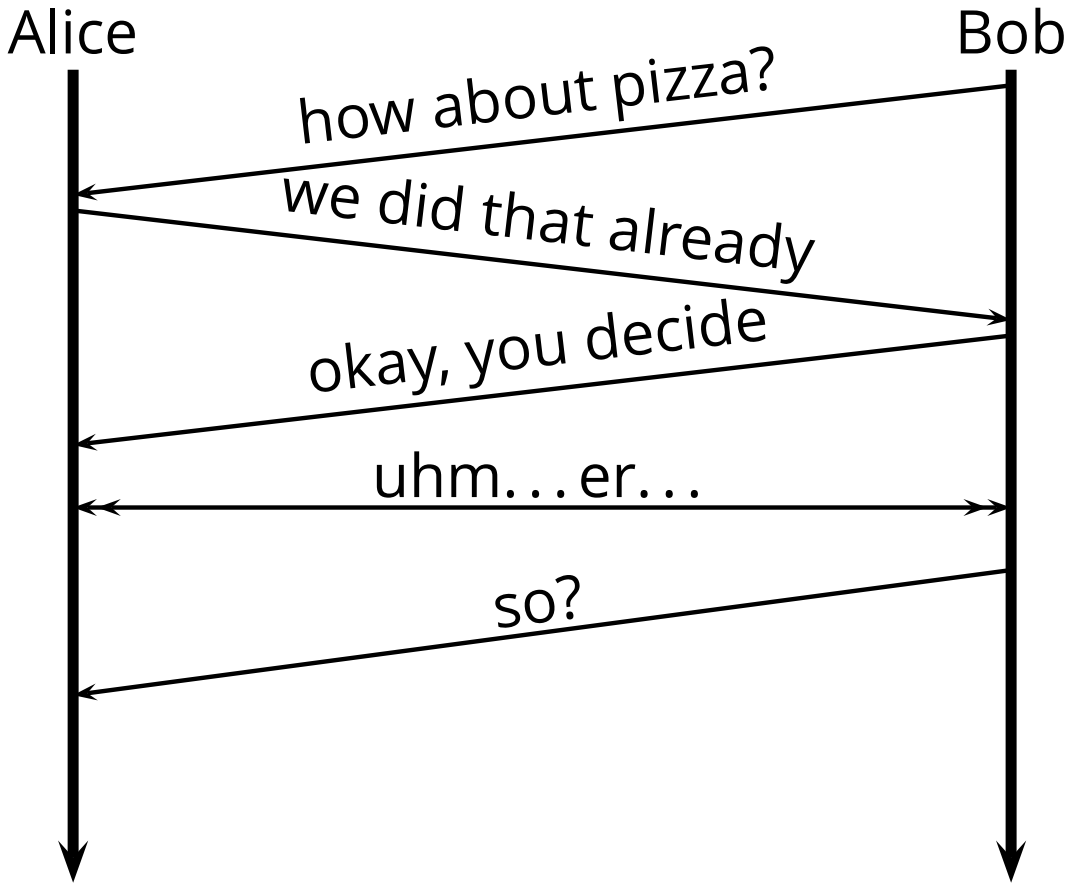

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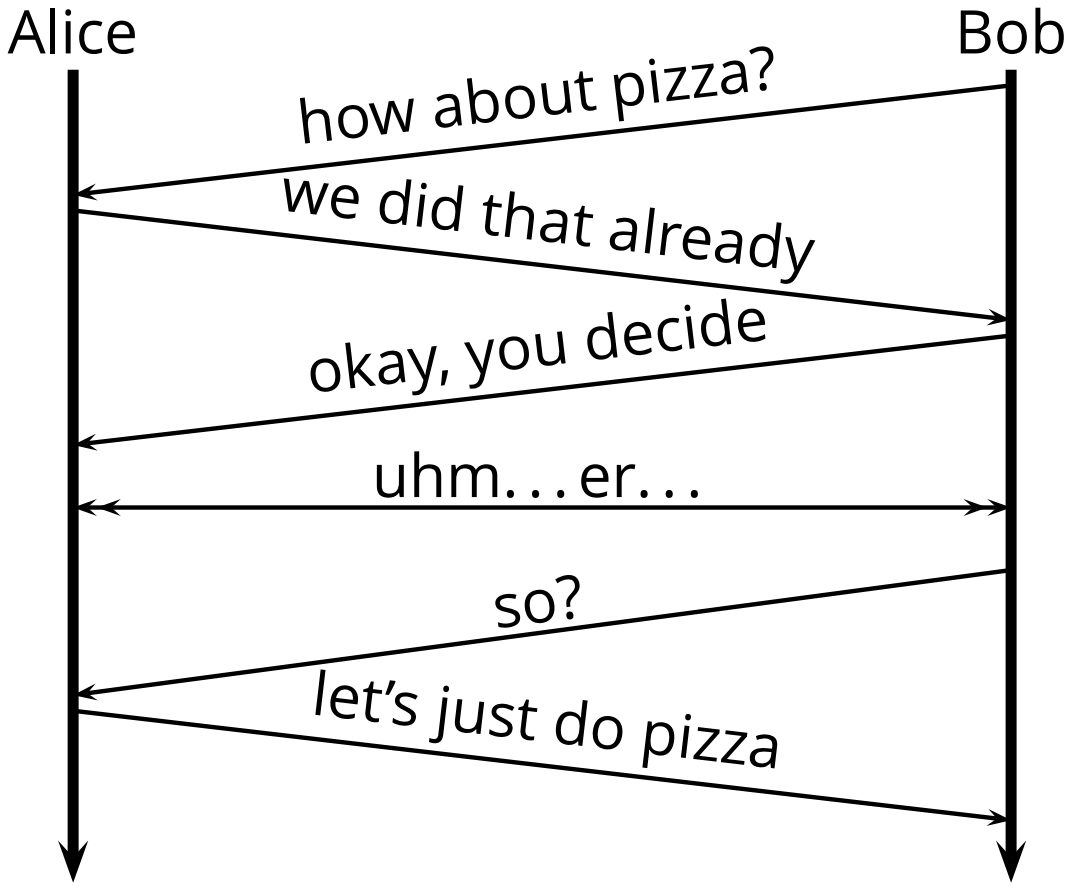

