CS 725/825 & IT 725
Lecture 2
Basic Concepts

August 30, 2023
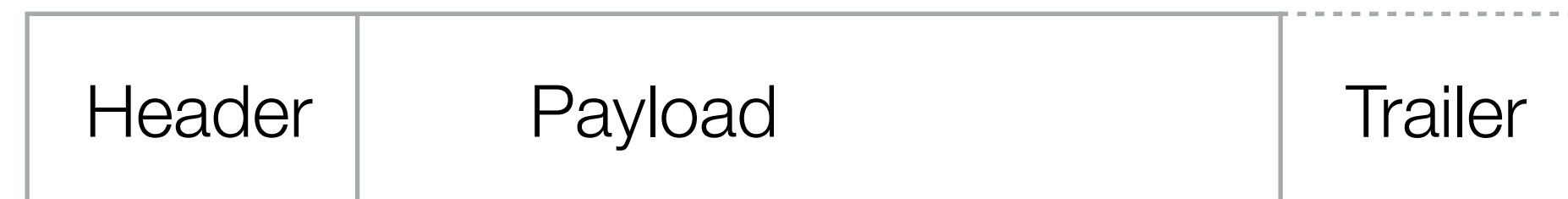
Basic Concepts

Basic Terms

▸ Protocol

– An agreement on how a communication is to proceed

▸ Packet (frame, message, datagram, cell, ….)

– header, data (payload), trailer

Header	Payload	Trailer

▸ ?-cast

– unicast, multicast, broadcast, anycast, …

▸ Single hop vs. multihop
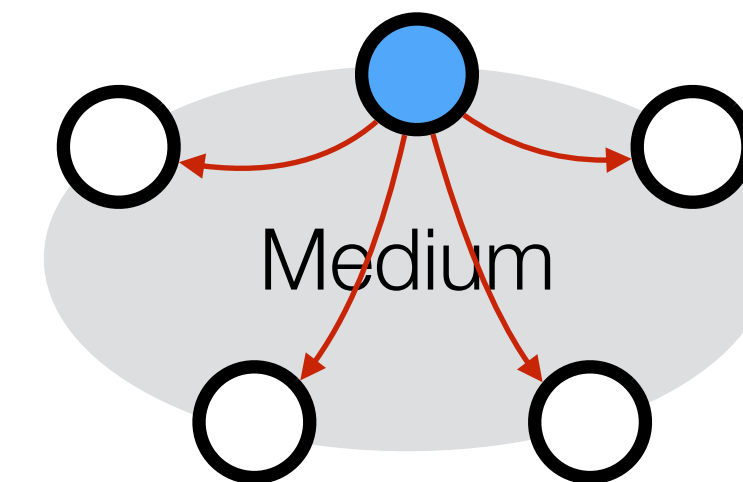
Communication medium types

▸ **Point to point**

– between two participants

– simplex, duplex, full duplex

– no need for addressing

Medium

▸ **Broadcast and select**

– multiple nodes attached to a shared medium

– everyone hears every transmissions (*broadcast*)

