Dr SABER Takfarinas
takfarinas.saber@dcu.ie

CA169
Networks & Internet

Reference Models

Reference Models

- We will discuss two important network architectures:
  - the OSI reference model and
  - the TCP/IP reference model

- Although the *protocols* associated with the OSI model are not used any more, the *model* itself is actually quite general and still valid

- The TCP/IP model has the opposite properties: the model itself is not of much use but the protocols are widely used.

The OSI Reference Model

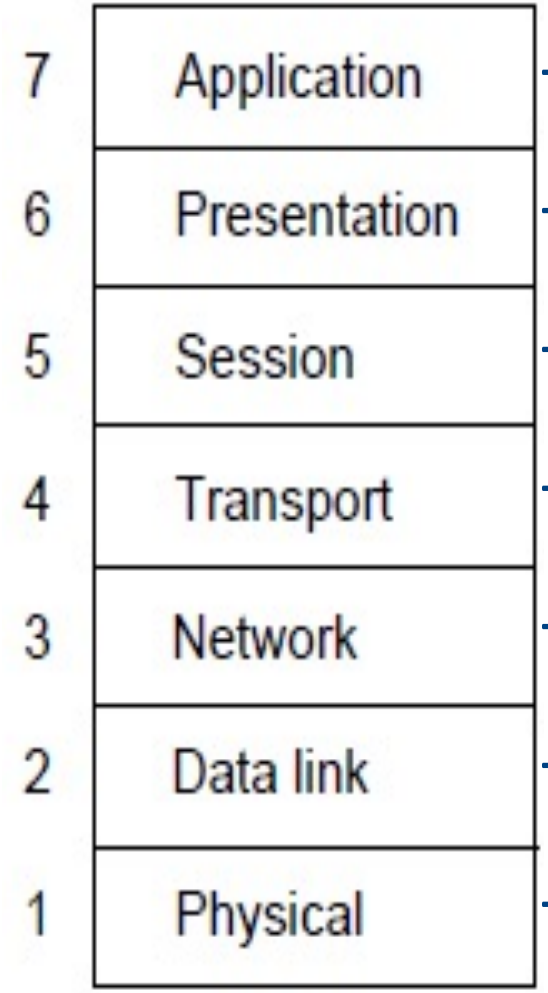
- This model is based on a proposal developed by the International Standards Organization (ISO) as a first step toward international standardization of the protocols used in the various layers

- The model is called the ISO **OSI** (**Open Systems Interconnection**) Reference Model but we will just call it the **OSI model** for short.

OSI Model

- The OSI model has seven layers. The principles that were applied to arrive at the seven layers can be briefly summarized as follows:
  - A layer should be created where a different abstraction is needed.
  - Each layer should perform a well-defined function.
  - The function of each layer should be chosen with an eye toward defining internationally standardized protocols.
  - The layer boundaries should be chosen to minimize the information flow across the interfaces.
  - The number of layers should be large enough that distinct functions need not be thrown together in the same layer out of necessity and small enough that the architecture does not become unwieldy.

OSI Model



– Provides functions needed by users

– Converts different representations

– Manages task dialogs

– Provides end-to-end delivery

– Sends packets over multiple links

– Sends frames of information

– Sends bits as signals

The Physical Layer

- The **physical layer** is concerned with transmitting raw bits over a communication channel
- The design issues have to do with making sure that when one side sends a 1 bit it is received by the other side as a 1 bit, not as a 0 bit
- Typical questions here are what electrical signals should be used to represent a 1 and a 0 or how many nanoseconds a single bit lasts

DCU
Ollscoil Chathair
Bhaile Átha Cliath
Dublin City University

The Data Link Layer

- The main task of the **data link layer** is to transform a raw transmission facility into a line that appears free of undetected transmission errors
- It does so by **hiding** the real errors so the network layer does not see them
- This is done by having the sender break up the input data into **data frames** (typically a few hundred or a few thousand bytes) and transmit the frames sequentially
- If the service is reliable, the receiver confirms correct receipt of each frame by sending back an **acknowledgement frame**

The Network Layer

- The **network layer** controls the operation of the network
- A key design issue is determining how packets are **routed** from source to destination.
  - Routes can be based on static tables that are ‘‘wired into’’ the network and rarely changed, or more often they can be updated automatically to avoid failed components
- If too many packets are present in the network at the same time, they will get in one another’s way, forming **bottlenecks**.
  - Handling **congestion** is also a responsibility of the network layer

DCU
Ollscoil Chathair
Bhaile Átha Cliath
Dublin City University

The Transport Layer

- The basic function of the **transport layer** is to accept data from above it, split it up into smaller units if need be, pass these to the network layer, and ensure that the pieces all arrive correctly at the other end

- The transport layer is a true end-to-end layer; it carries data all the way from the source to the destination

- In the lower layers, each protocols is between a machine and its immediate neighbors, and not between the ultimate source and destination machines

The Session Layer

- The session layer allows users on different machines to establish **sessions** between them

- Sessions offer various services, including **dialog control**, **token management** and **synchronization**
  - **Dialog control** means keeping track of whose turn it is to transmit
  - **Token management** means preventing two parties from attempting the same critical operation at the same time
  - **Synchronization** means checkpointing long transmissions to allow them to pick up from where they left off in the event of a crash and subsequent recovery

The Presentation Layer

- The **presentation layer** is concerned with the syntax and semantics of the information transmitted

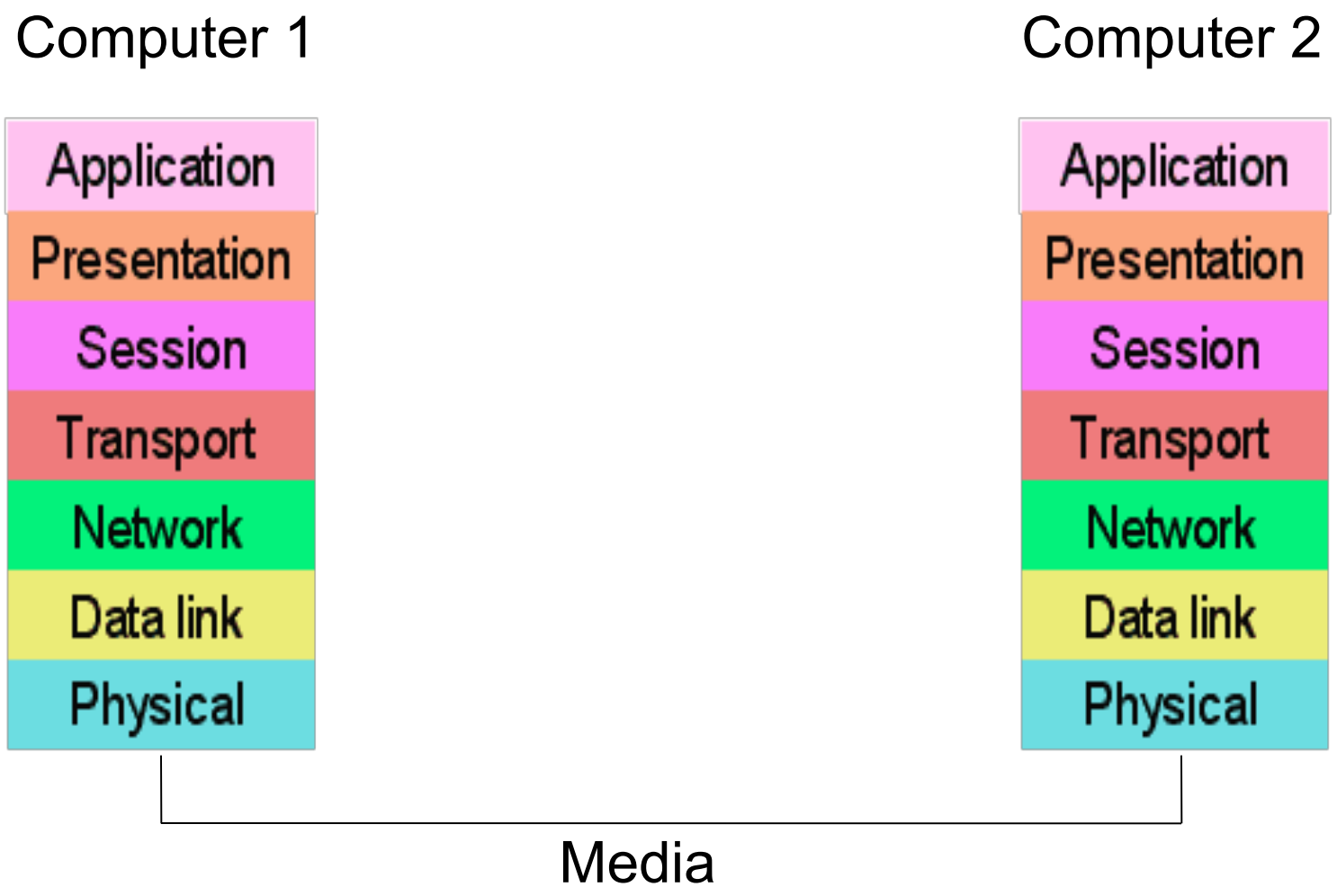
- In order to make it possible for computers with different internal data representations to communicate, the data structures to be exchanged can be defined in an abstract way, along with a standard encoding to be used

- The presentation layer manages these abstract data structures and allows higher-level data structures (e.g., banking records) to be defined and exchanged.

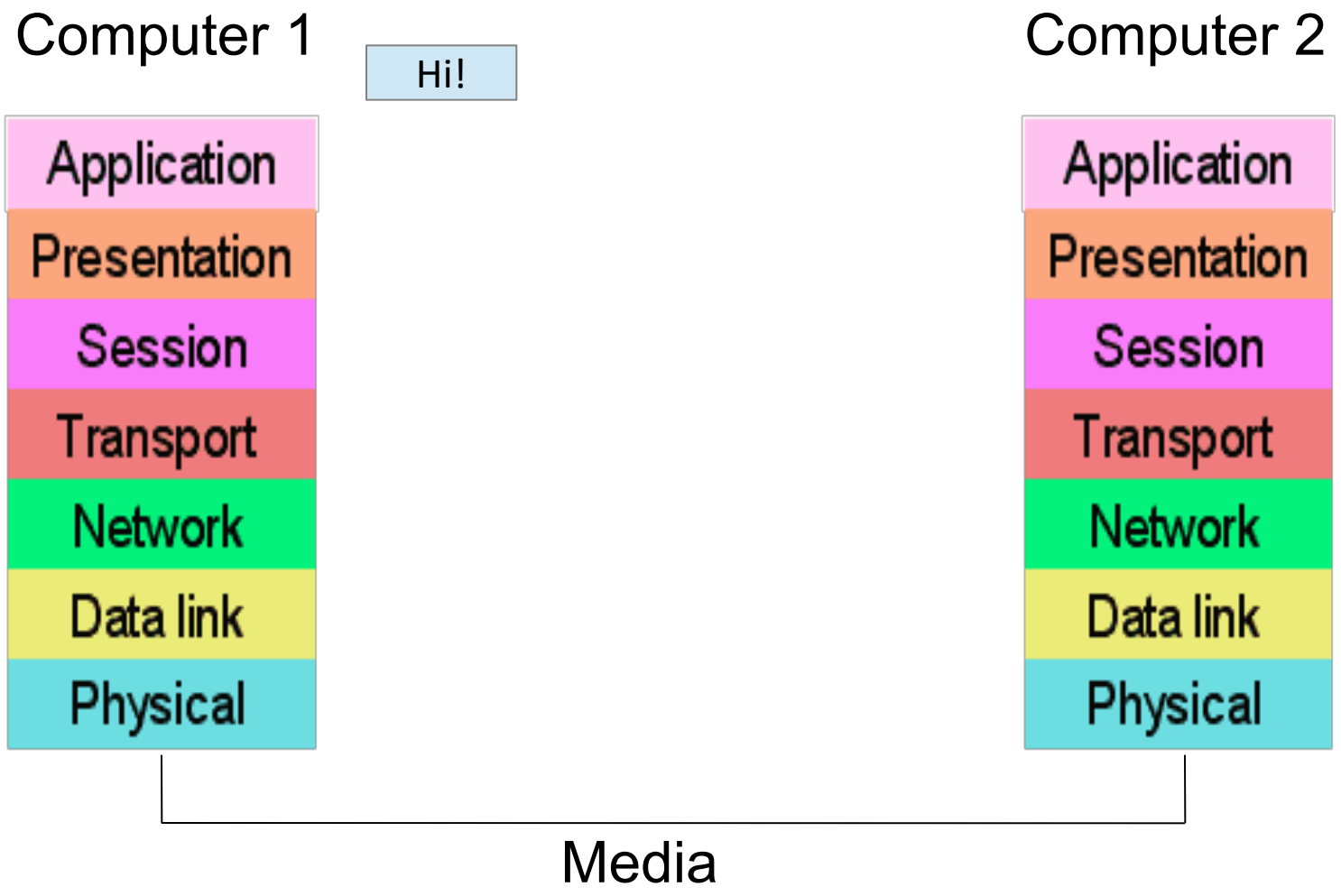
The Application Layer

- The **application layer** contains a variety of protocols that are commonly needed by users
- One widely used application protocol is **HTTP** (**HyperText Transfer Protocol**), which is the basis for the World Wide Web
- When a browser wants a Web page, it sends the name of the page it wants to the server hosting the page using HTTP