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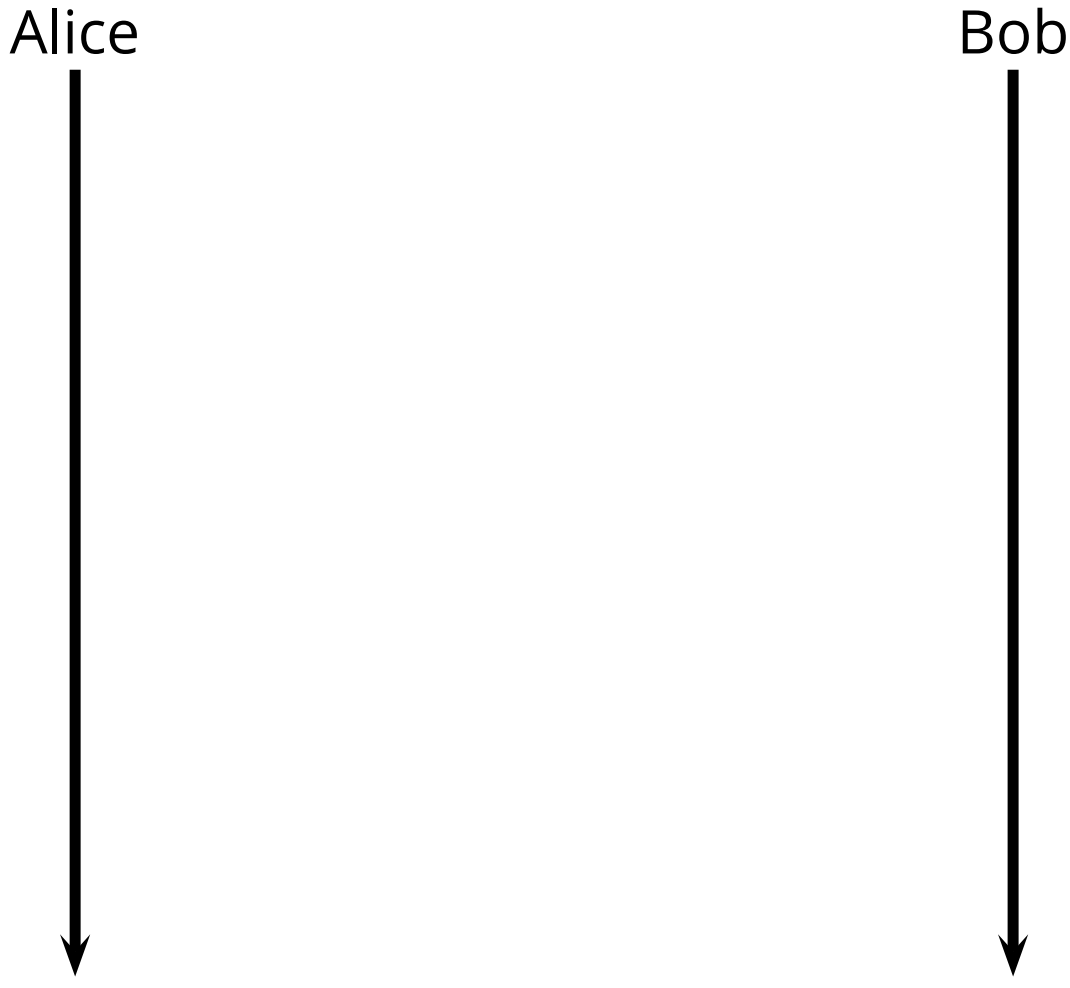

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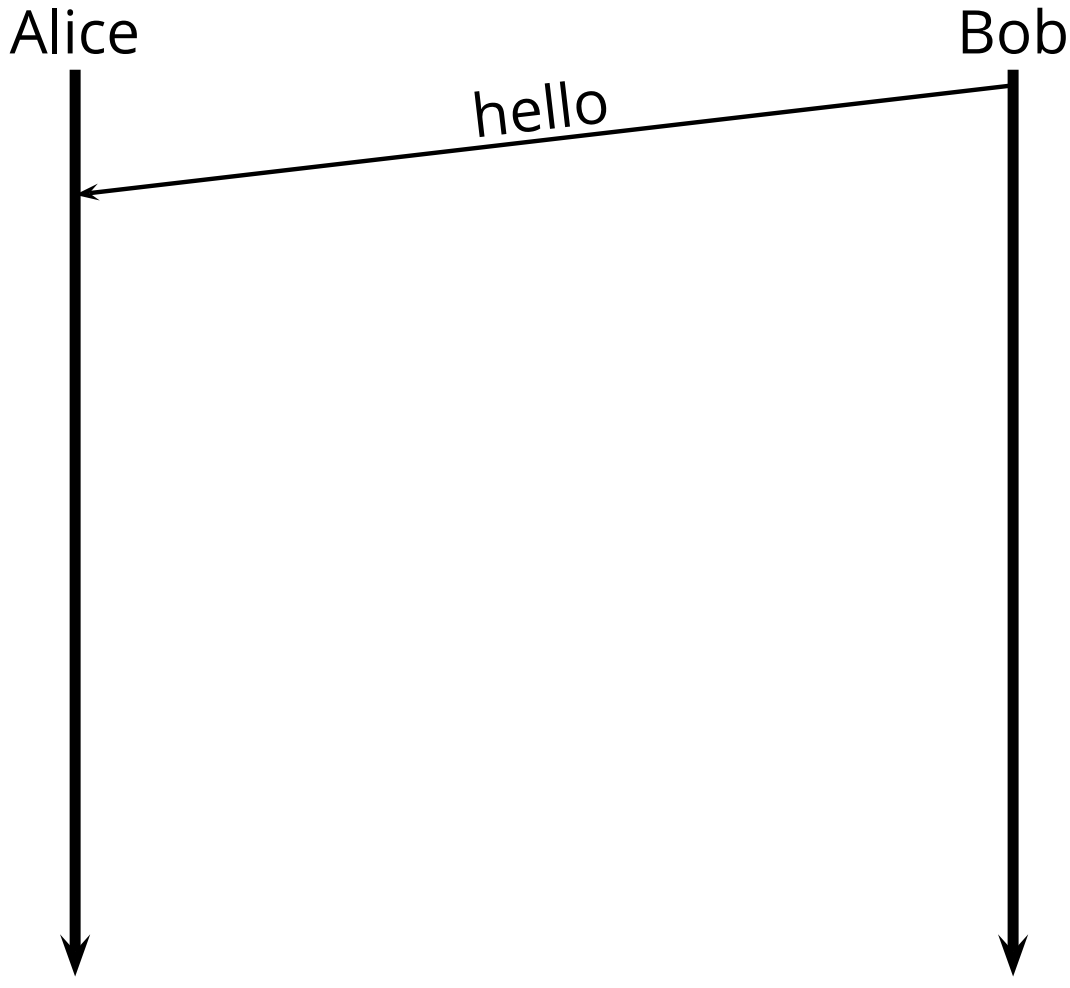