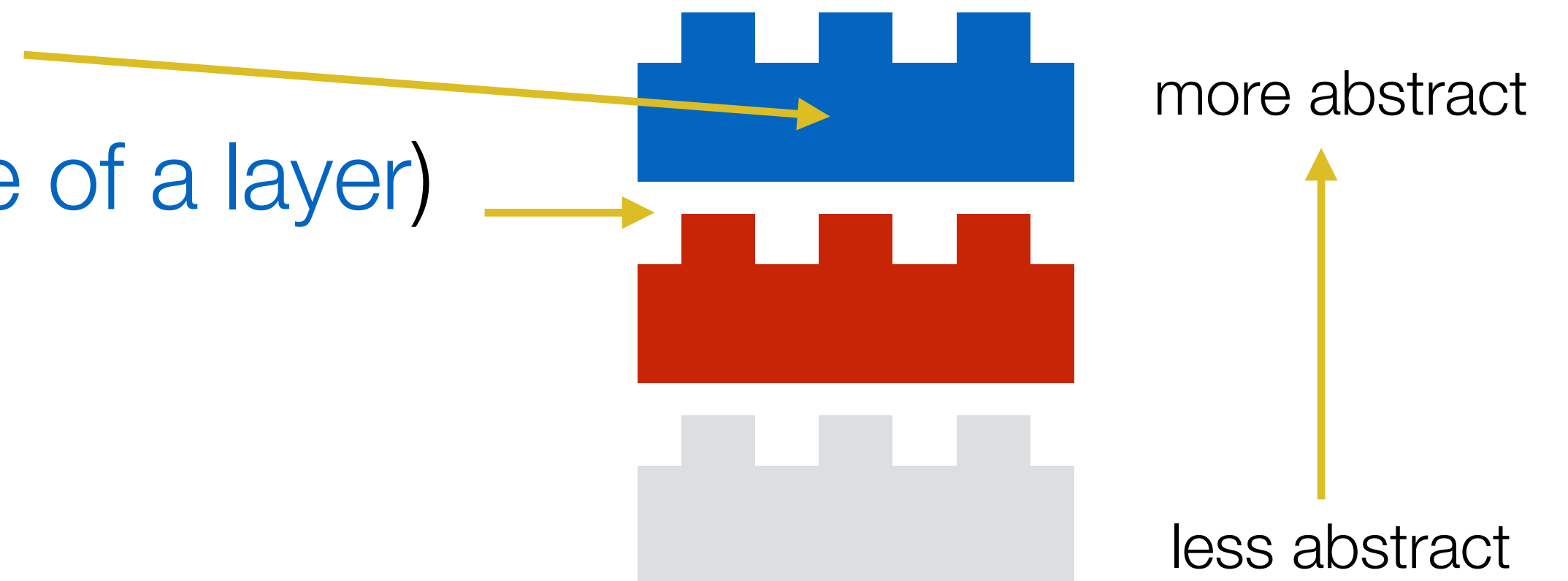– addresses needed to *select* transmission intended for a node
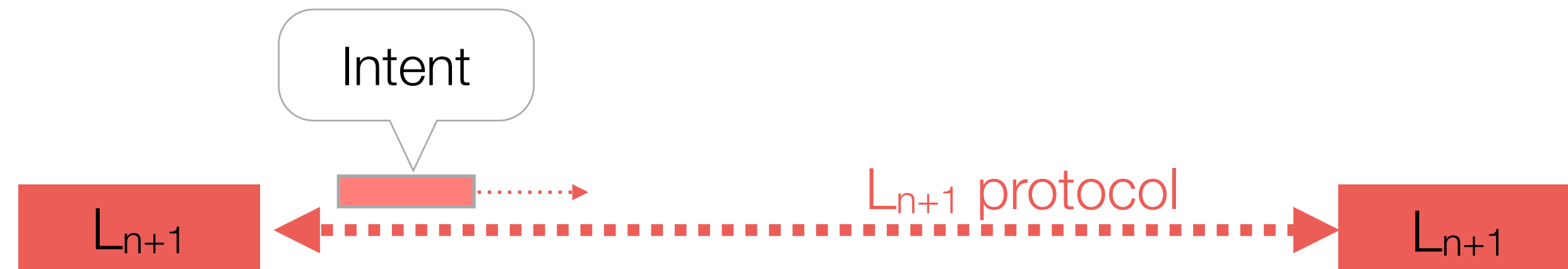
Medium