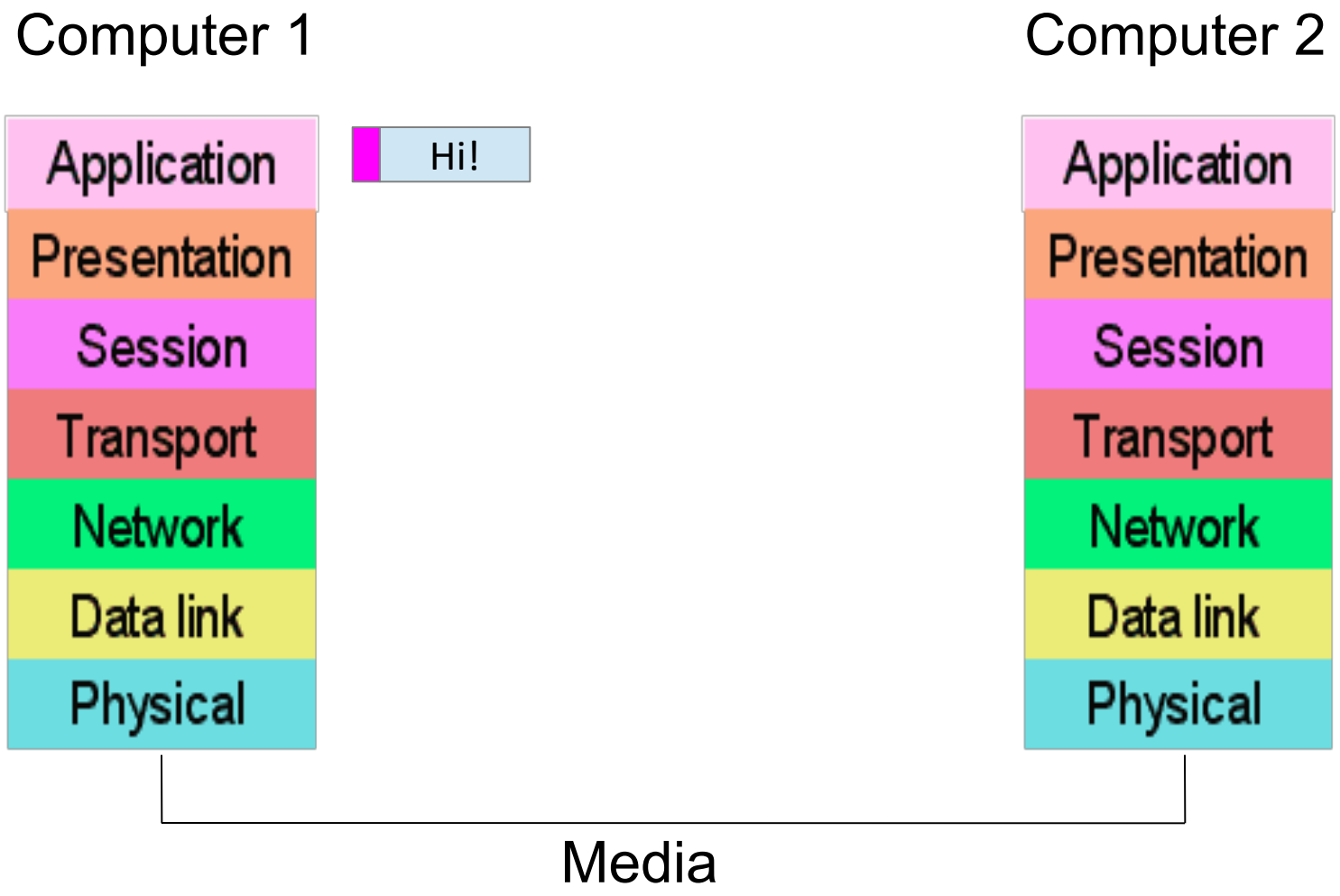
The OSI Reference Model



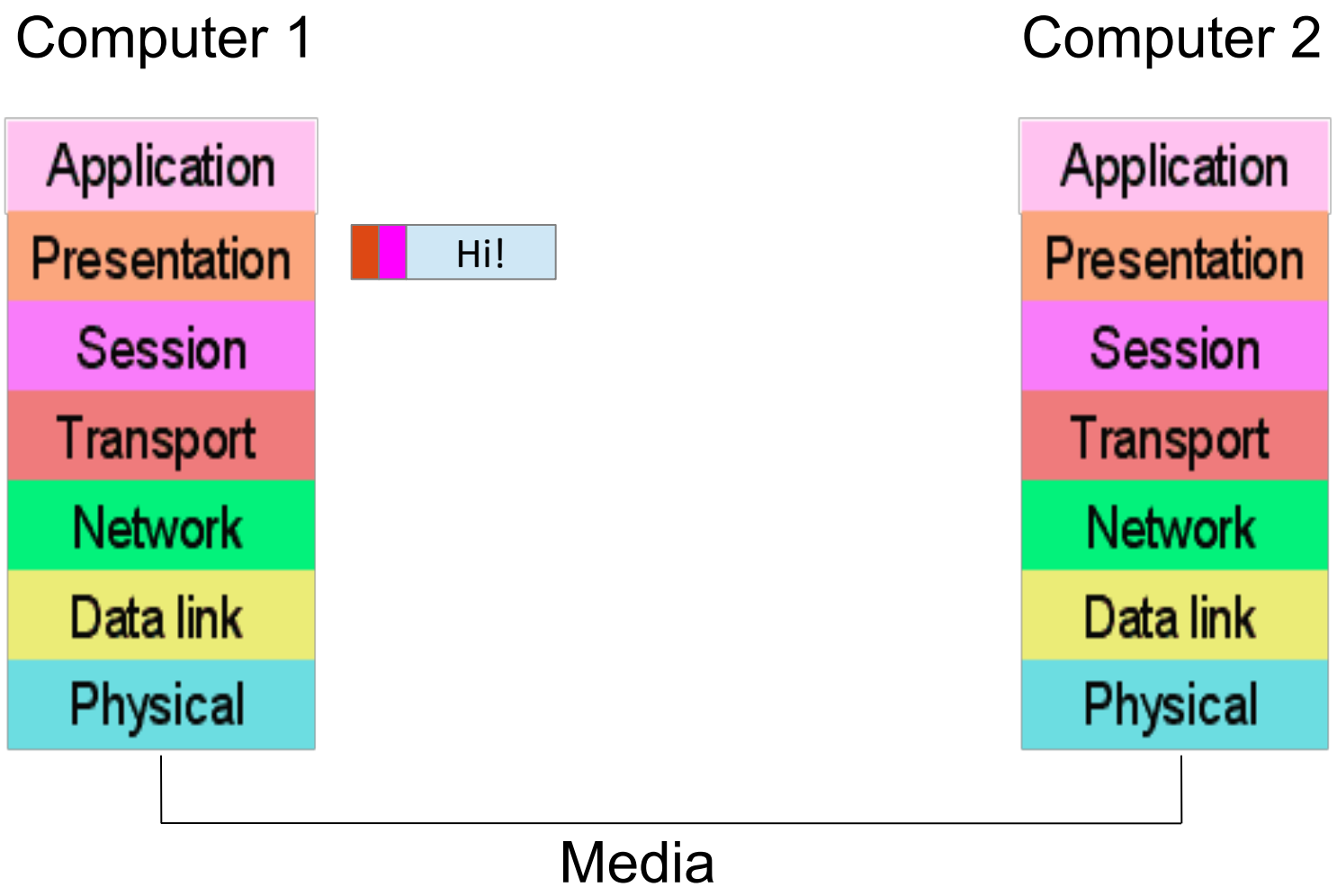
The OSI Reference Model



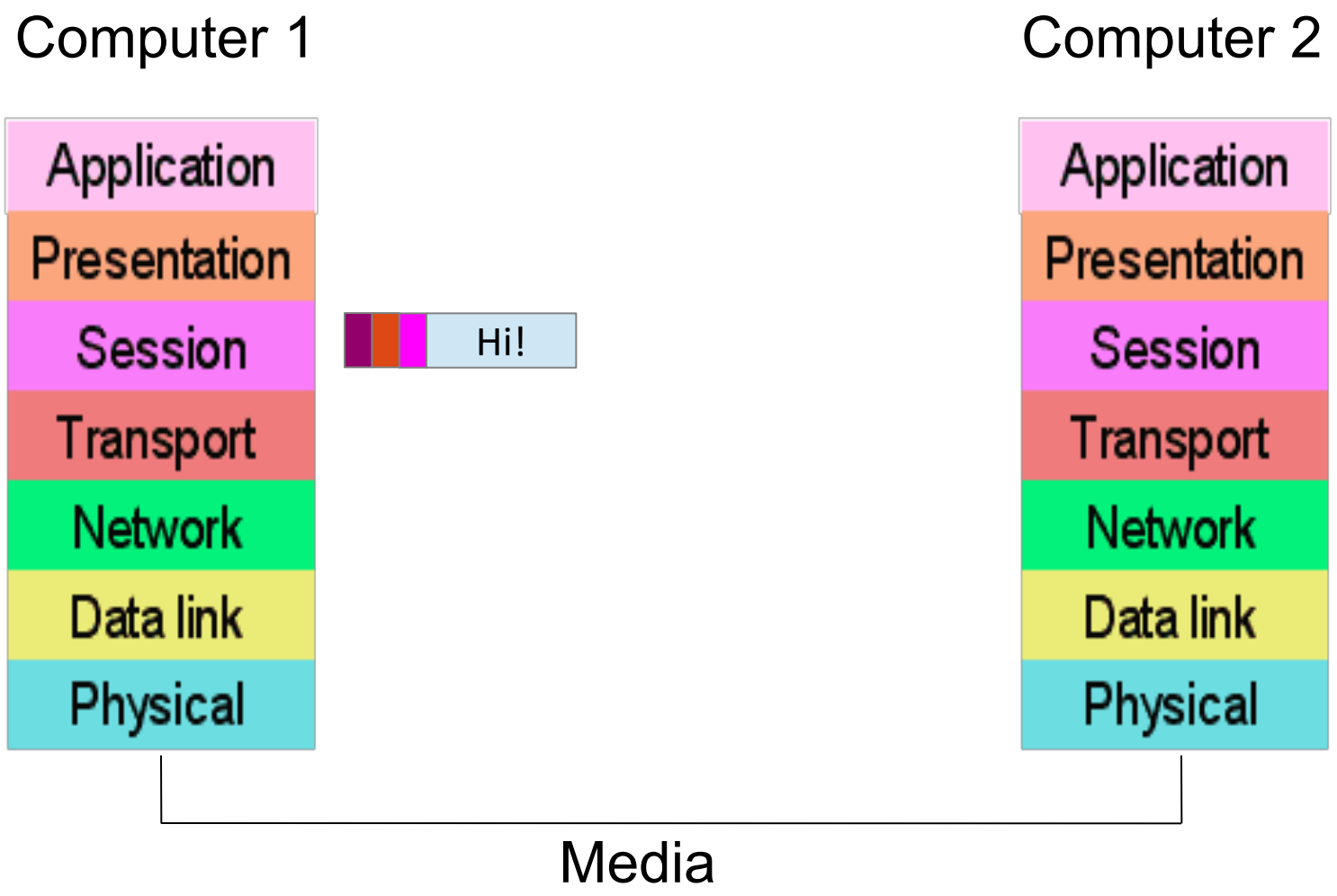
The OSI Reference Model



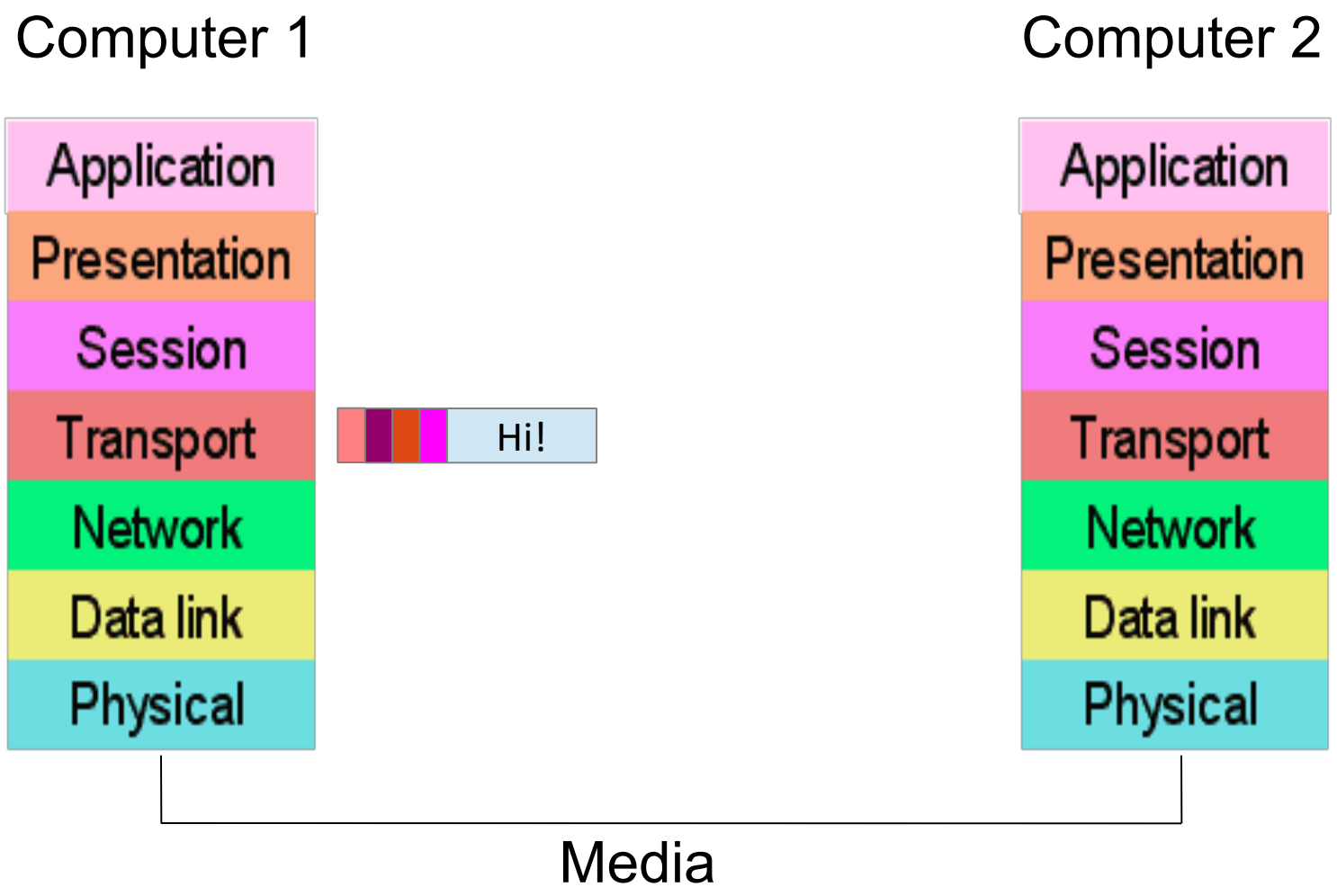
The OSI Reference Model



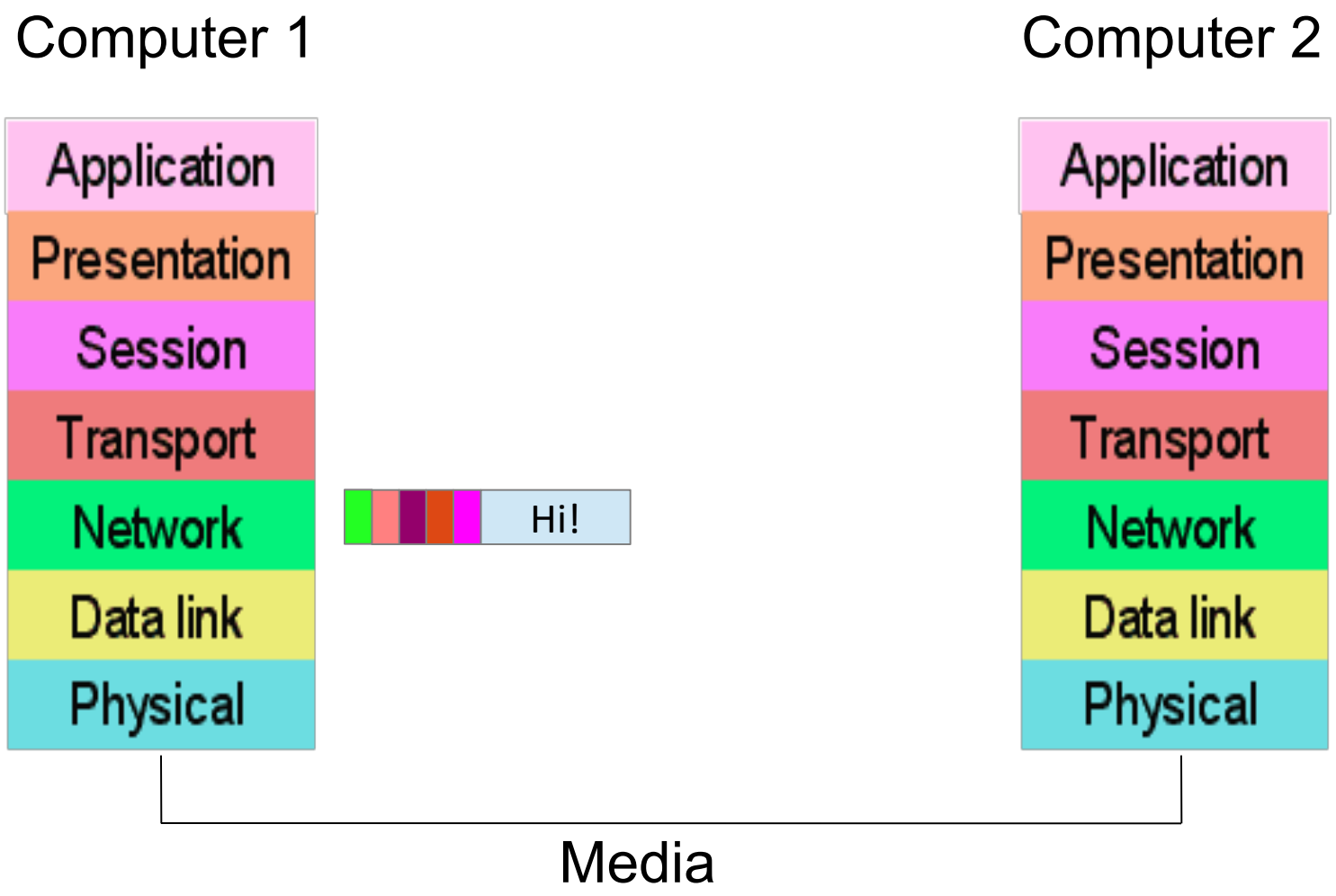
The OSI Reference Model



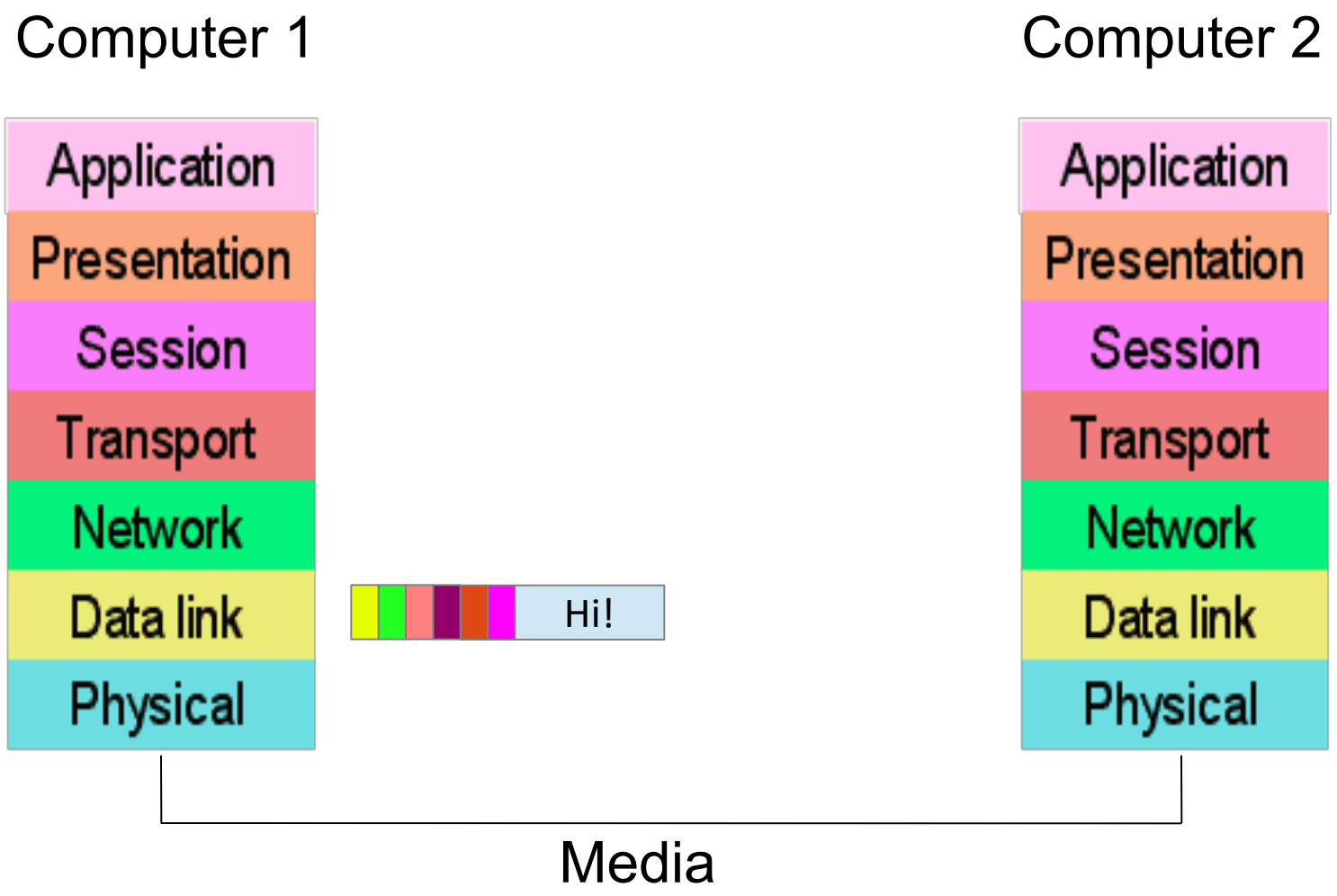
The OSI Reference Model



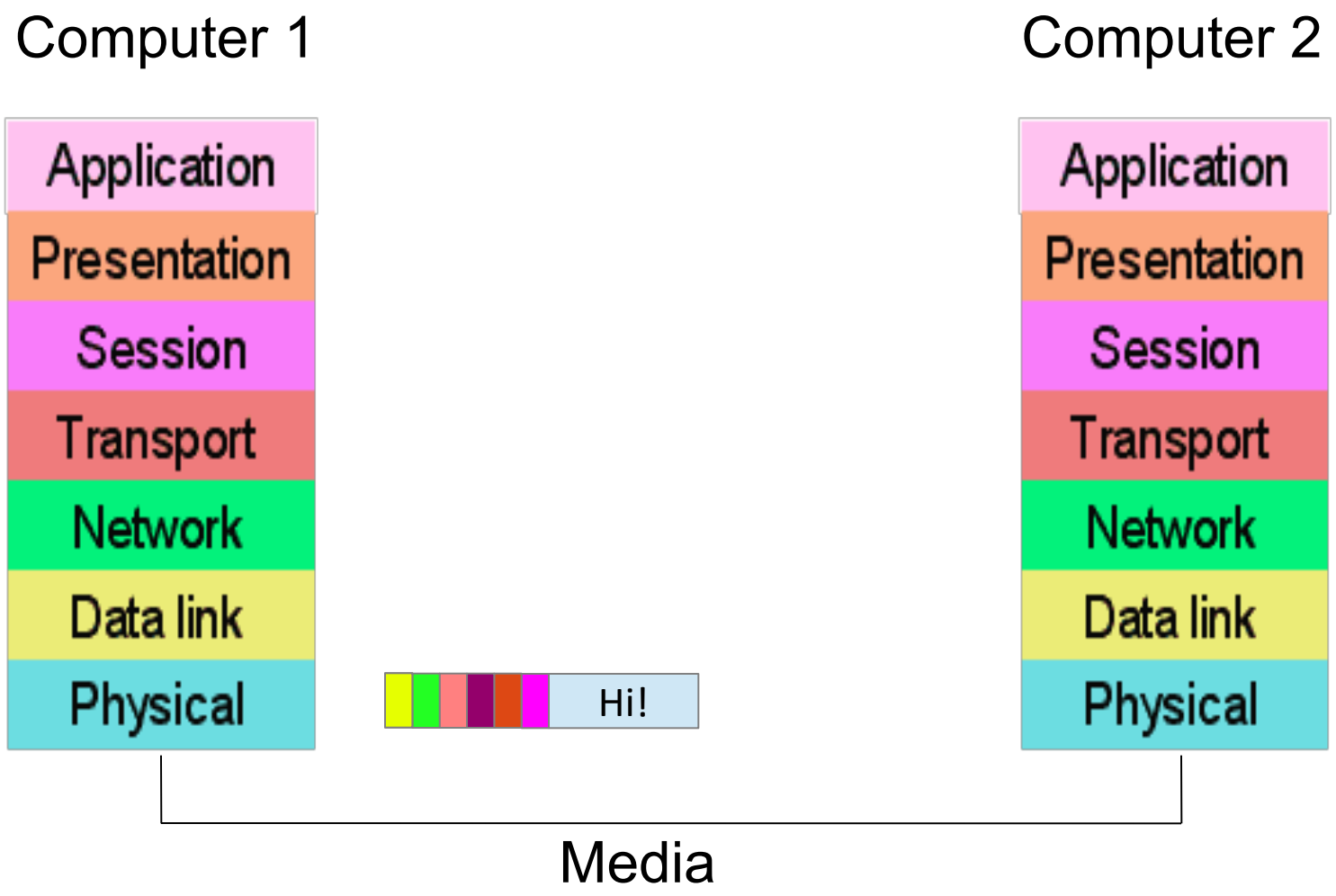
The OSI Reference Model



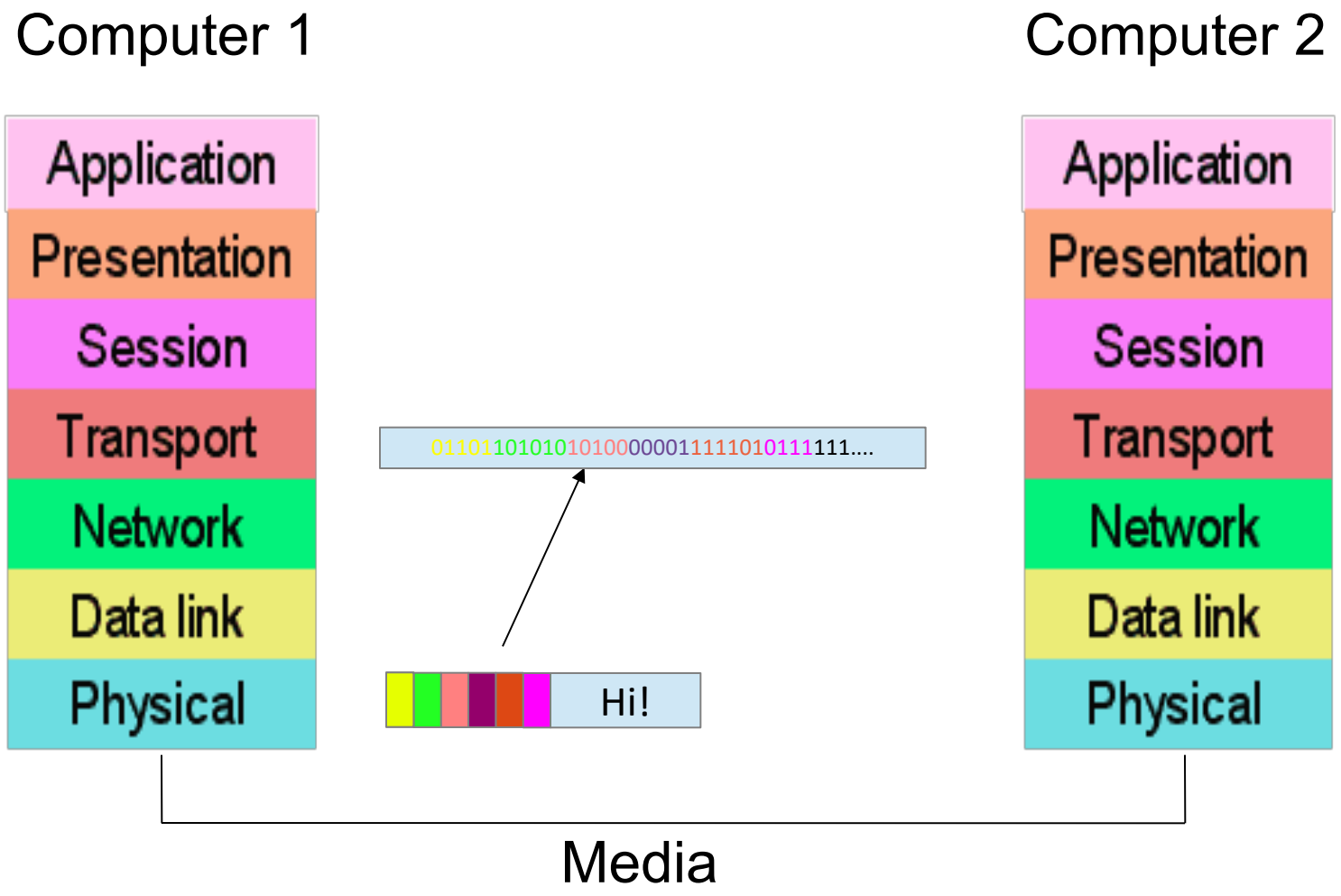
The OSI Reference Model



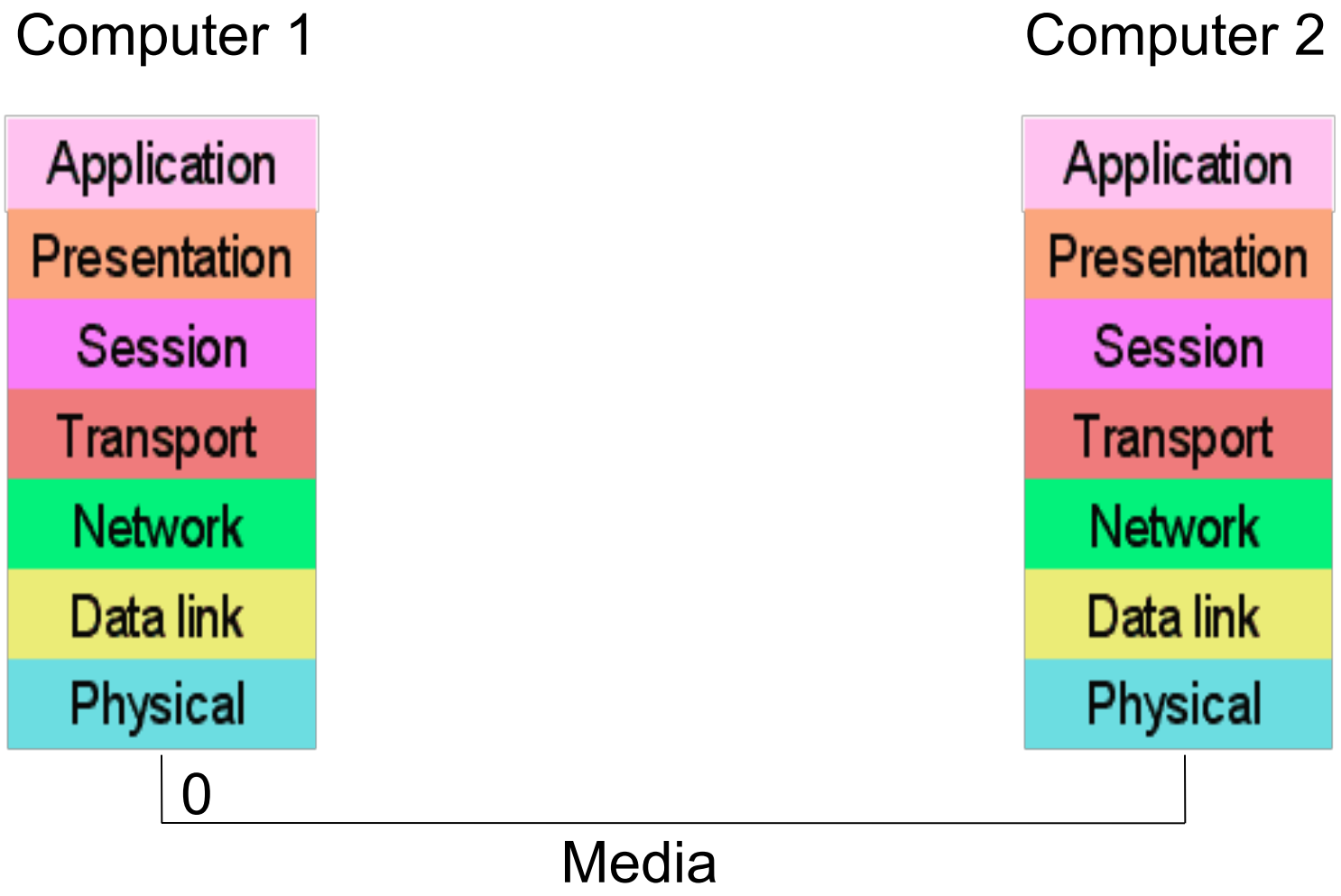
The OSI Reference Model



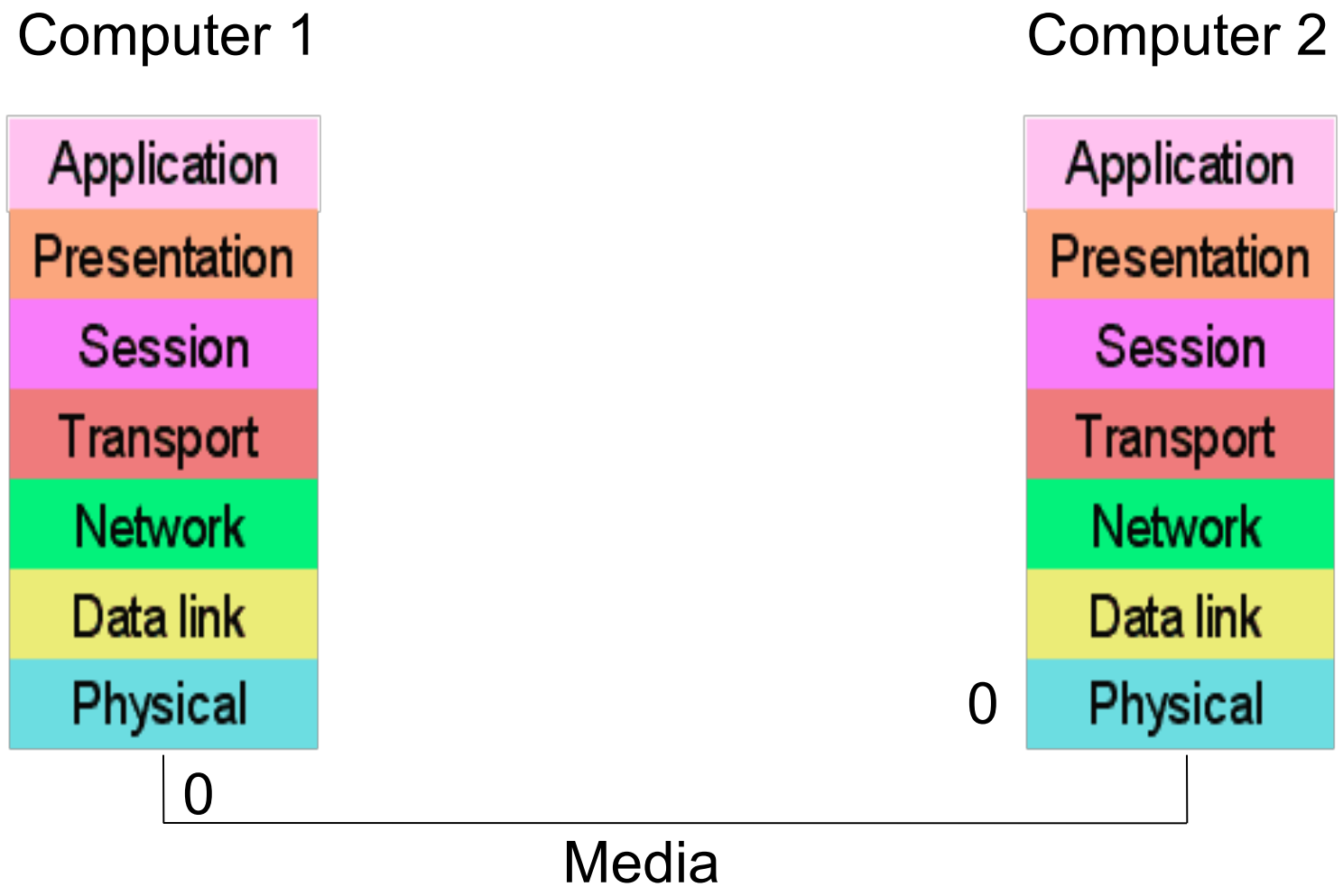
The OSI Reference Model



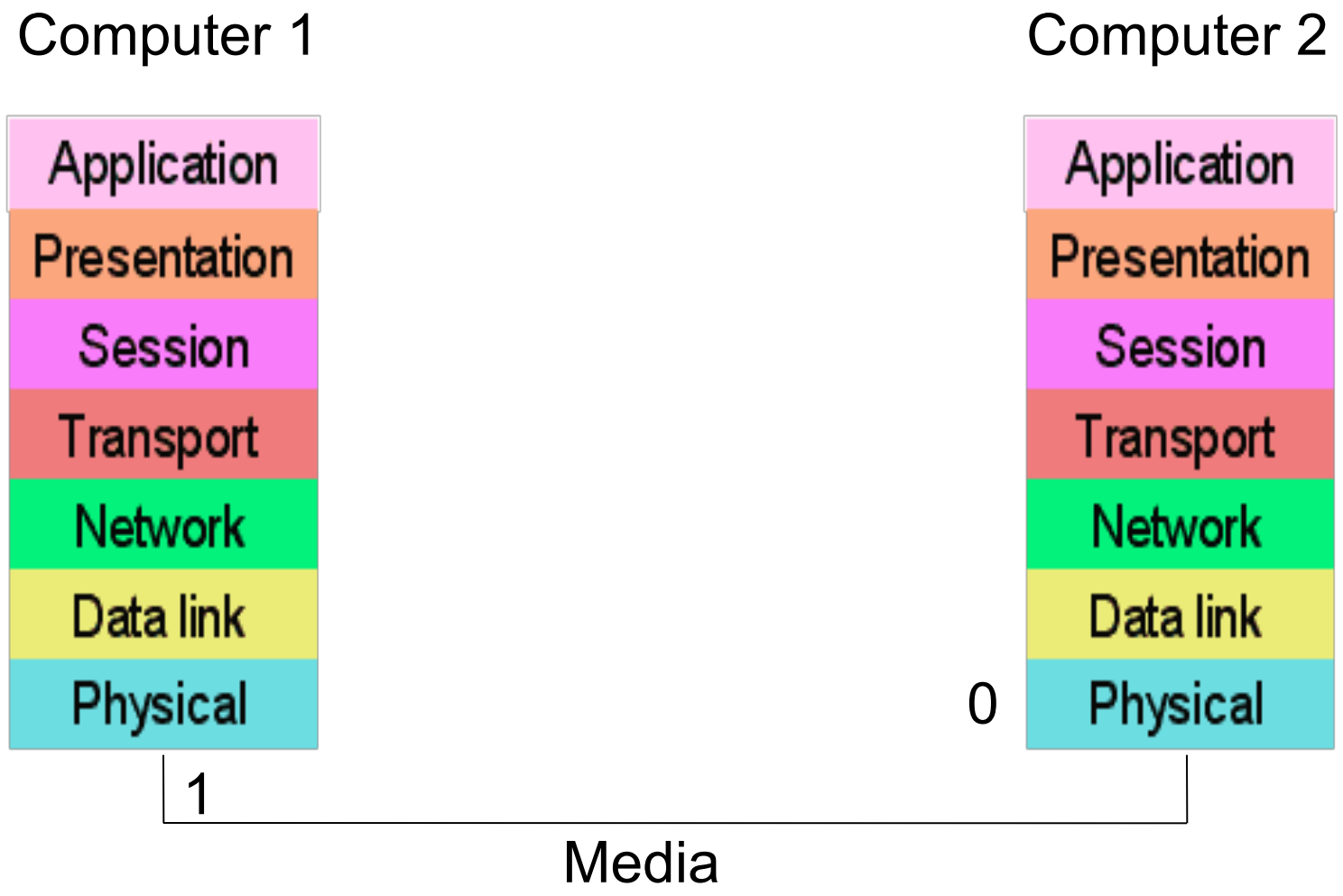
The OSI Reference Model