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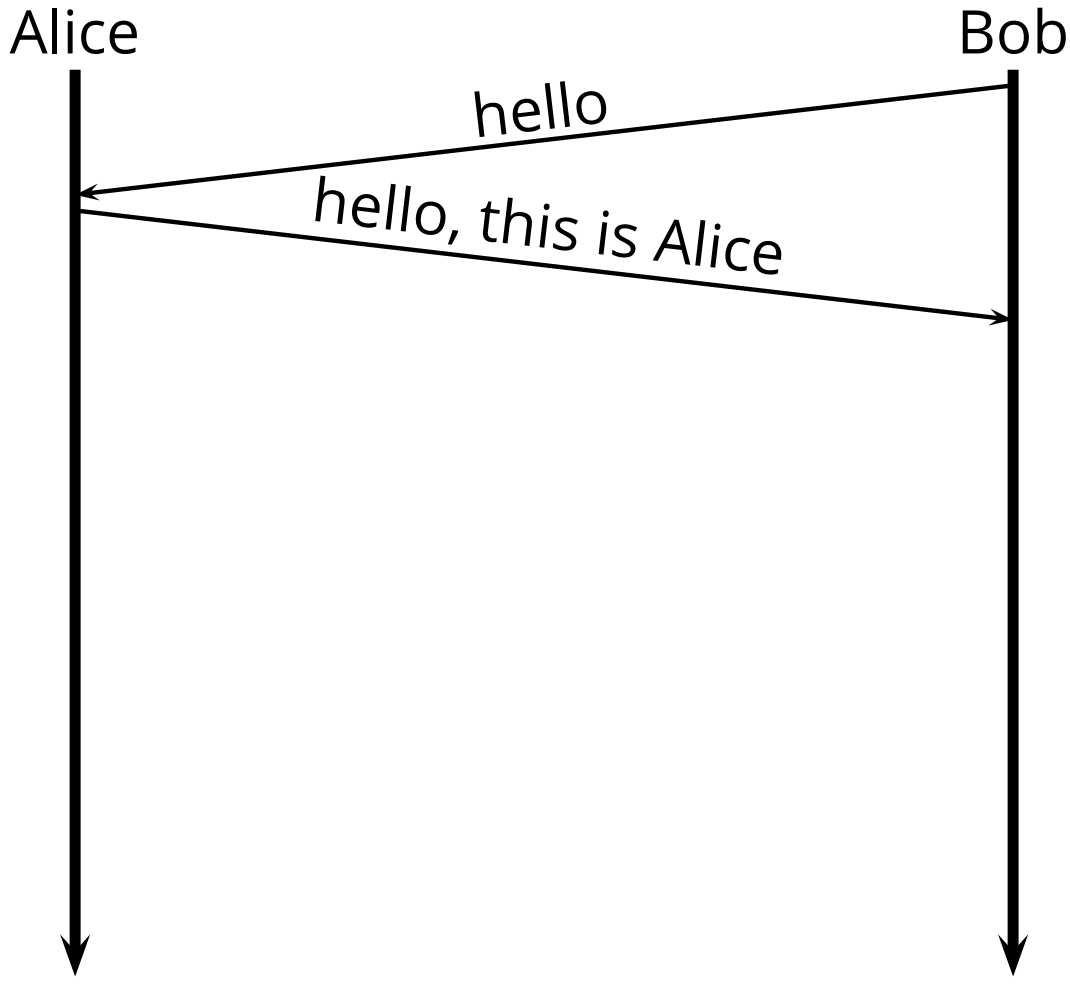