Layered models

▸ Motivation

– networks require many different types of expertise
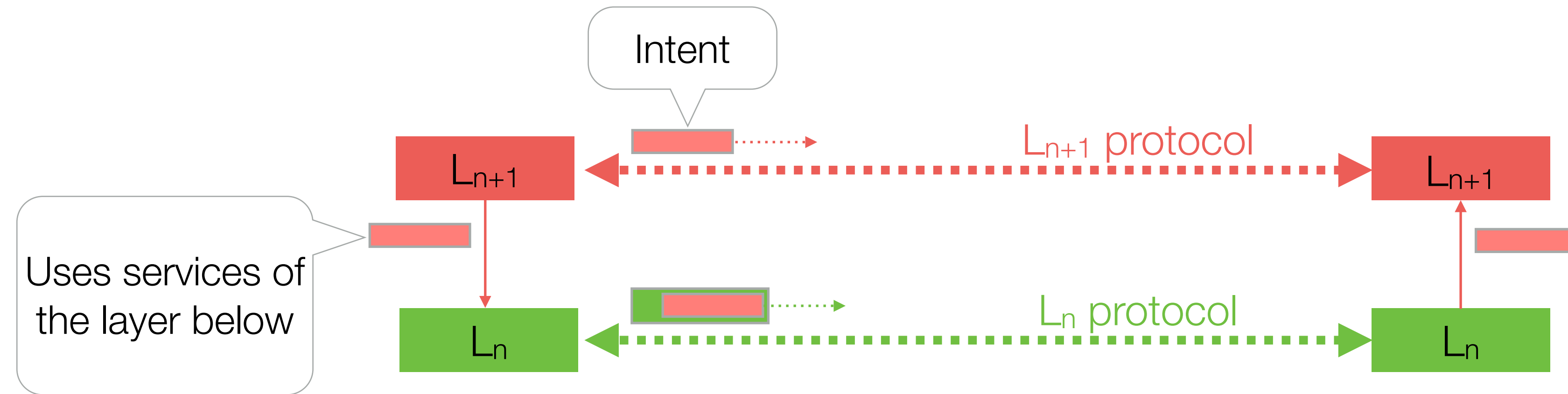
– need to mix-and-match

▸ Characteristics

– black box functionality (abstraction)

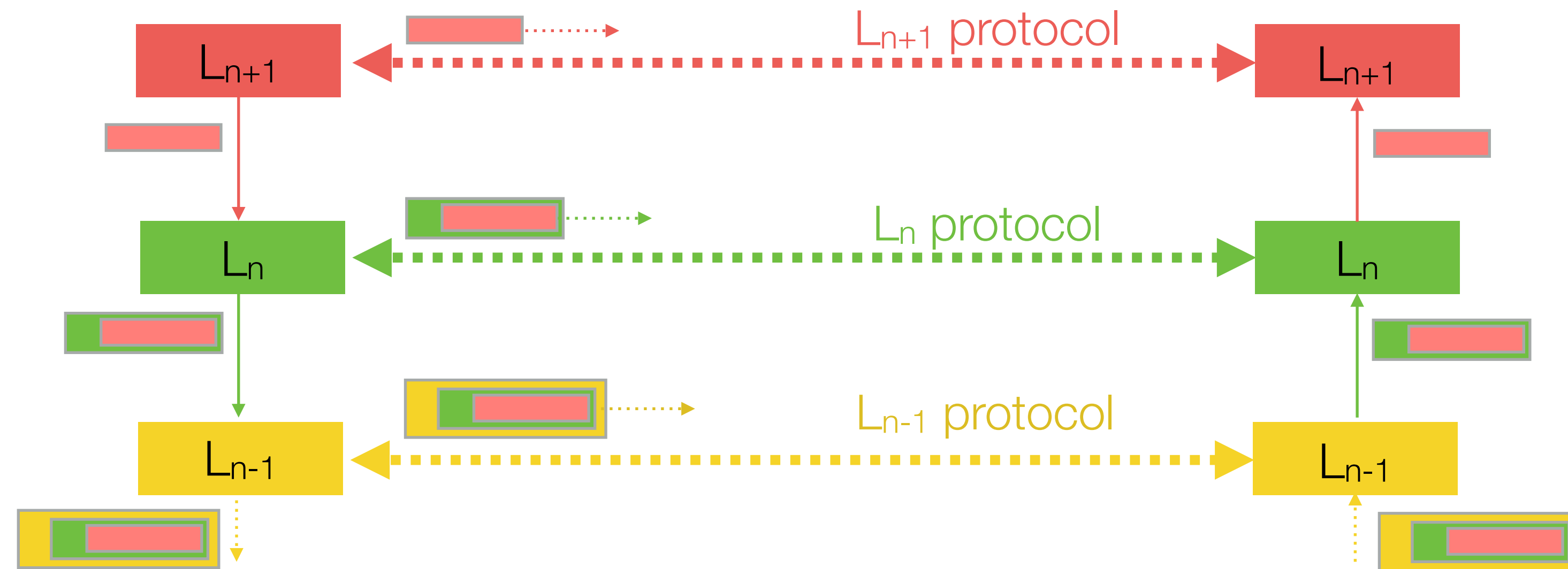– simple, well defined interfaces (service of a layer)