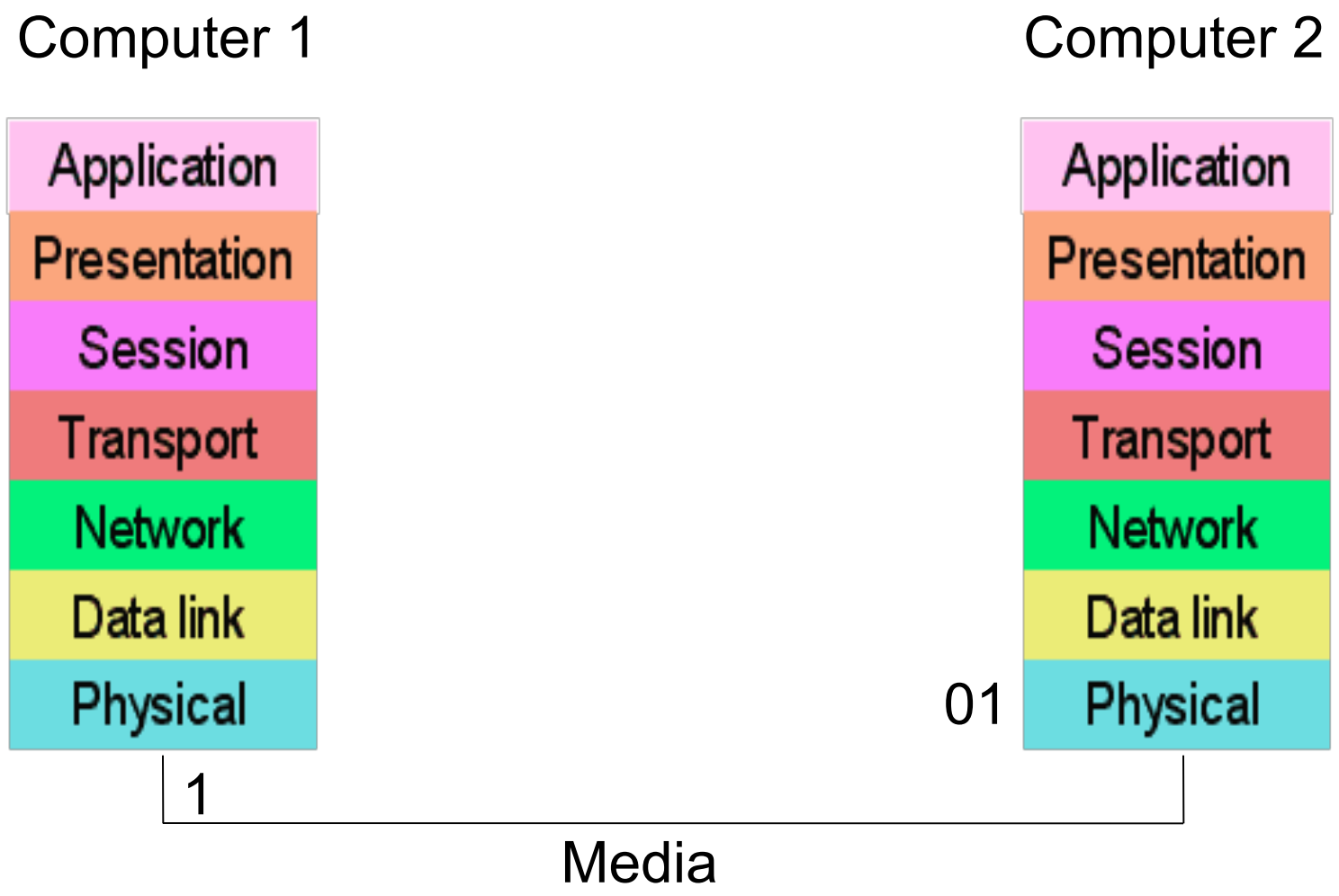
The OSI Reference Model



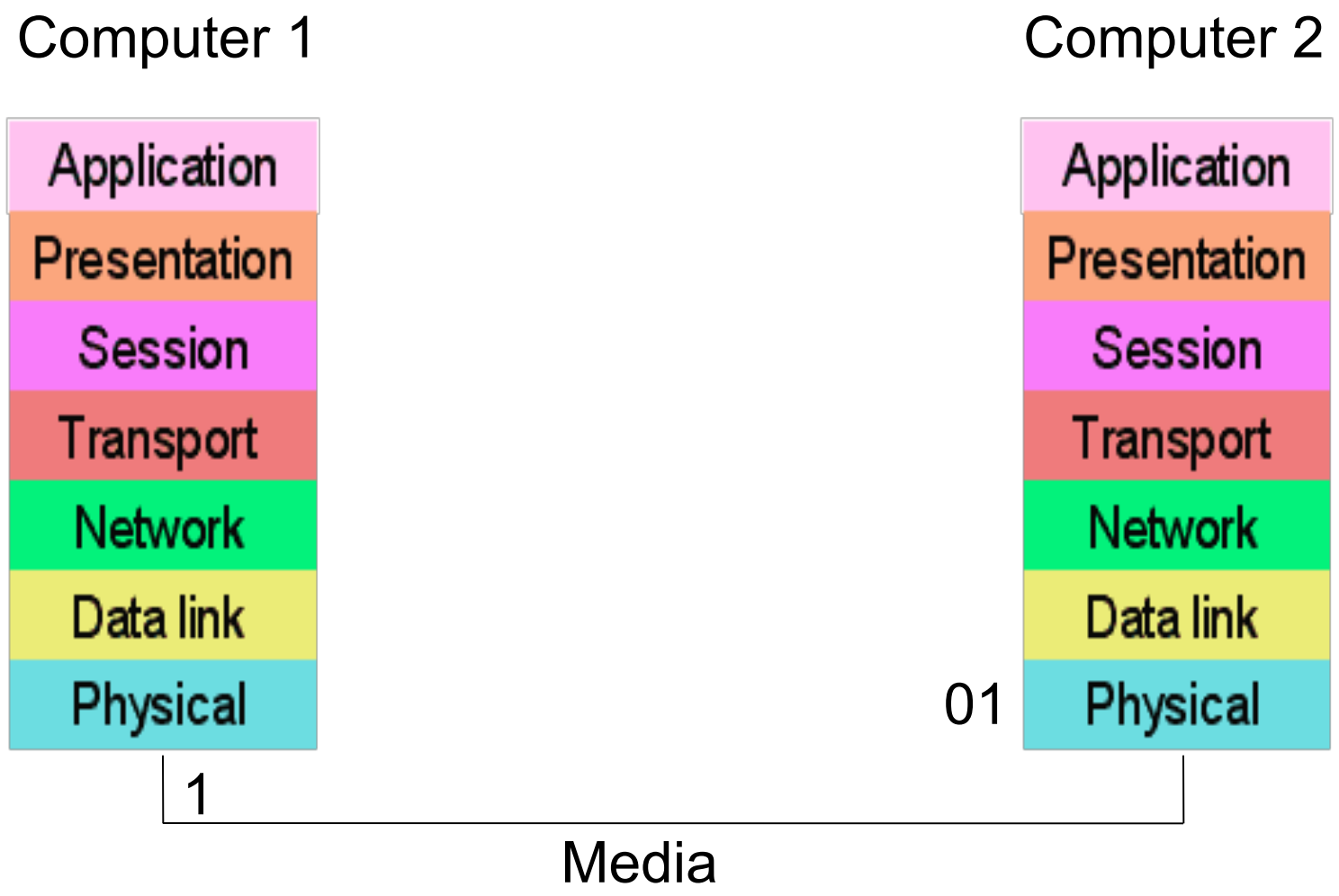
The OSI Reference Model



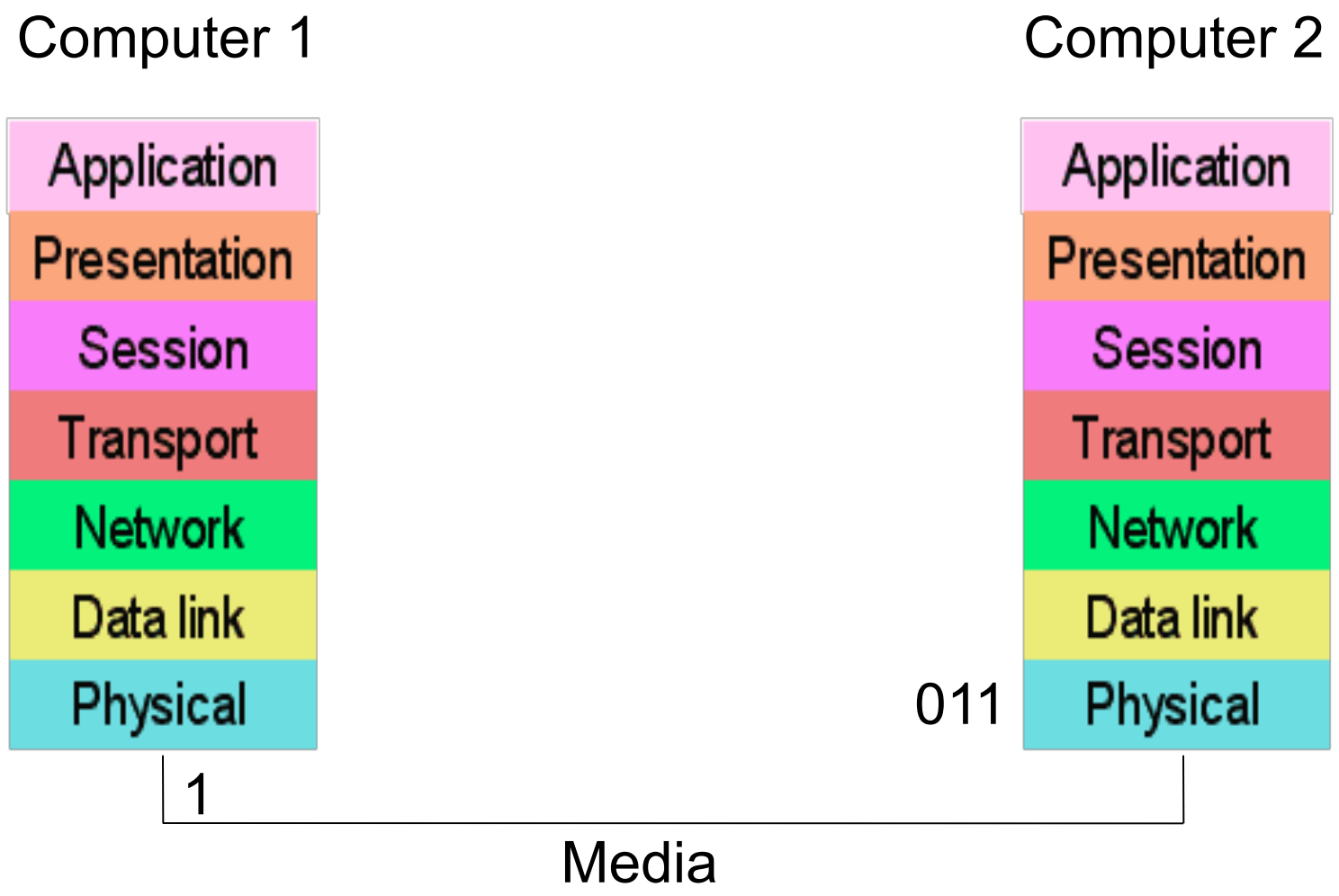
The OSI Reference Model



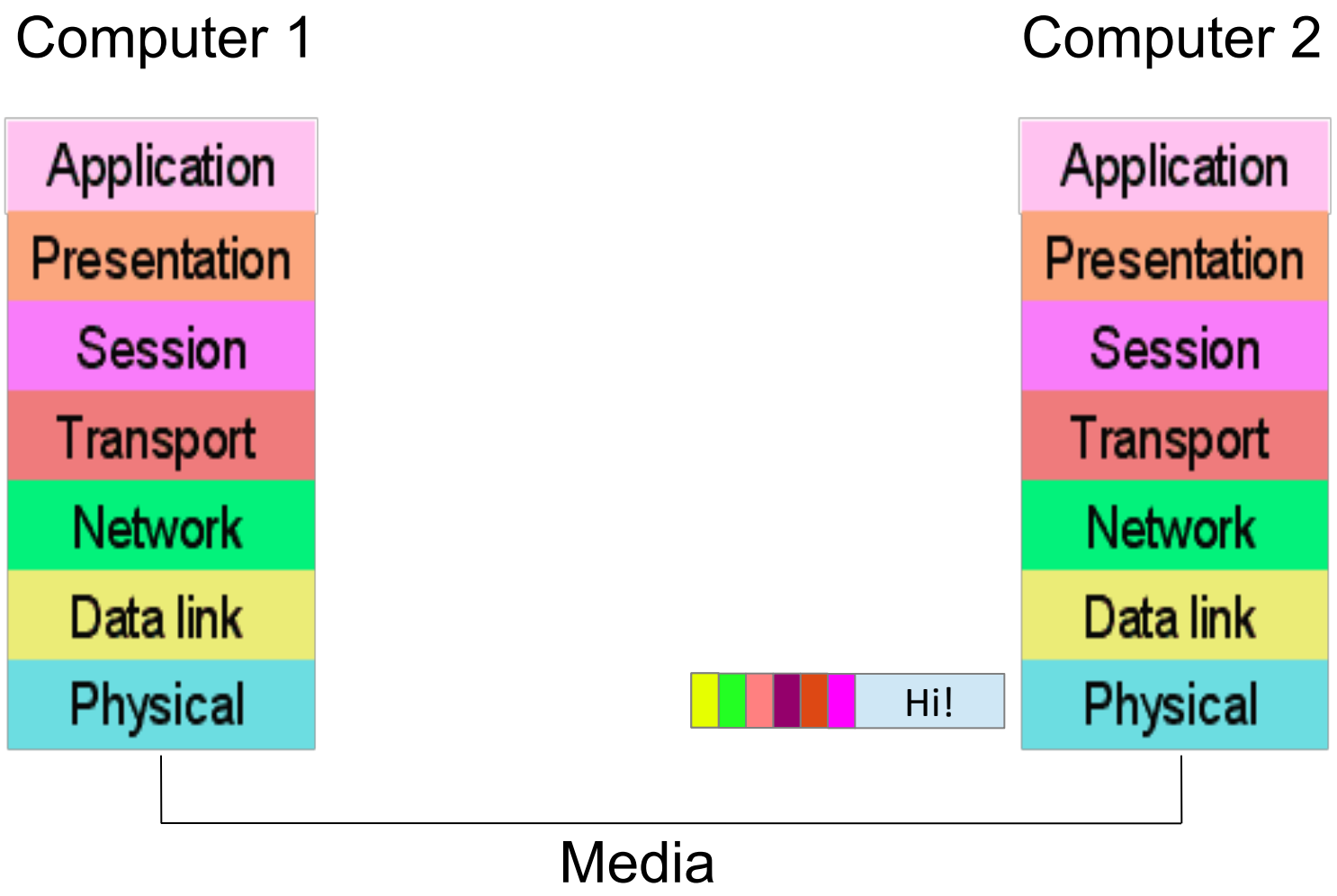
The OSI Reference Model



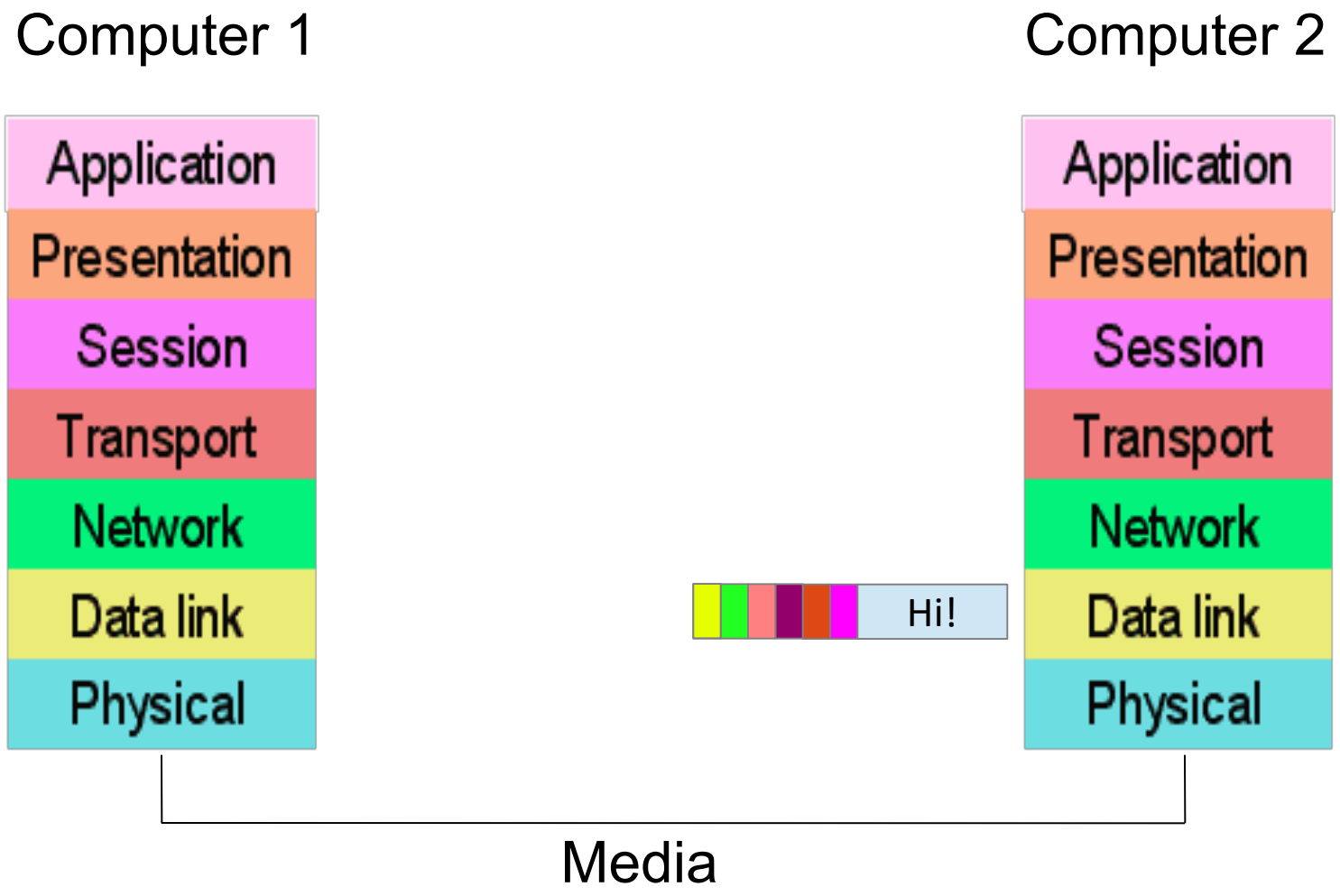
The OSI Reference Model



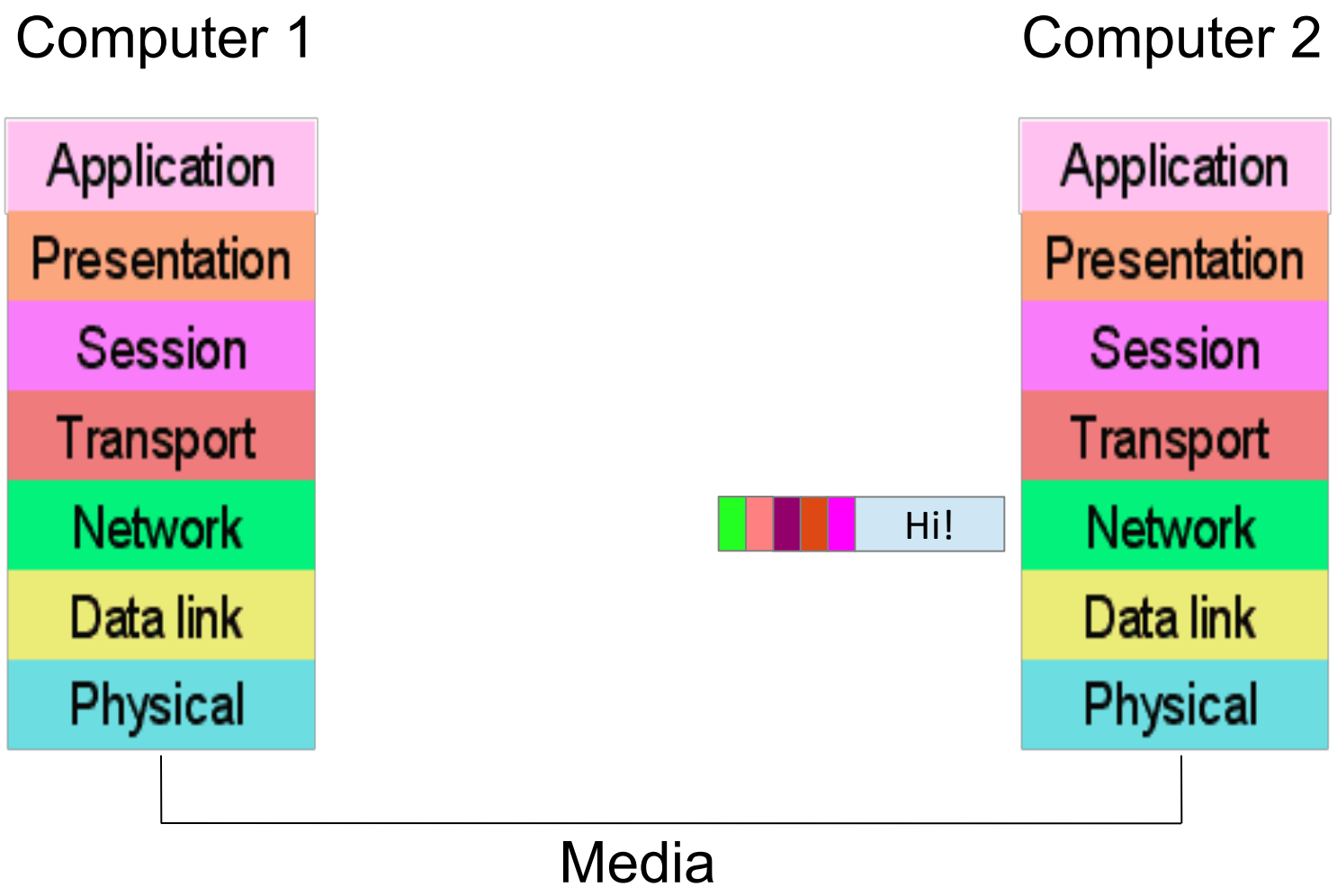
The OSI Reference Model



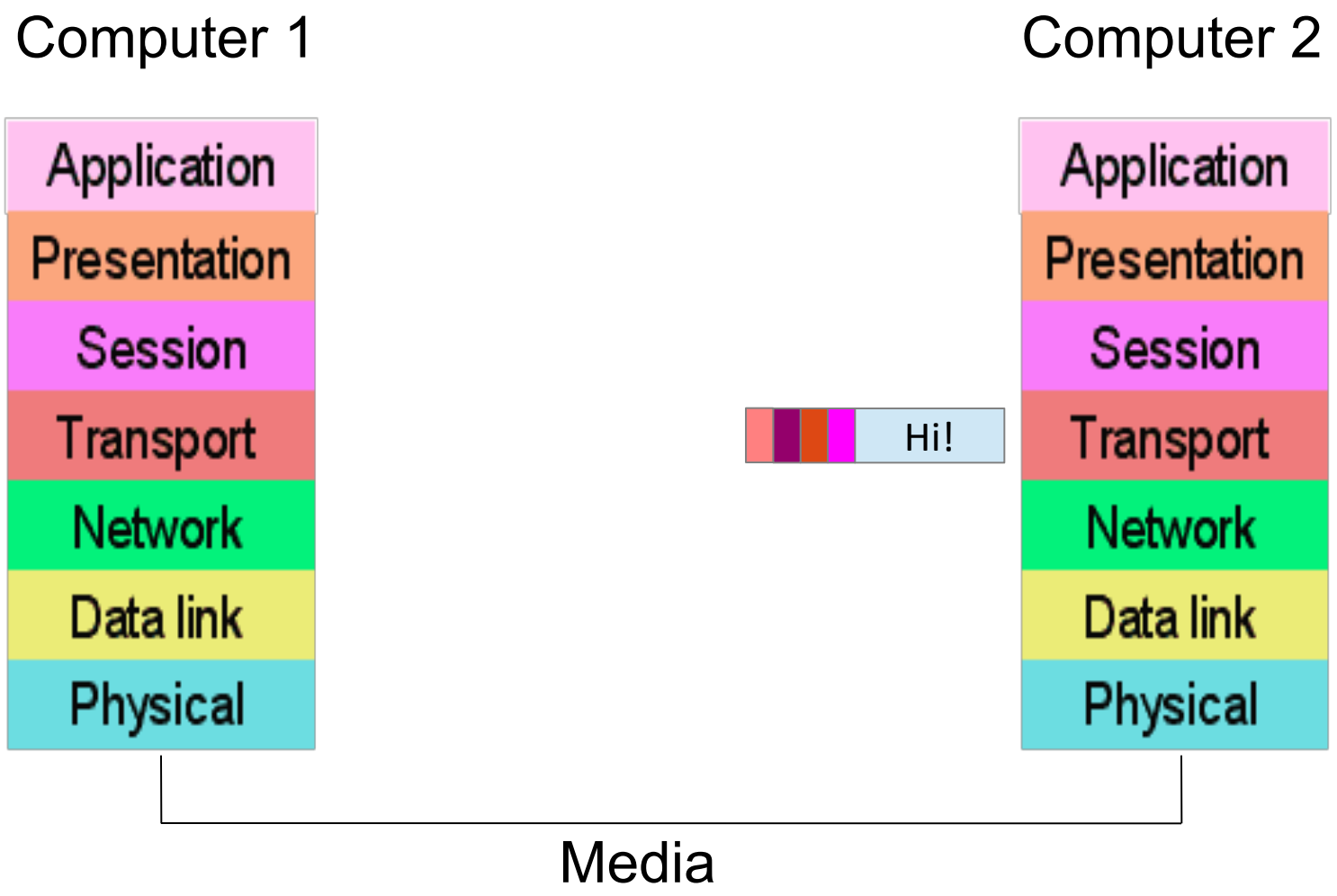
The OSI Reference Model



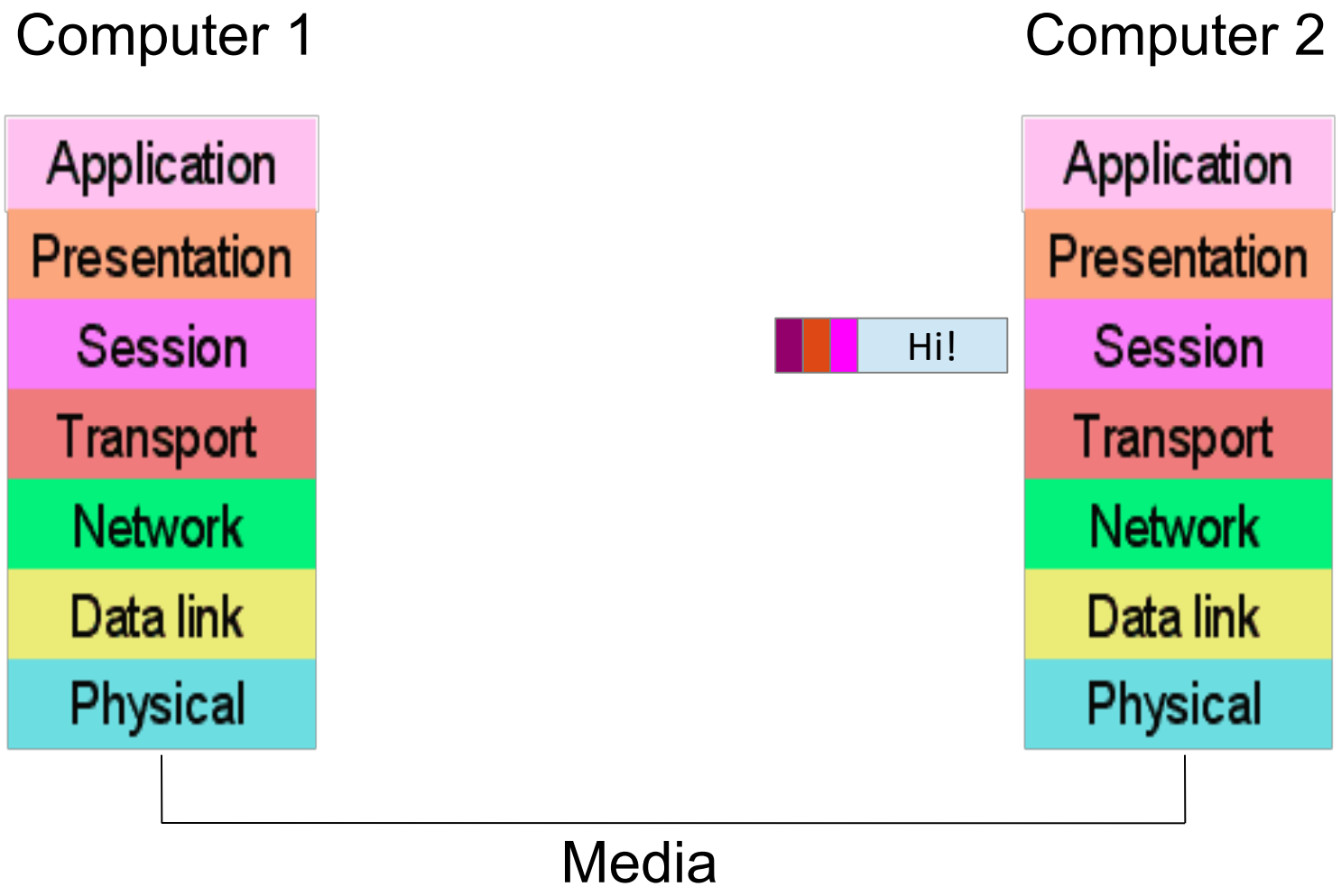
The OSI Reference Model



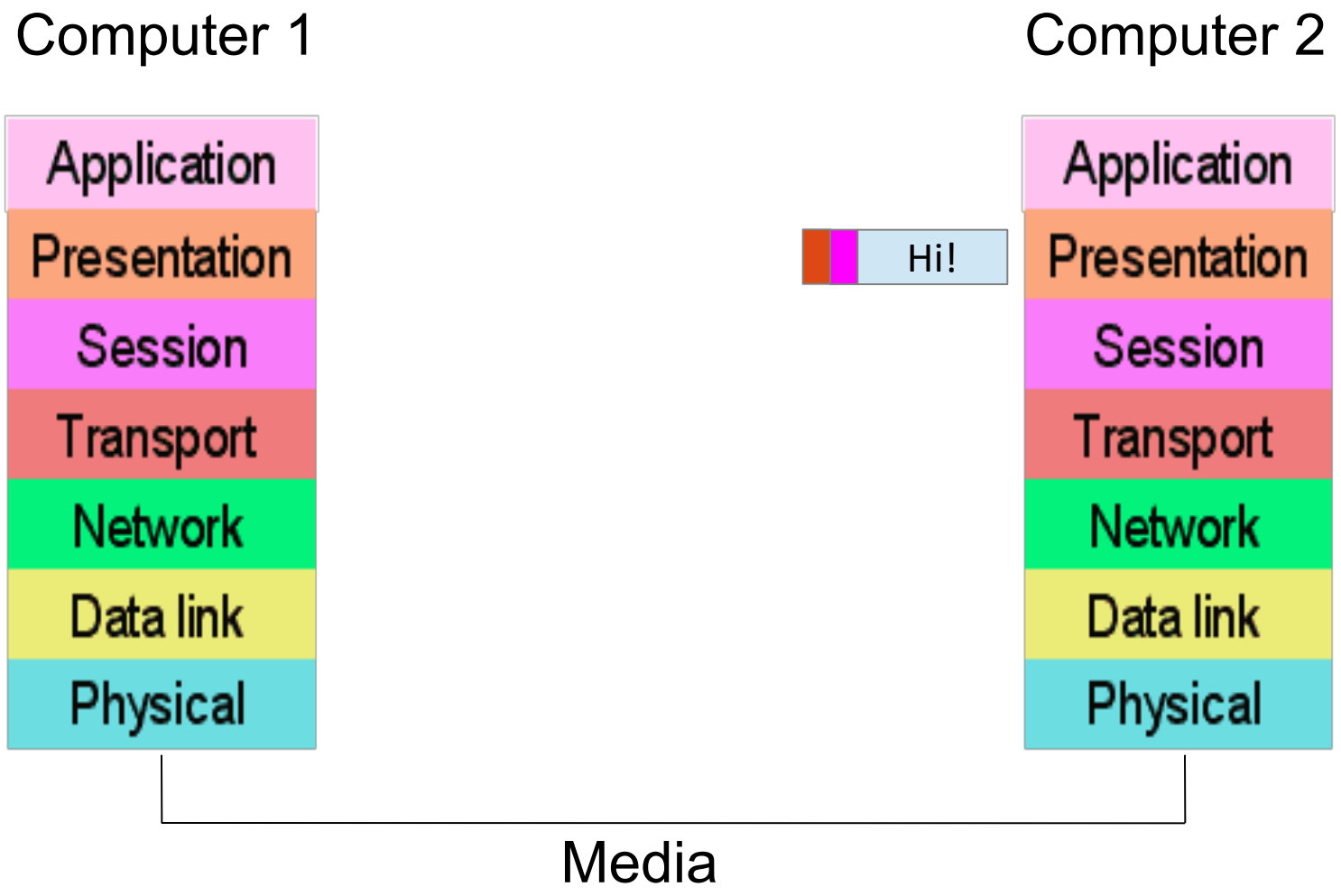
The OSI Reference Model



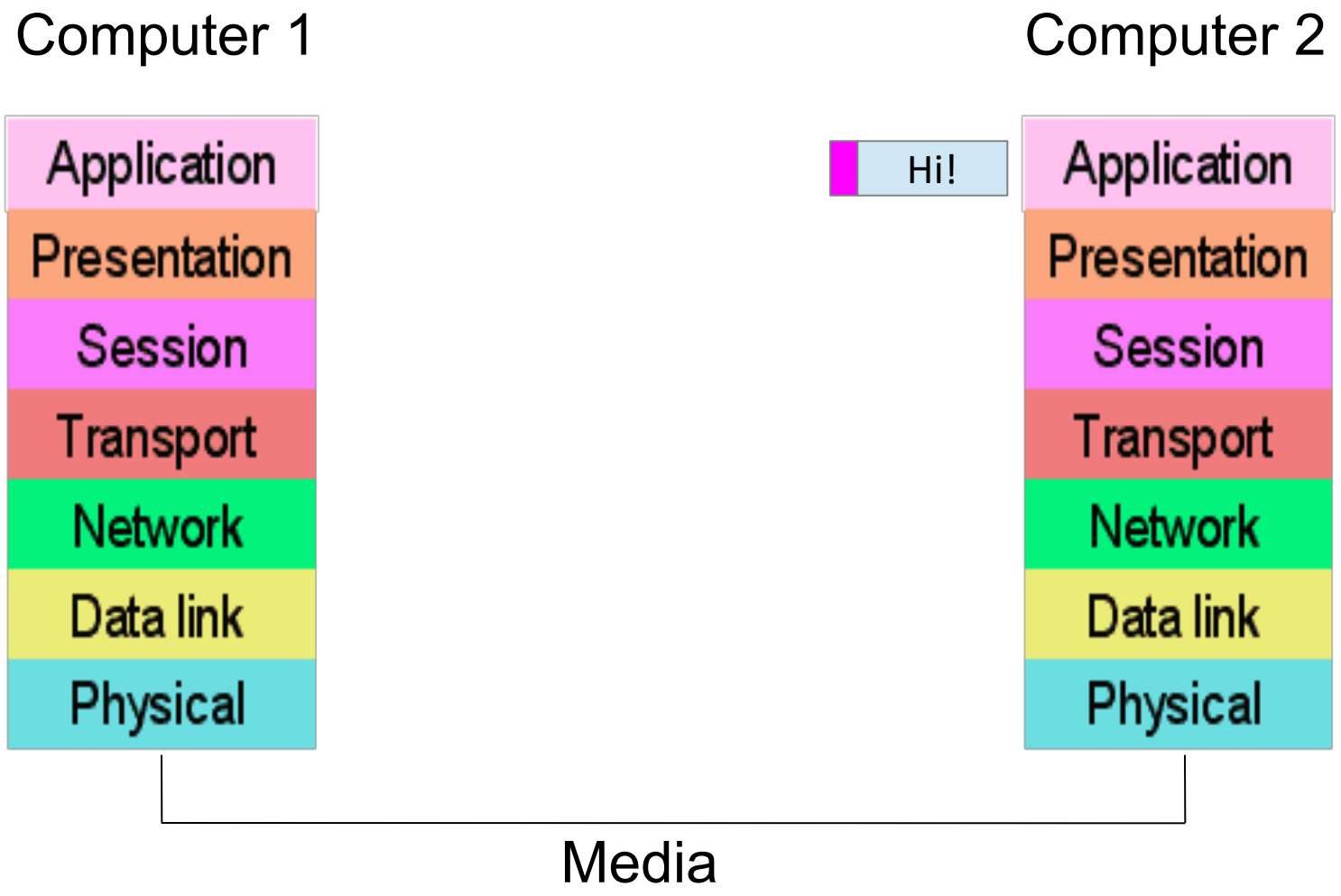
The OSI Reference Model



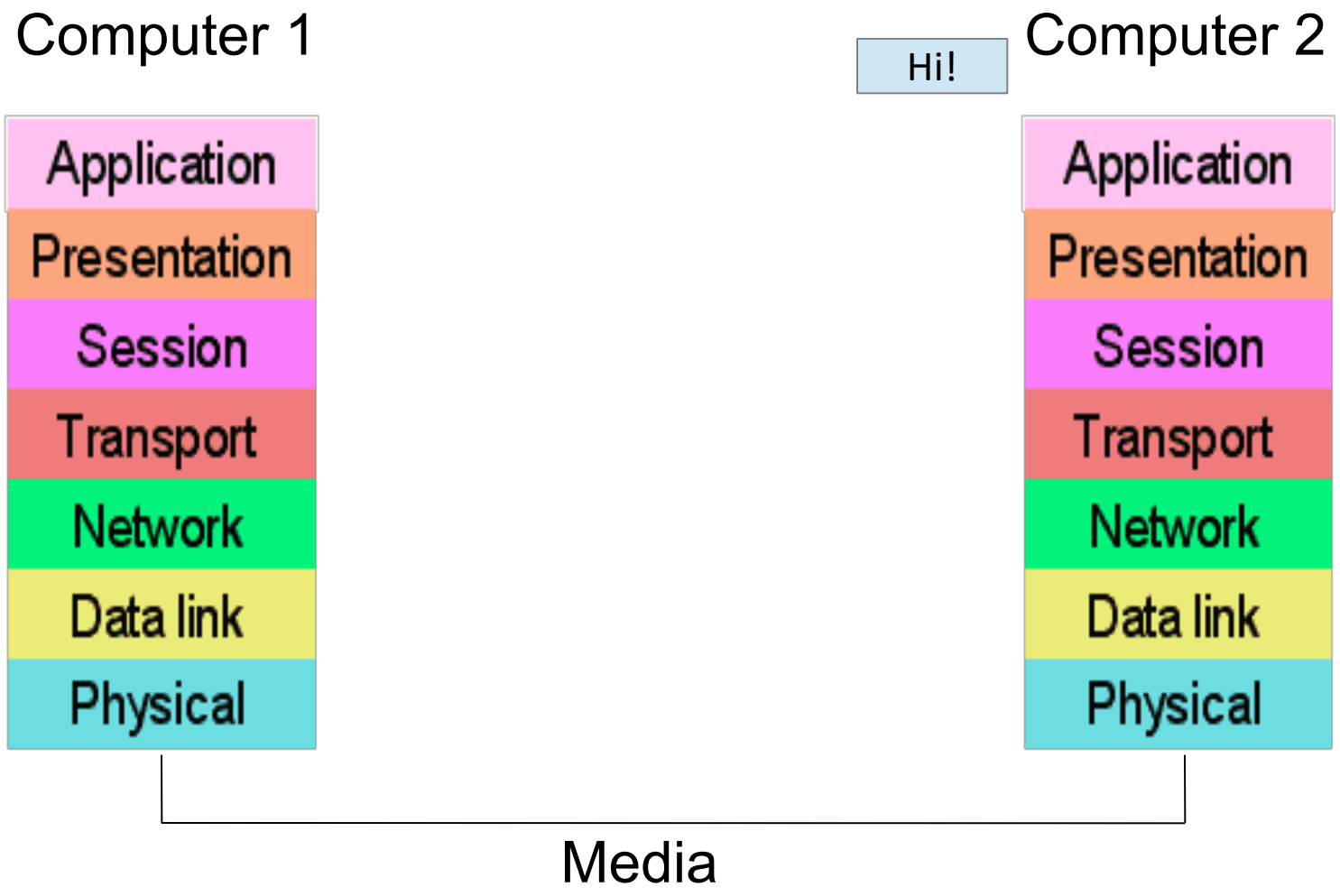
The OSI Reference Model