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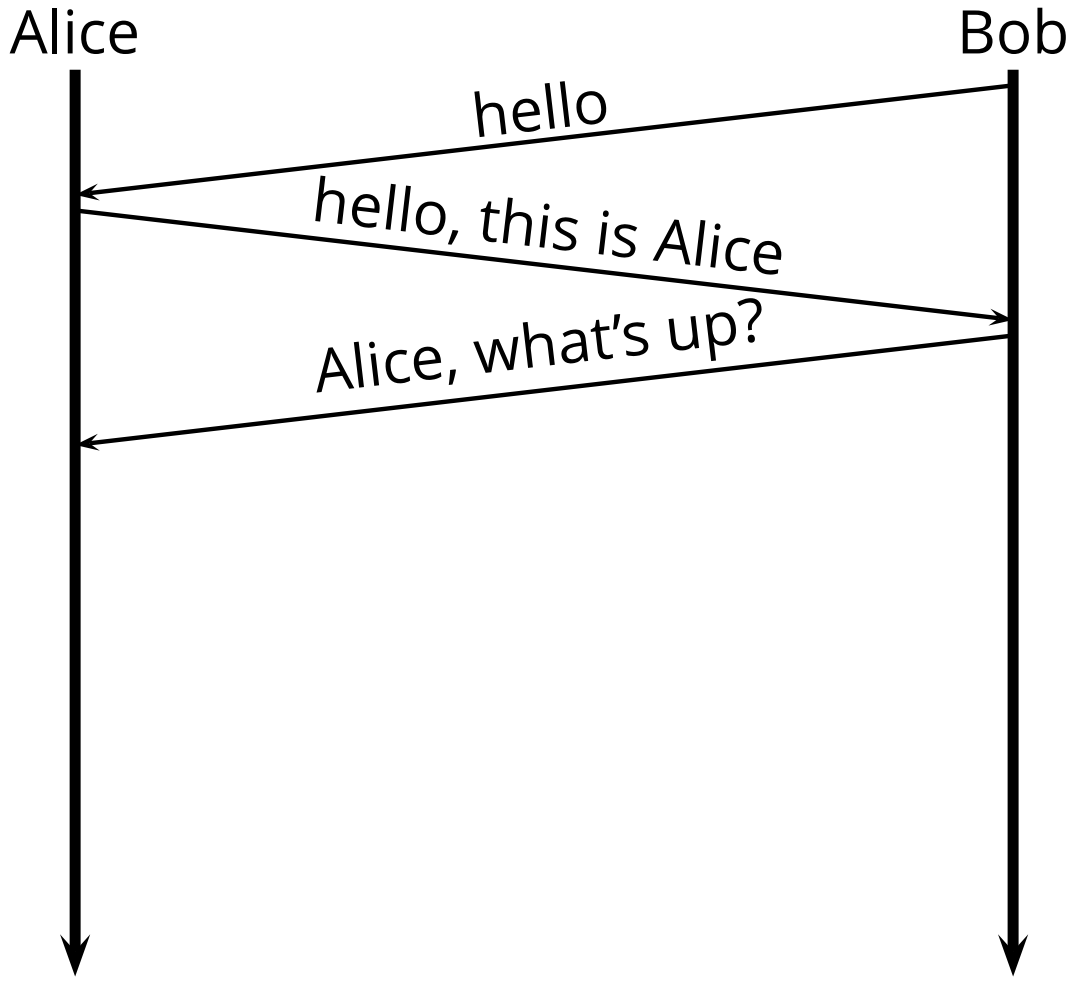

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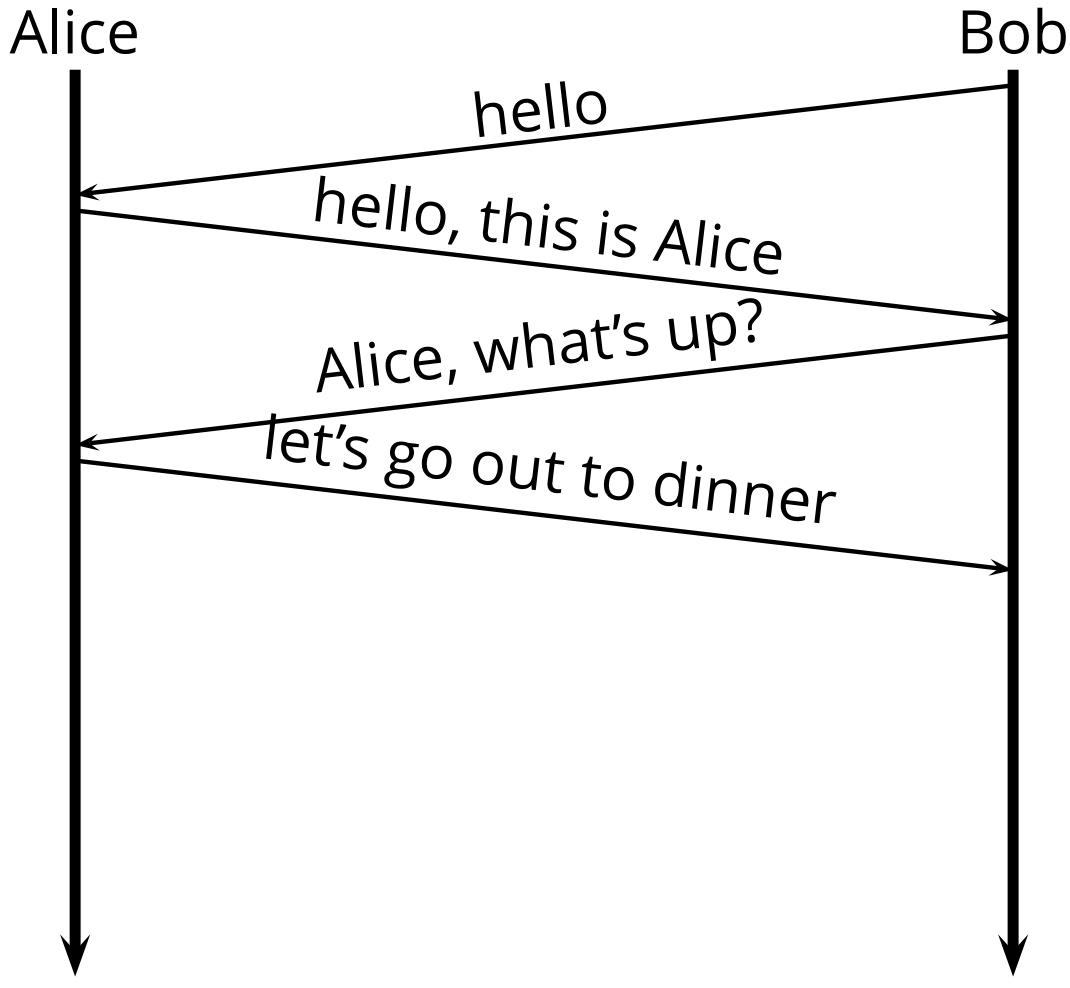