– vertically stacked

more abstract

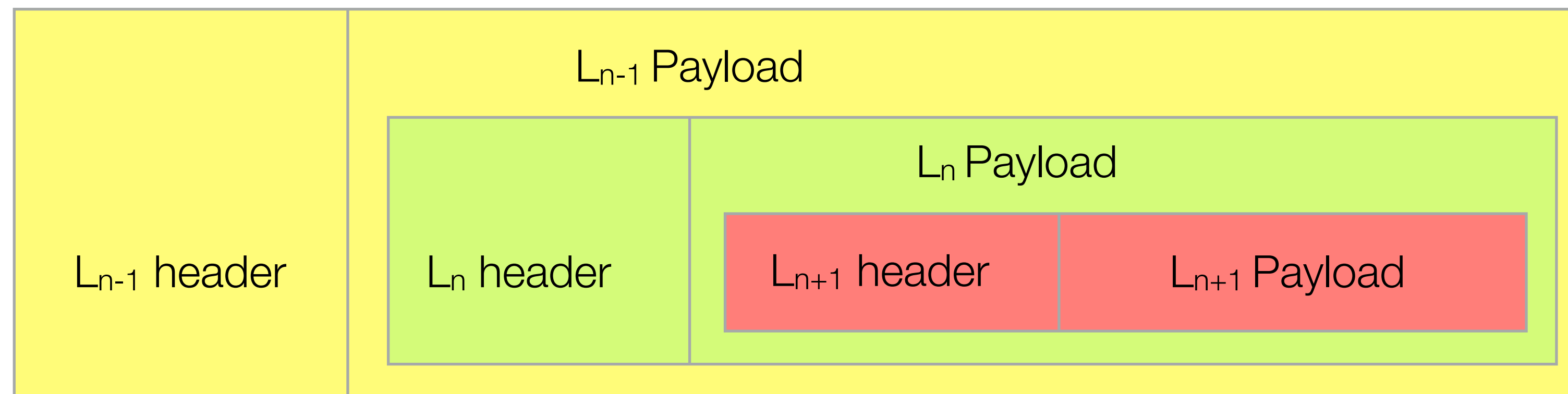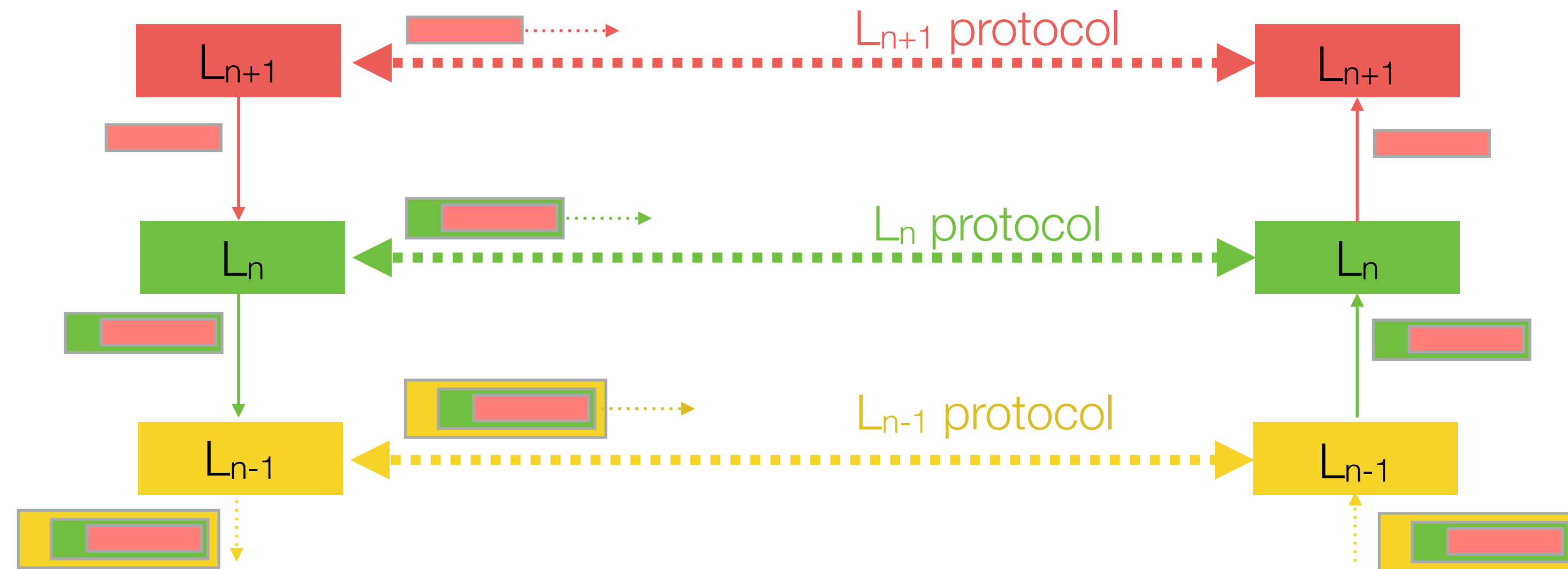less abstract

