System and Network Security

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Protocol Hierarchies

- To reduce design complexity, most networks are organized as a stack of “layers” or “levels”, each one is built upon the one below it.
- The number of layers, the name of the layer, the contents of each layer, and the function of each layer differ from network to network.
- In a sense, each layer is a kind of virtual machine, offering certain services to the layer above it.

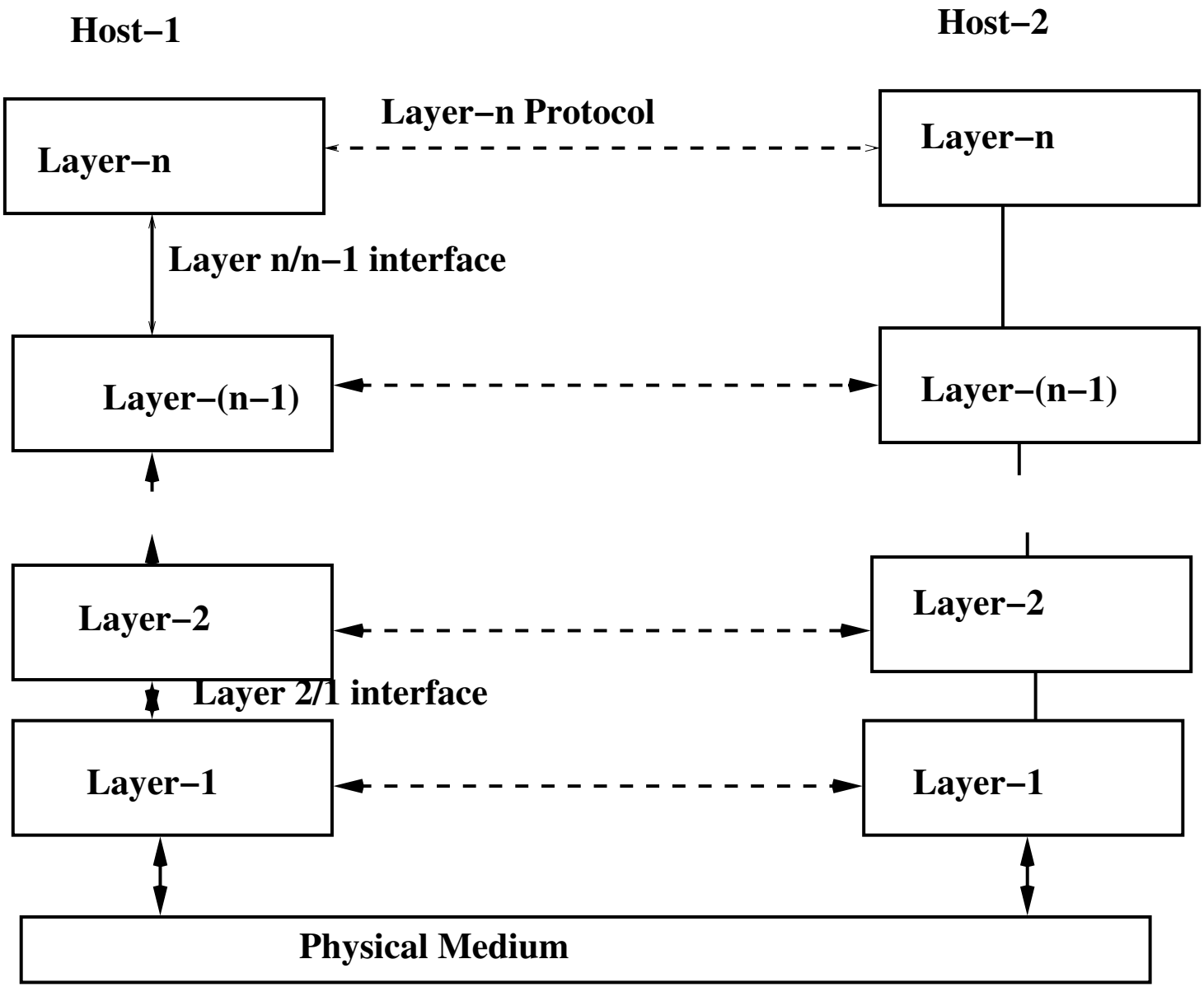
Why layering is needed?

- To provide well-defined interfaces between adjacent layers.
  - A change in one layer does not affect the other layer.
  - Interface must remain the same. [Interface defines which primitive operations and services the lower layer makes available to the upper layer.]
- Allows a structured development of network software.