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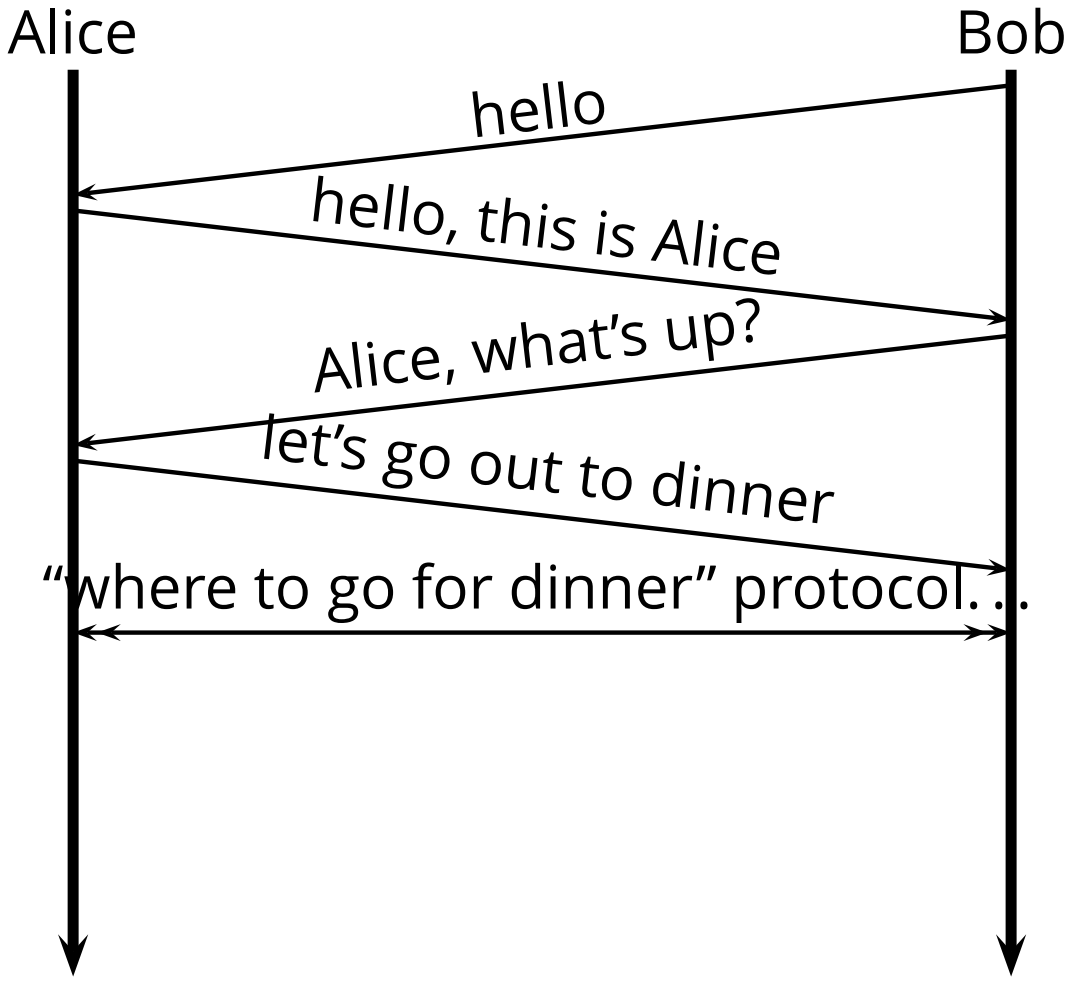

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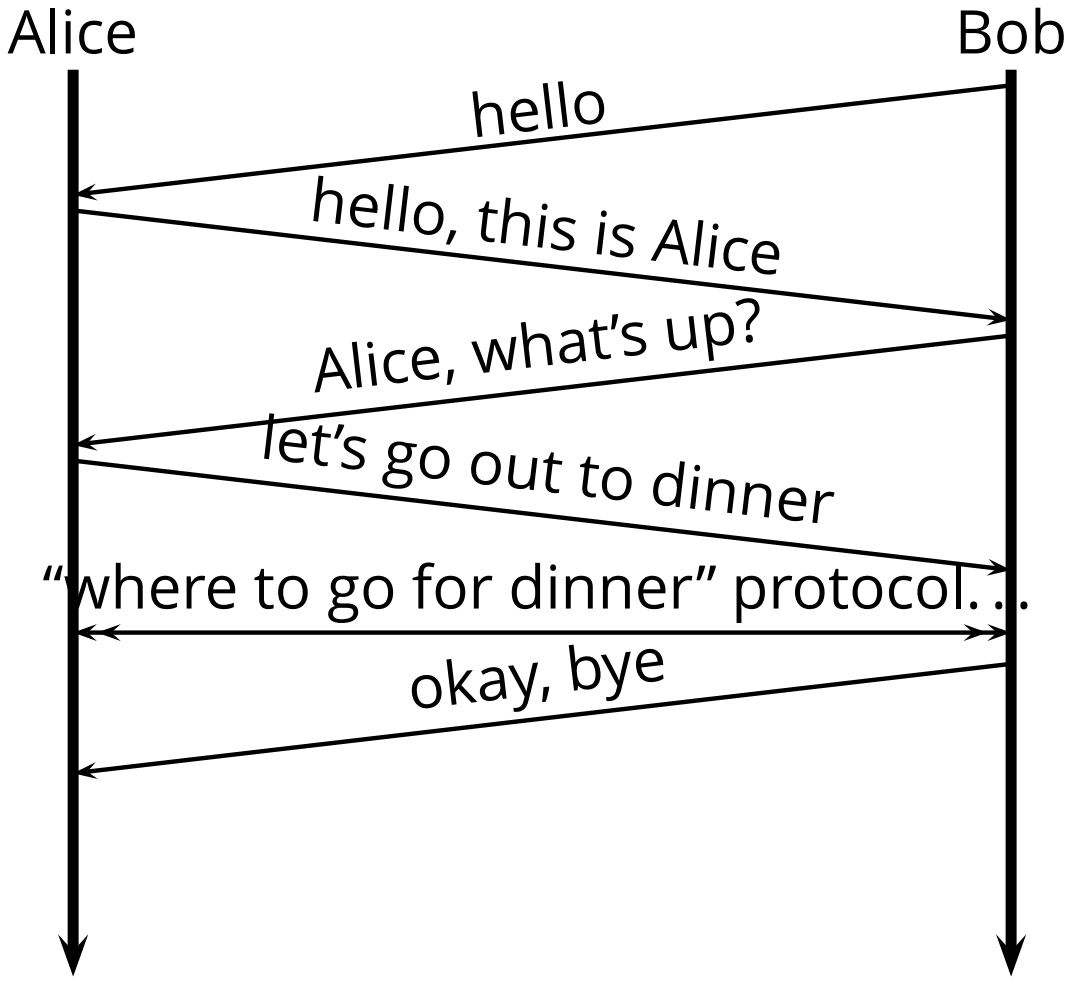