Protocol hierarchy

Protocol hierarchy

Protocol hierarchy

Protocol hierarchy

Protocol hierarchy

▸ Conceptual view

L_{n-1} header	L_{n-1} Payload			
	L_n header	L_n Payload		
			L_{n+1} header	L_{n+1} Payload

▸ Real protocol example

Ethernet header	IP header	TCP header	TCP Payload (e.g., HTTP)

IP payload

Ethernet payload
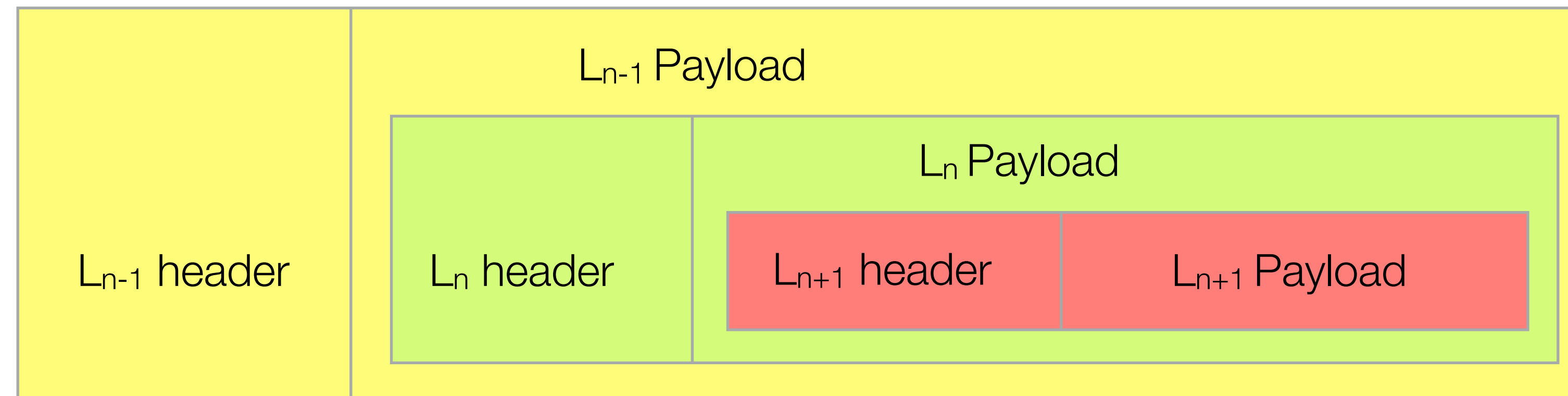
Protocol hierarchy
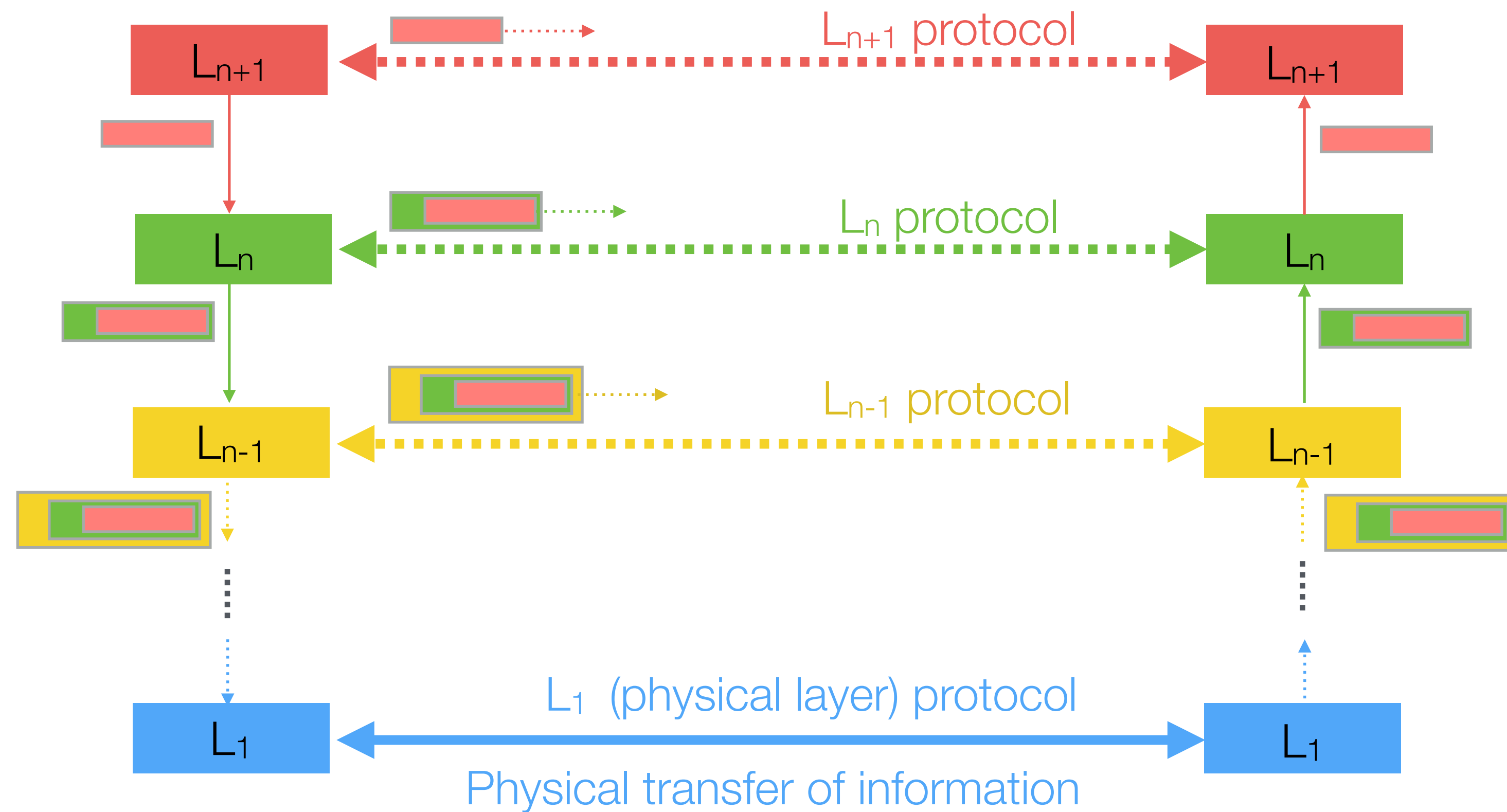
Multiple layer implementations

▸ Multiple lower layers

  – Example: wired and wireless Ethernet

L(n)
L(n-1)	L(n-1)
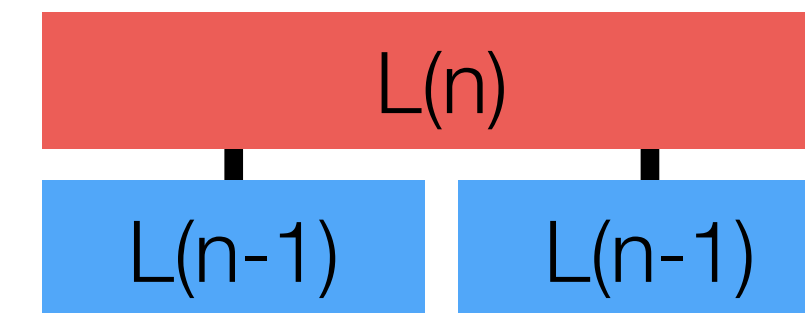
▸ Multiple higher layers

  – Example: email and web

L(n+1)	L(n+1)
L(n)
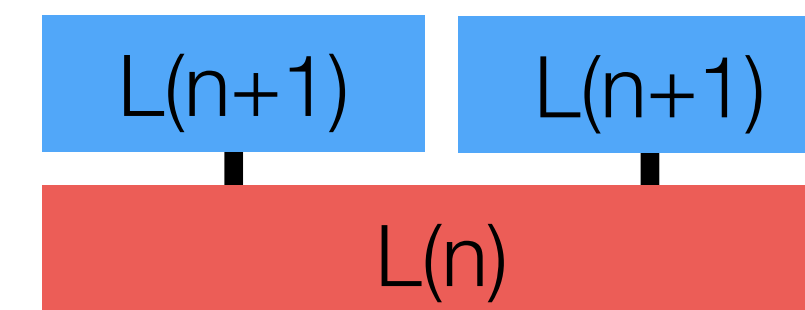
OSI 7-Layer Model

▸ L7 - Application

▸ L6 - Presentation - data representation

▸ L5 - Session - open/close/maintain session

▸ L4 - Transport - end-to-end error and flow control

▸ L3 - Network - end-to-end delivery (routing)

▸ L2 - Link - node-to-node delivery (single hop)

▸ L1 - Physical - send bits over a physical channel

"Internet" layers today

▶ L7 - Application

▶ L6 - Presentation

▶ L5 - Session

▶ L4 - Transport

▶ L3 - Network

▶ L2 - Link

▶ L1 - Physical

▶ L7 - Application

▶ L4 - Transport

▶ L3 - Network

▶ L1 & L2 - Link & Physical

"Internet" layers today

▶ L7 - Application

▶ L6 - Presentation

▶ L5 - Session

▶ L4 - Transport

▶ L3 - Network

▶ L2 - Link

▶ L1 - Physical

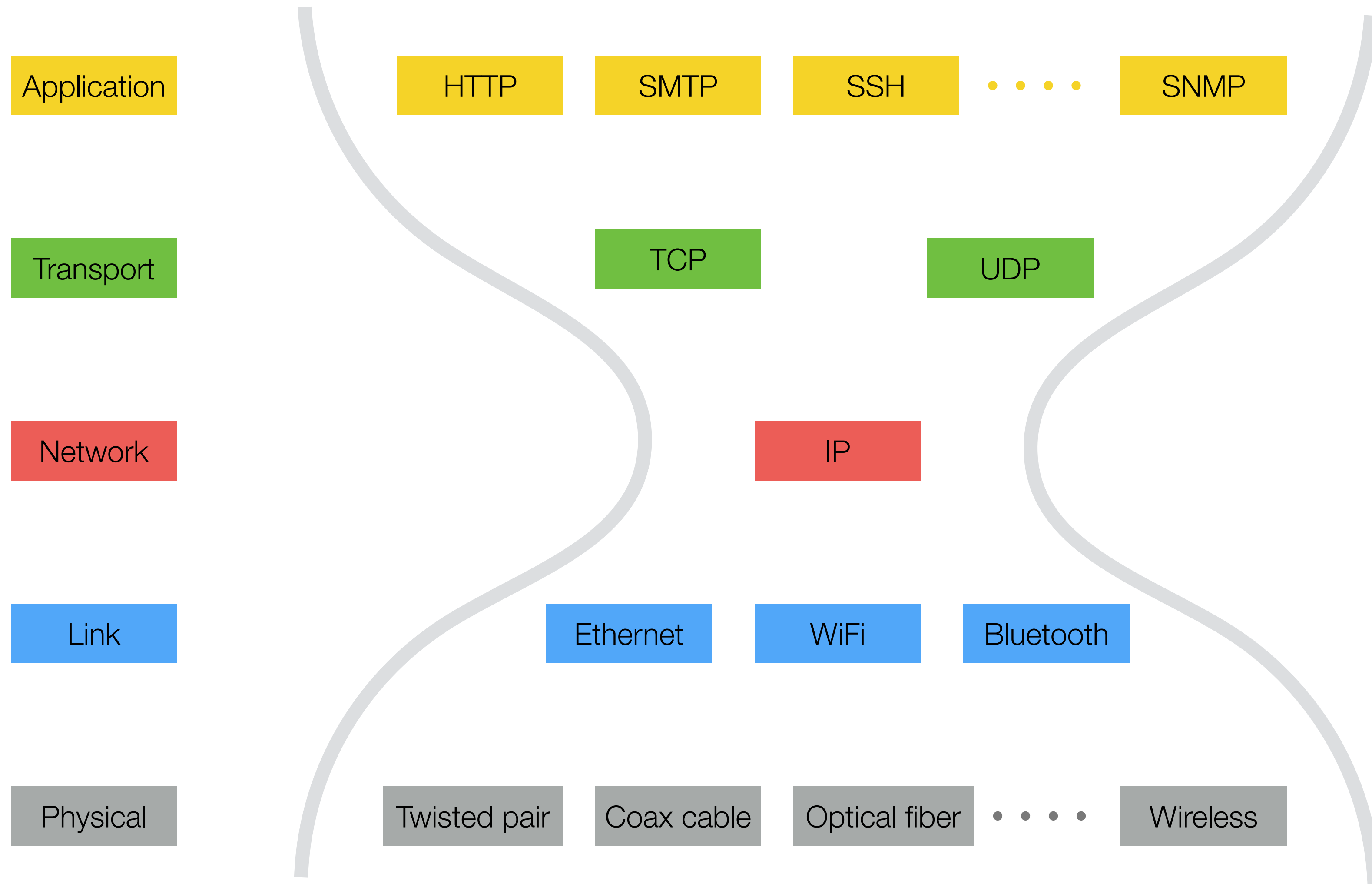▶ L7 - Application

"security layer"

▶ L4 - Transport

▶ L3 - Network

▶ L1 & L2 - Link & Physical

Internet protocol examples

▸ **Application** layer

– HTTP/HTTPS, SMTP (email), streaming, messaging, etc.

▸ **Security** layer: TLS (a.k.a. SSL)

▸ **Transport** layer

– TCP, UDP

▸ **Network** layer

– IPv4, IPv6

▸ **Link & Physical** layer

– Wired Ethernet, WiFi, etc.

Internet "Hourglass"

| Application | HTTP | SMTP | SSH | ⋯ | SNMP |

| Transport | TCP | UDP |

| Network | IP |

| Link | Ethernet | WiFi | Bluetooth |

| Physical | Twisted pair | Coax cable | Optical fiber | ⋯ | Wireless |

Protocols going forward

▸ HTTP/3 (formerly known as QUIC)

- – Enhanced HTTP over TLS 1.3 over UDP over IP …

- – Developed by Google and widely deployed in their services

- – Design goal: reduction of transaction latency

- – Implemented in the user space (application)