The OSI Reference Model



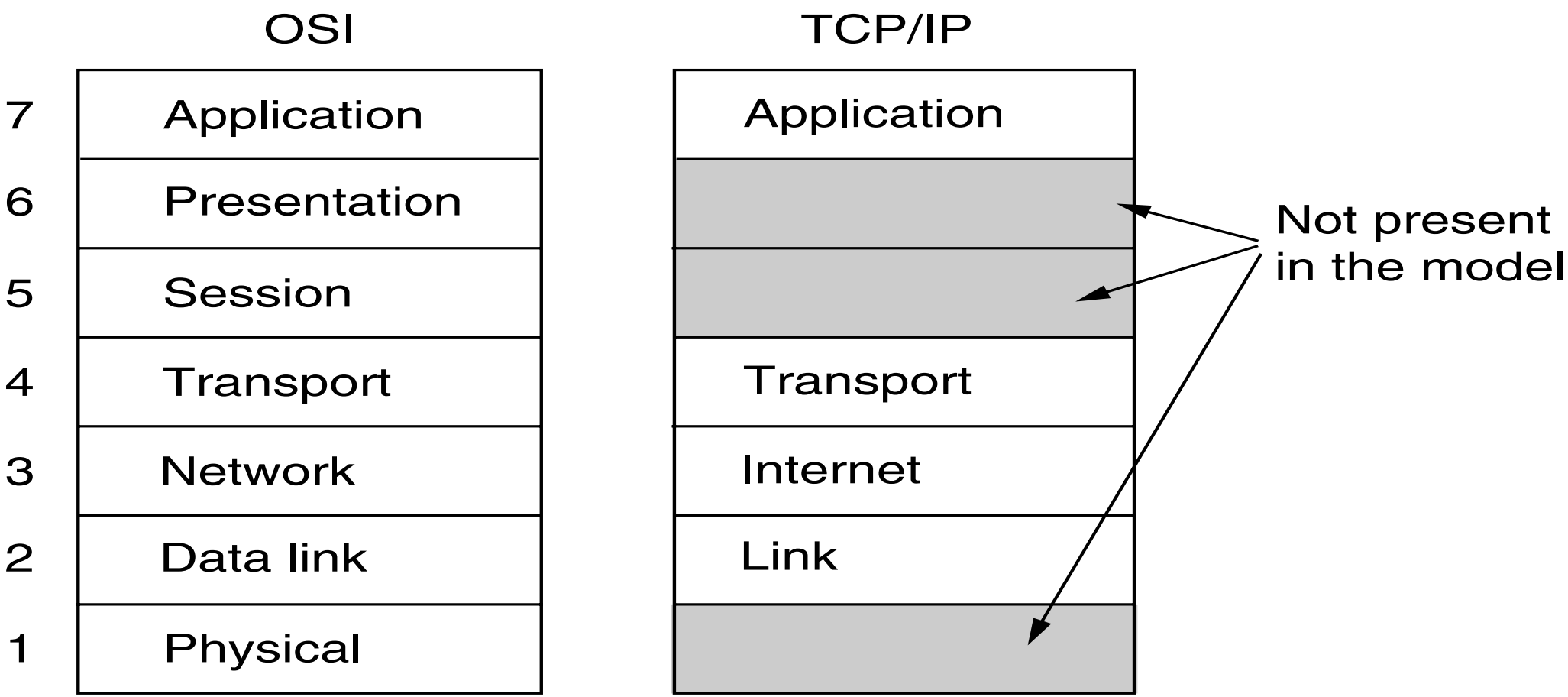
The OSI Reference Model



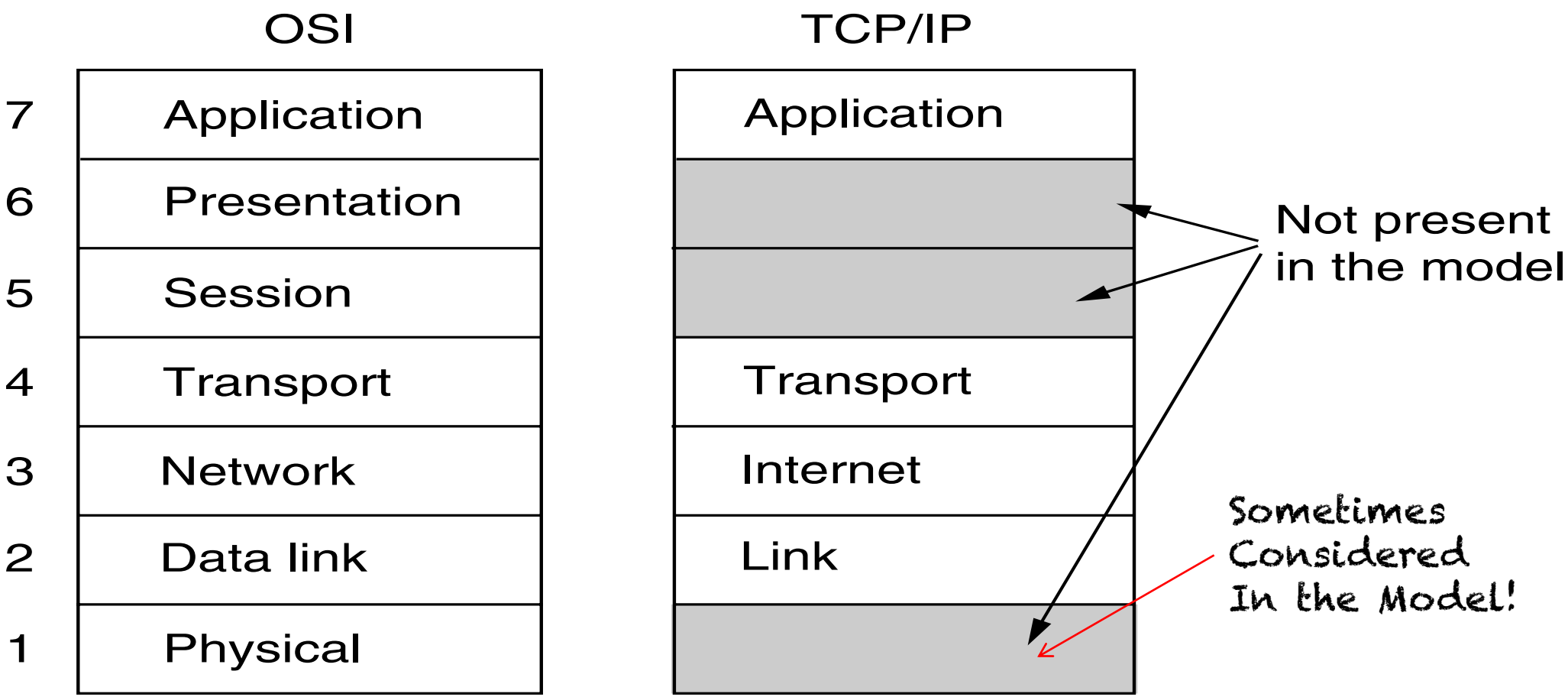
The TCP/IP Reference Model

- This model evolved from the earliest versions of the Internet
  - Often called the internet protocols
  - It was designed to keep the network functioning for as long as possible in the face of systems failures
- It is the dominant protocol in use today
- It combines several layers together to provide a simpler and more efficient model
  - The TCP/IP model does not have session or presentation layers. No need for them was perceived.
  - Instead, applications simply include any session and presentation functions that they require

The TCP/IP Reference Model



The TCP/IP Reference Model



The Link Layer

- Based on the requirements of the early internet, a packet-switching network based on a connectionless layer that runs across different networks was chosen
- The **link layer** describes what links such as serial lines and classic Ethernet must do to meet the needs of this connectionless internet layer
- It mostly takes the form of an interface between hosts and transmission links

The Internet Layer

- The **internet layer** is the linchpin that holds the whole architecture together
- Its job is to allow hosts to insert packets into any network and have them travel independently to the destination
- They may even arrive in a completely different order than they were sent, in which case it is the job of higher layers to rearrange them

The Internet Layer

- The internet layer defines an official packet format and protocol called **IP** (**Internet Protocol**)

- The job of the internet layer is to deliver IP packets where they are supposed to go

The Transport Layer

- The transport Layer is designed to allow peer entities on the source and destination hosts to carry on a conversation

- Two end-to-end transport protocols have been defined here.
  - **Transmission Control Protocol (TCP)**
  - **User Datagram Protocol (UDP)**

Transmission Control Protocol

- TCP is a reliable connection-oriented protocol that allows a byte stream originating on one machine to be delivered without error on any other machine in the internet
- It segments the incoming byte stream into discrete messages and passes each one on to the internet layer
- At the destination, the receiving TCP process reassembles the received messages into the output stream
- TCP also handles flow control

User Datagram Protocol

- UDP is an **unreliable**, **connectionless** protocol for applications that do not want TCP's sequencing or flow control and wish to provide their own

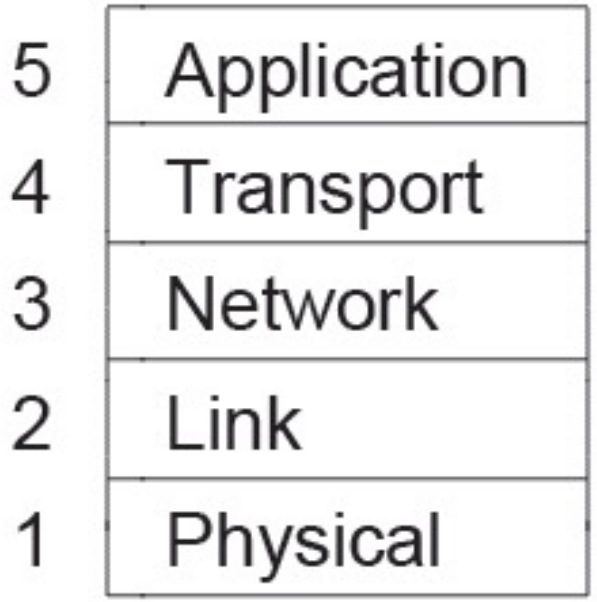
- It is also widely used for one-shot, client-server-type request-reply queries and applications in which **timely** delivery is more important than **accurate** delivery,
  - Such as transmitting speech or video

The Application Layer

- The application layer contains all the higher-level protocols.
- The early ones included virtual terminal (TELNET), file transfer (FTP), and electronic mail (SMTP)
- There are many more such as the Domain Name System (DNS), for mapping host names onto their network addresses, HTTP, the protocol for fetching pages on the World Wide Web, and RTP, the protocol for delivering real-time media such as voice or movies

Model Used in this Course

- Based on the TCP/IP model with the addition of the physical layer



Critique of OSI & TCP/IP

- OSI:
  - \+ Very influential model with clear concepts
  - – Models, protocols and adoption all bogged down by politics and complexity
- TCP/IP:
  - \+ Very successful protocols that worked well and thrived
  - – Weak model derived after the fact from protocols