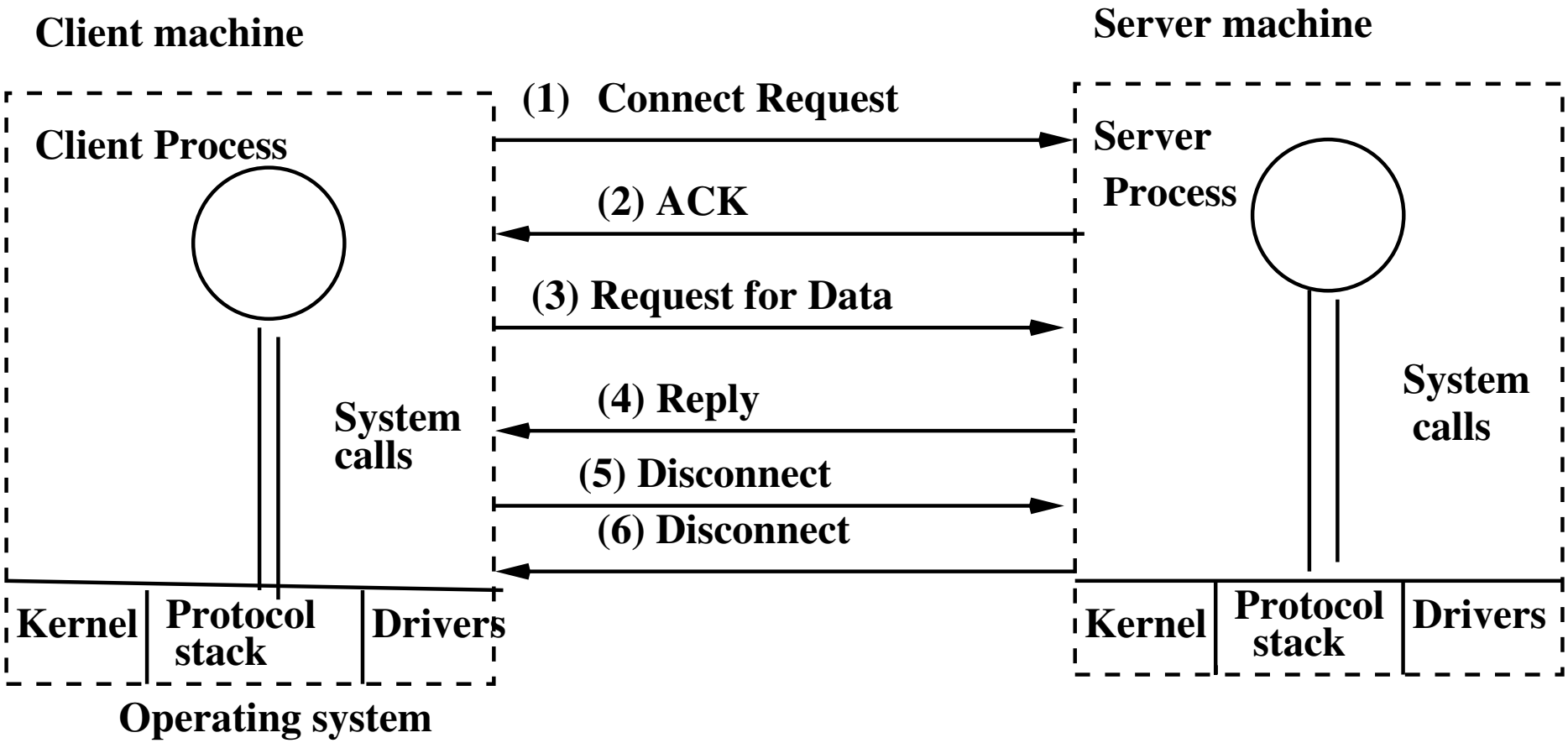
Protocol Hierarchies

- A set of layers and protocols is called a “network architecture”.
- A list of protocols used by a certain system, one protocol per layer, is called a “protocol stack”.