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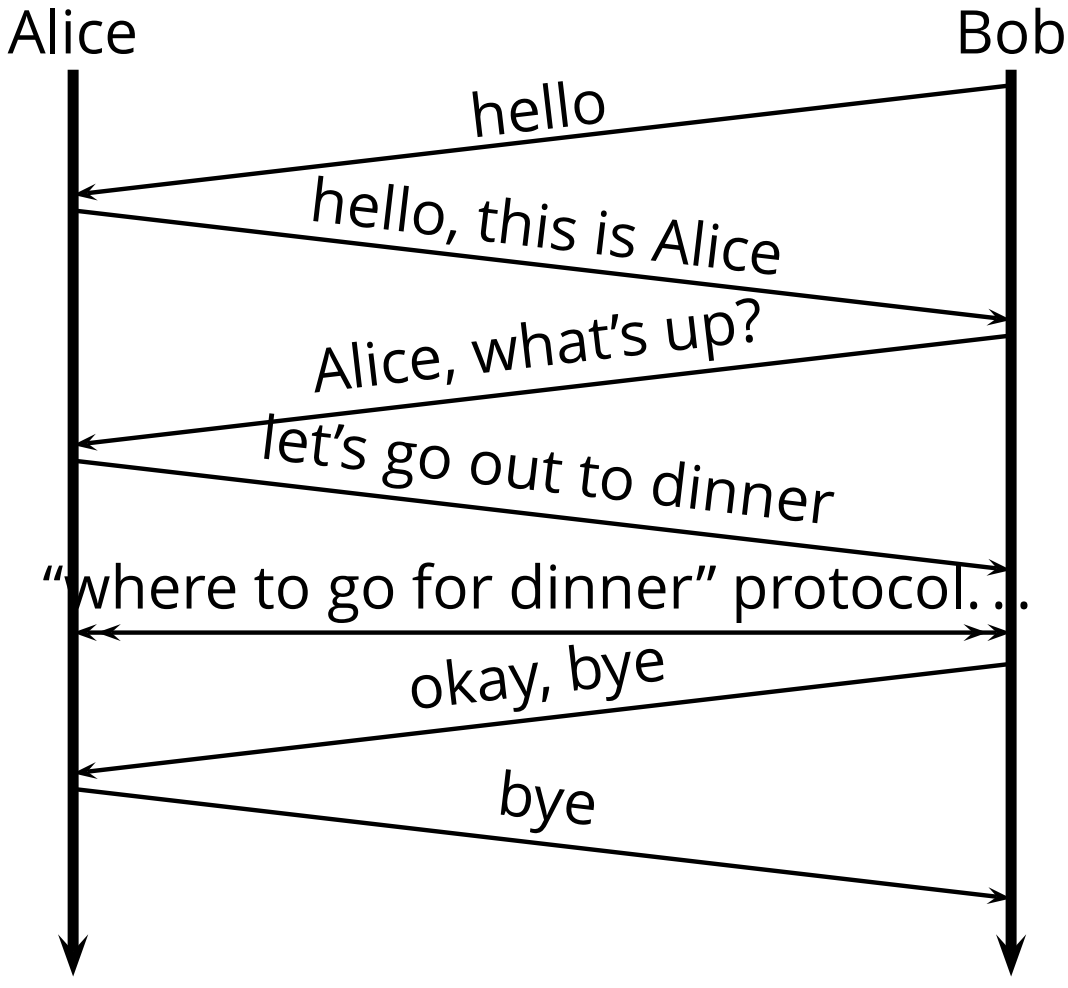

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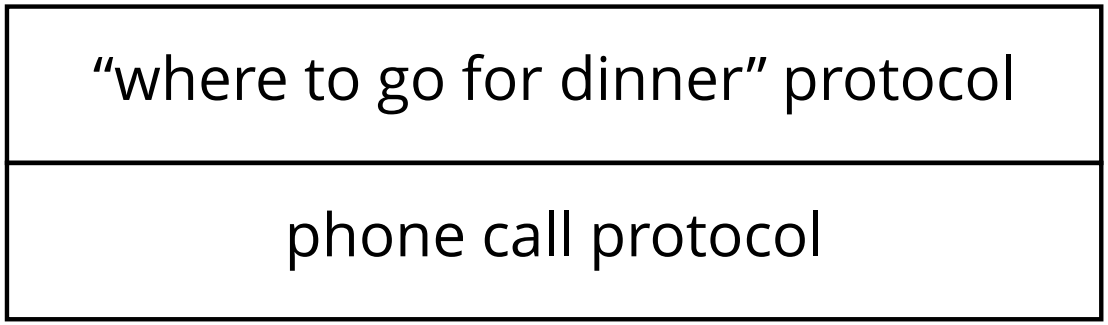

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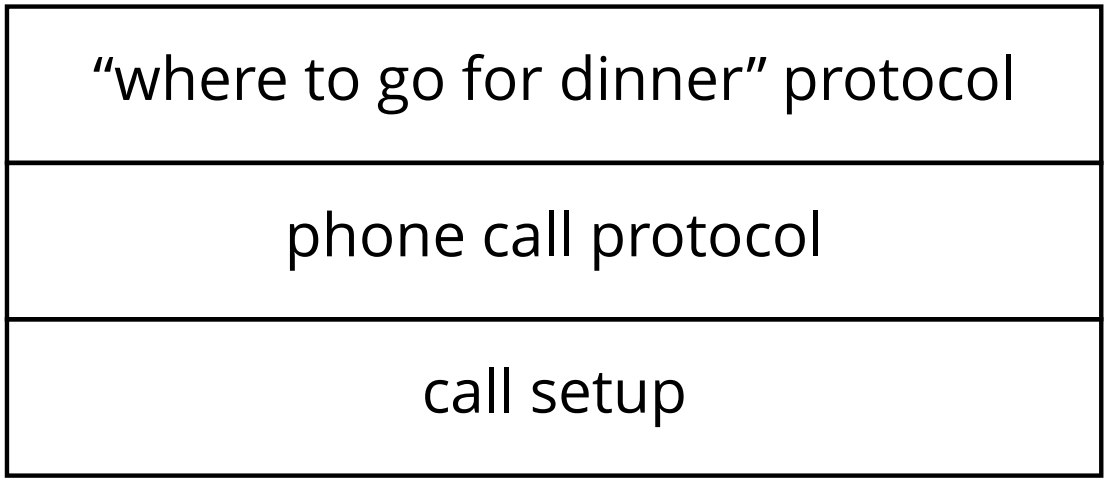

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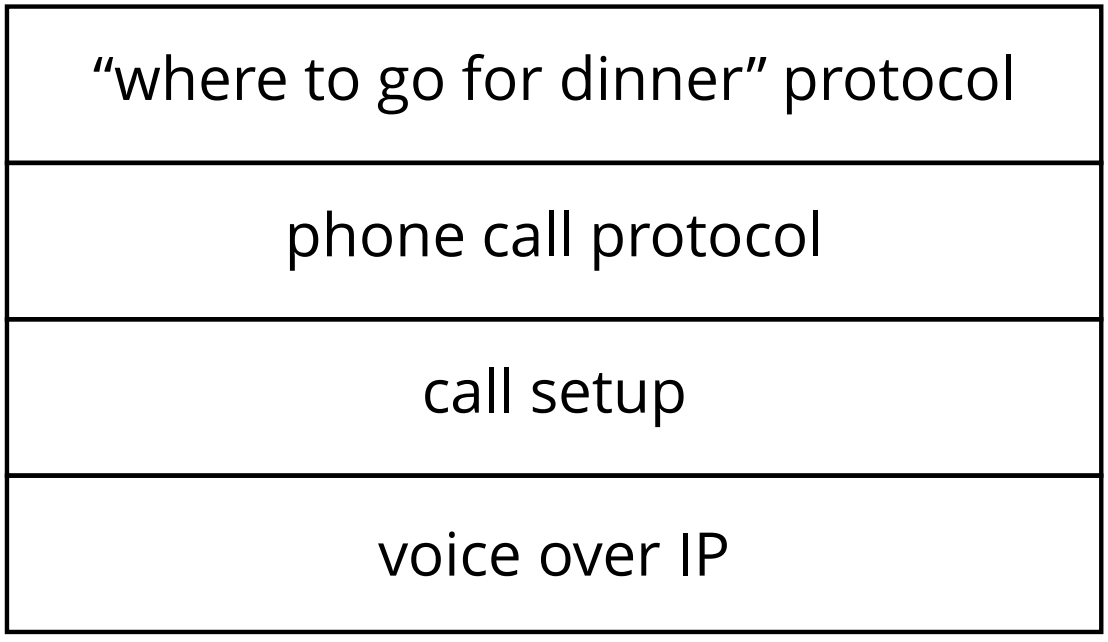

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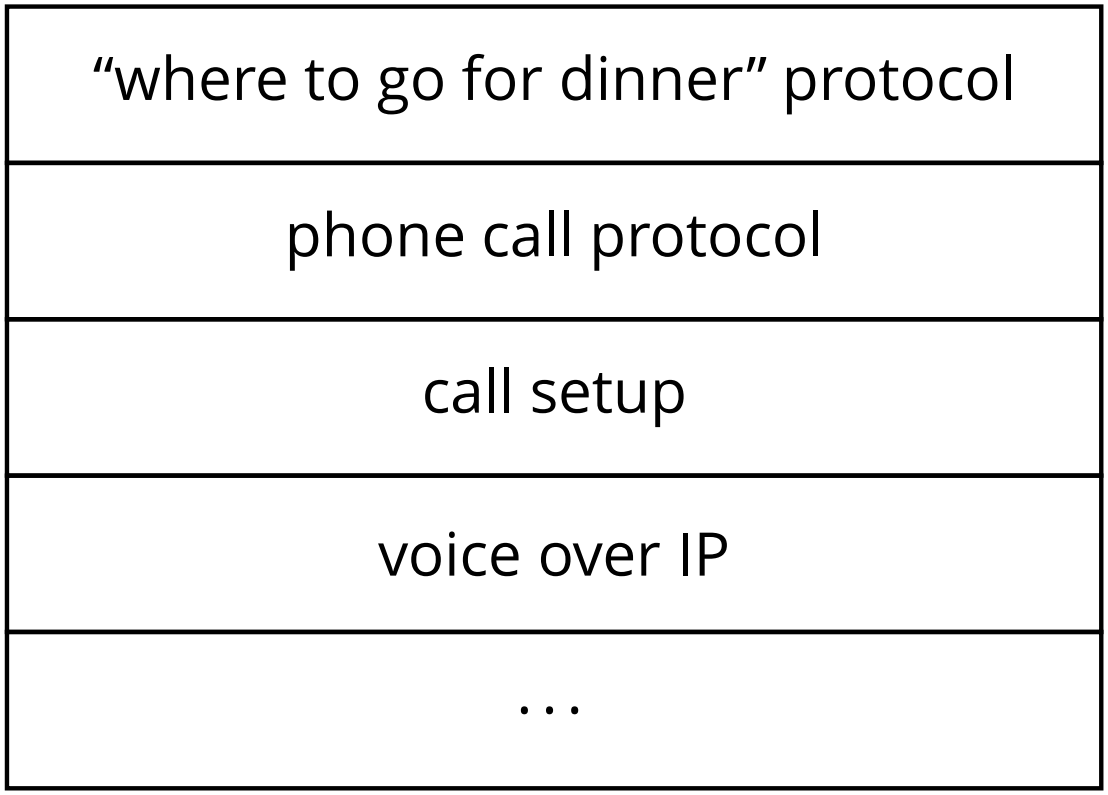

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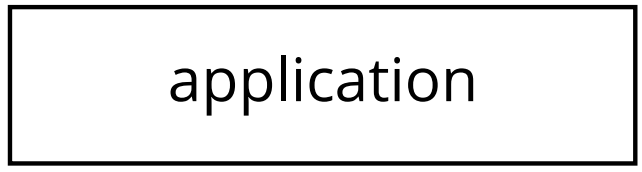

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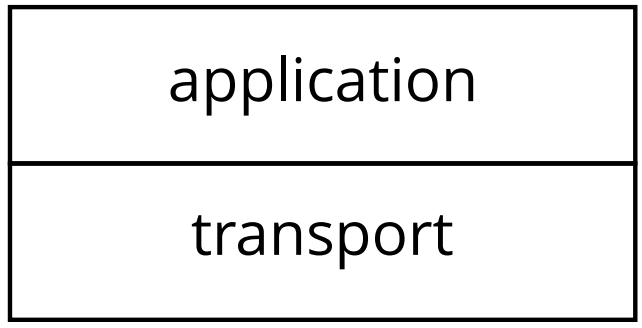

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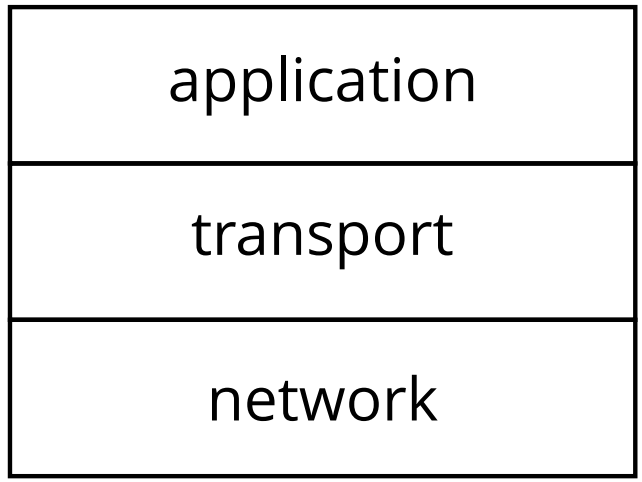

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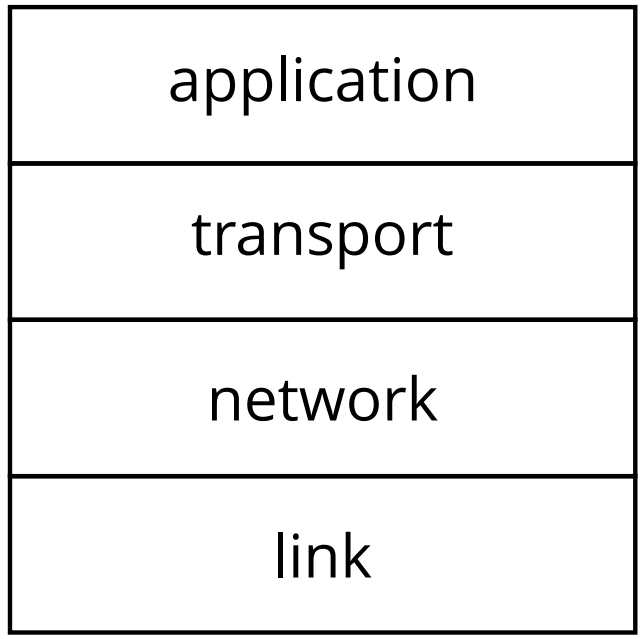

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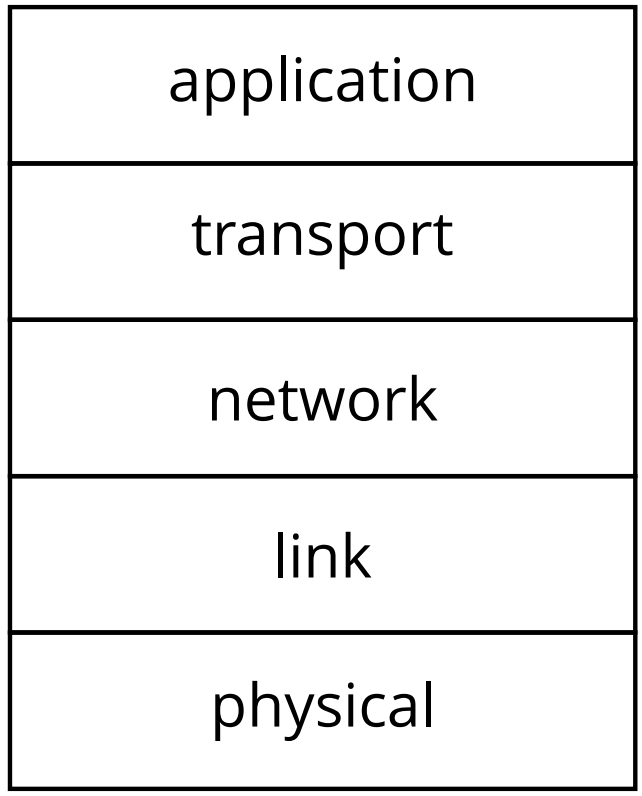

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