Layered Network Architecture



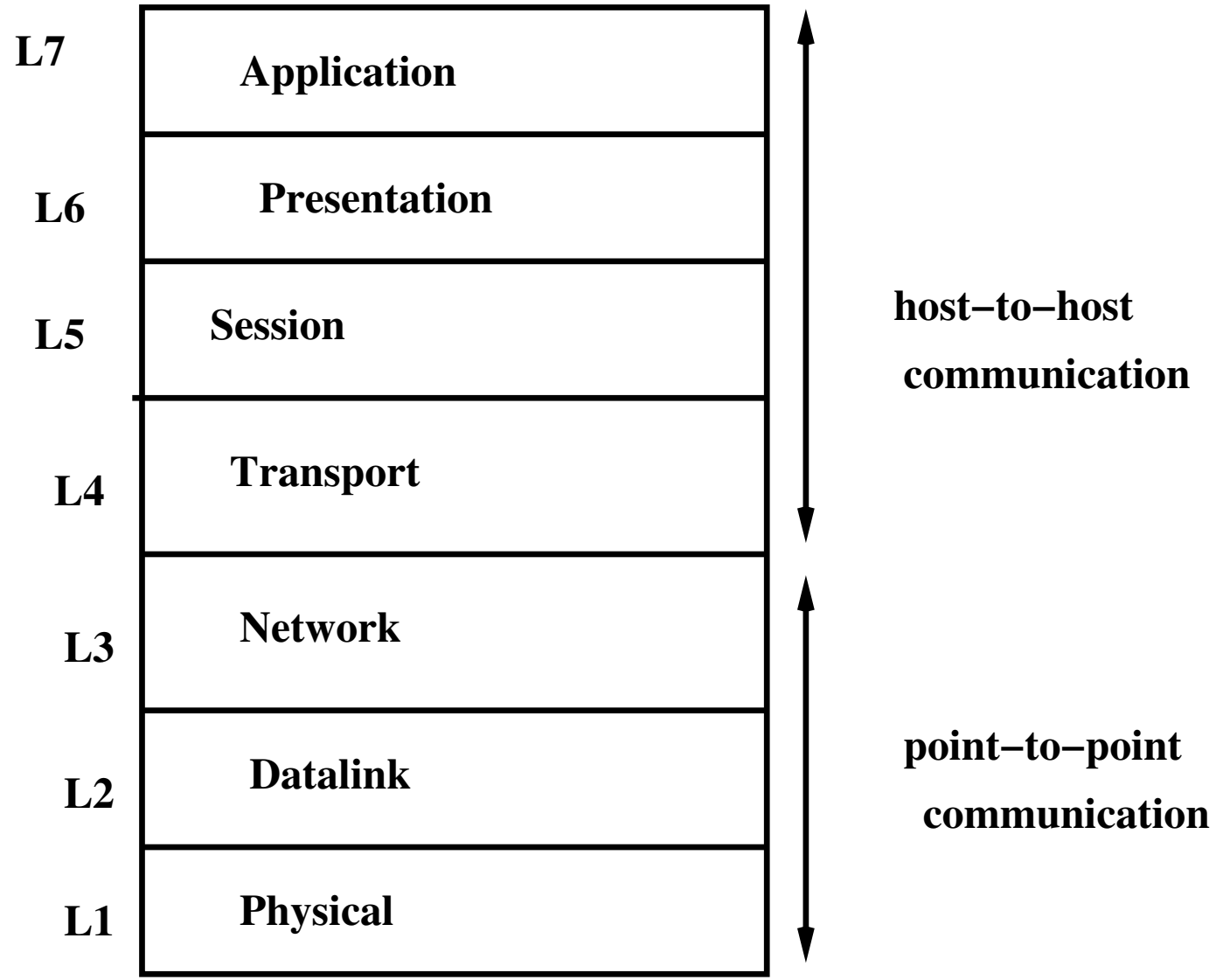
A simple client-server interaction on a connection-oriented network



The OSI Reference Model

- In 1978, International Standards Organization (OSI) proposed a 7-layer reference model for network services and protocols, known as the OSI model.
- The main objective of the OSI model as
  (1) Systematic approach to design.
  (2) Changes in one layer should not require changes in other layers.

The OSI Reference Model



Layer functions

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Physical Layer:

- Transmits raw bit stream over a physical medium.
- The design issues have to do making sure that when one side sends a 1 bit, it is received by the other side as a 1 bit, not a 0 bit.
- The design issues largely deal with mechanical, electrical, and timing interfaces, and the physical transmission medium, which lies below the physical layer.
- Network components: Repeater, Multiplexer, Hubs, Amplifier.

Layer functions

Datalink Layer:

- Reliable transfer of frames (data) over a point-to-point link.
- Responsible for flow control, error control (error detection/correction), congestion control.
- Network components: Bridge, Switch, NIC, Advanced Cable Tester.

Layer functions

Network Layer:

- Establishing, maintaining and terminating connections.
- Routes packets (messages) through point-to-point link.
- Network components: Router, Frame Relay Device, ATM Switch.

Layer functions

Transport Layer:

- End-to-end reliable data transfer, with error recovery and flow control.
- Network components: Gateway.

Layer functions

Session Layer:

- Allows users on different machines (hosts) to establish sessions between them.
- Session offer various services, including
  - Dialog Control: Keeping track of whose turn it is to transmit.
  - Token Management: Preventing two parties from attempting the same critical operation at the same time.
  - Synchronization: Checkpointing long transmissions to allow them to continue from where they were after a crash.
- Network components: Gateway.

Layer functions

Presentation Layer:

- Translates data from application to network format, and vice-versa.
- All different formats from all sources are made into a common uniform format that the rest of the OSI model can understand.
- Network components: Gateway.

Layer functions

Application Layer:

- Interface point for user applications.
- Network components: Gateway.

Layer functions

Data handled in a particular layer: