The Open Systems Interconnection (OSI) Model

The OSI layer model will help us to understand the overall picture of how computer networks work without getting into too many low-level details.

WE'LL COVER THE FOLLOWING

Common Models

There are several models along which computer networks are organized. The two most common ones are the **Open Systems Interconnection (OSI)** model and the **Transmission Control Protocol/Internet Protocol (TCP/IP)** model.

We will discuss each model and the differences between the two in detail starting with the OSI model.

The OSI Model

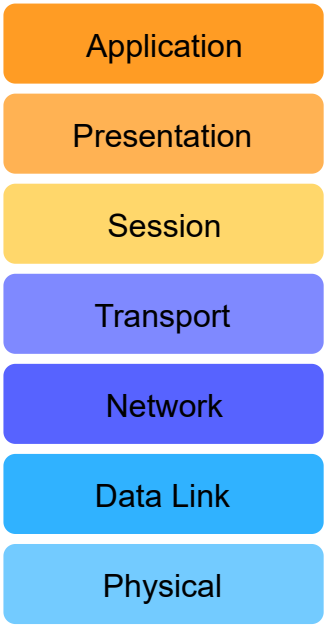
The OSI Model was developed in the '70s by the Organization for

Standardization (ISO). At this time, the Internet was in its infancy and its protocols had not fully matured. The OSI model **provides a standard** for different computer systems to be able to communicate with each other.

The Layers of the OSI Model

The model splits up a communication system into 7 **abstract layers**, stacked upon each other.

Here are the seven layers of the OSI Model.



The OSI Network Stack

Mnemonic

A good mnemonic device to help remember these layers is:

Please Do Not Throw Sausage Pizza Away

Mnemonic to Memorize the Layers of The Network Stack

Network protocols are implemented in software, hardware or a combination of both, and their hardware and software components are organized into these layers. So the **main purpose** of this 'network stack' is to **understand *how* the components of these protocols fit into the stack and work with each other**.

Here are some key responsibilities of each layer. Note that we are listing only *some* of the responsibilities of each layer. The exhaustive discussion is deferred to later chapters.

Application Layer

- These applications or protocols are almost **always implemented in software**.
- **End-users interact** with the application layer.
- The application layer is where most **end-user applications** such as web browsing and email **live**.
- The application layer is where an outgoing message starts its journey so it **provides data for the layer below**.

> 🔎 **Did You Know?** Ascribing to the OSI model, **Layer 8** is a pseudo-layer that consists of the **end-users**! A lot of IT support humor has involved telling unsuspecting non-tech-savvy users that the issue is a "Layer 8 issue." So the application layer can technically be said to be sitting in between layers 8 and 6!

Presentation Layer

- **Presents data** in a way that can be easily understood and displayed by the application layer.
    - **Encoding** is an example of such presentation. The underlying layers might use a different character encoding compared to the one used by the application layer. The presentation layer is responsible for the

translation.

- **Encryption** (changing the data so that it is only readable by the parties it was intended for) is also usually done at this layer.
- **Abstracts**: the presentation layer assumes that a user session is being maintained by the lower layers and transforms content presentation to suit the application.
- **End-to-end Compression**: The presentation layer might also implement end to end compression to reduce the traffic in the network.

Session Layer

- The session layer's responsibility is to take the services of the transport layer and build a service on top of it that **manages user sessions**.
    - As we will see shortly, the transport layer is responsible for transporting session layer messages across the network to the destination. The session layer must manage the mapping of messages delivered by the transport layer to the sessions.
- A session is an exchange of information between local applications and remote services on other end systems.
    - For example, one session spans a customer's interaction with an e-commerce site whereby they search, browse and select products, then make the payment and logout.
- **Abstracts:** the session layer assumes that connections establishment and packet transportation is handled by the layers below it.

Transport Layer

- The **transport layer** also has protocols implemented largely in software.
- Since the application, presentation and session layers may be handing off large chunks of data, the transport layer segments it into smaller chunks.
    - These chunks are called **datagrams or segments** depending on the protocol used.
- Furthermore, sometimes some **additional information** is required to transmit the segment/datagram reliably. The transport layer **adds this**

information to the segment/datagram.

- An example of this would be the **checksum**, which helps ensure that the message is correctly delivered to the destination, i.e. that it's not corrupted and changed to something else on the way.
- When additional information is added to the **start** of a segment/datagram, it's called a **header**.
- When additional information is appended to the **end** it's called a **trailer**.

Network Layer

- Network layer messages are termed as **packets**.
- They facilitate the **transportation of packets** from one end system to another and help to **determine the best routes** that messages should take from one end system to another.
- **Routing protocols** are applications that run on the network layer and exchange messages with each other to develop information that helps them route transport layer messages.
- **Load Balancing** There are many links (copper wire, optical fiber, wireless) in a given network and one objective of the network layer is to keep them all roughly equally utilized. Otherwise, if some links are under-utilized, there will be concerns about the economic sense of deploying and managing them.

Data Link Layer

- Allows directly connected hosts to communicate. Sometimes these hosts are the only two things on a physical medium. In that case, the challenges that this layer addresses include **flow control** and **error detection/correction**.
- **Encapsulates packets** for transmission across a single link.
- **Resolves transmission conflicts** i.e., when two end systems send a message at the same time across one singular link.
- **Handles addressing** If the data link is a broadcast medium, addressing is another data link layer problem,
- **Multiplexing & Demultiplexing**:
  - Multiple data links can be multiplexed into something that appears

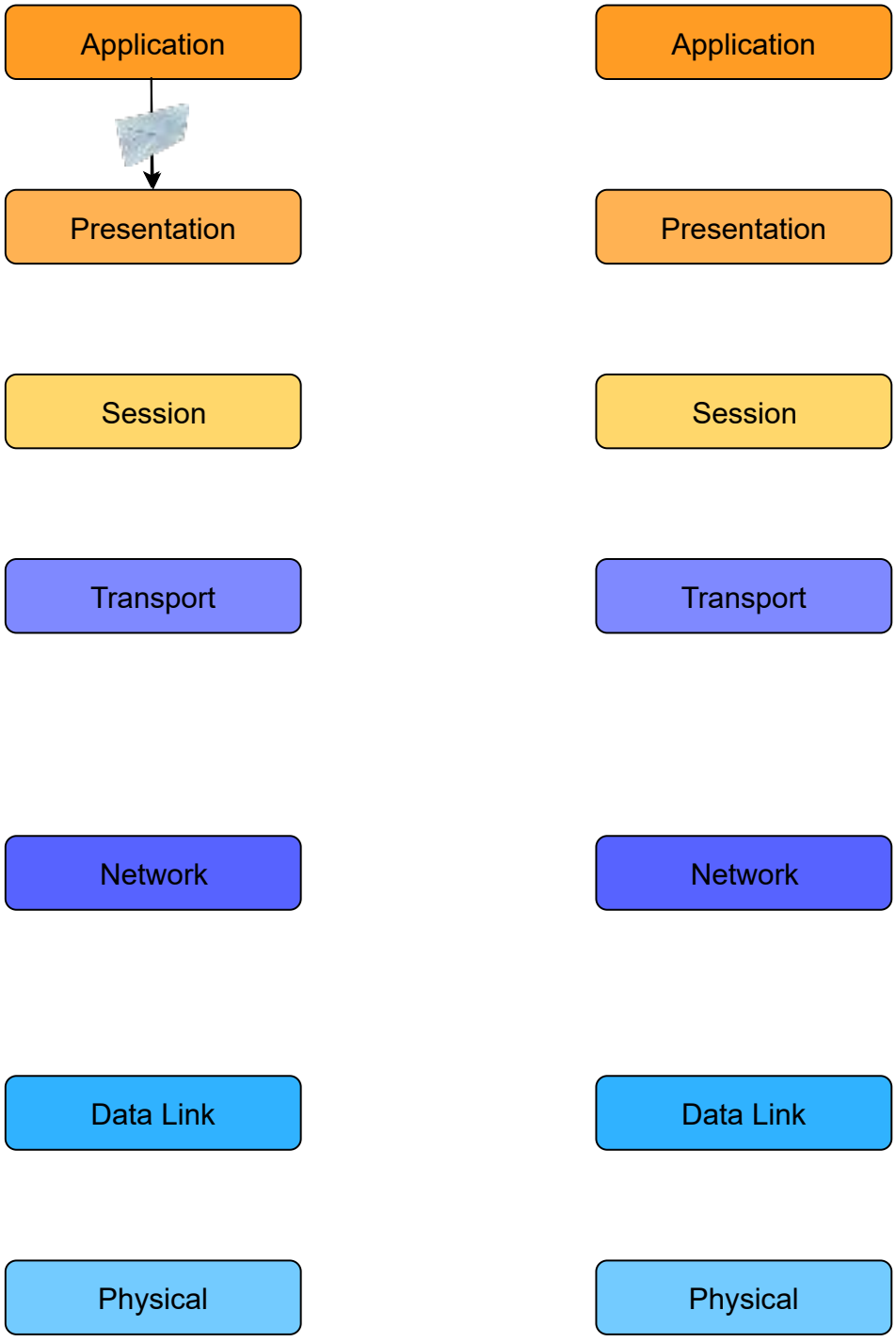
    - Multiple data links can be multiplexed into something that appears like one, to integrate their bandwidths.
    - Likewise, sometimes we disaggregate a single data link into virtual data links which appear like separate network interfaces.

Physical Layer

- Consists largely of hardware.
- Provides a solid electrical and mechanical medium to transmit the data.
- Transmits bits. Not logical packets, datagrams, or segments.
- Also has to deal with mechanical specifications about the makeup of the cables and the design of the connectors.

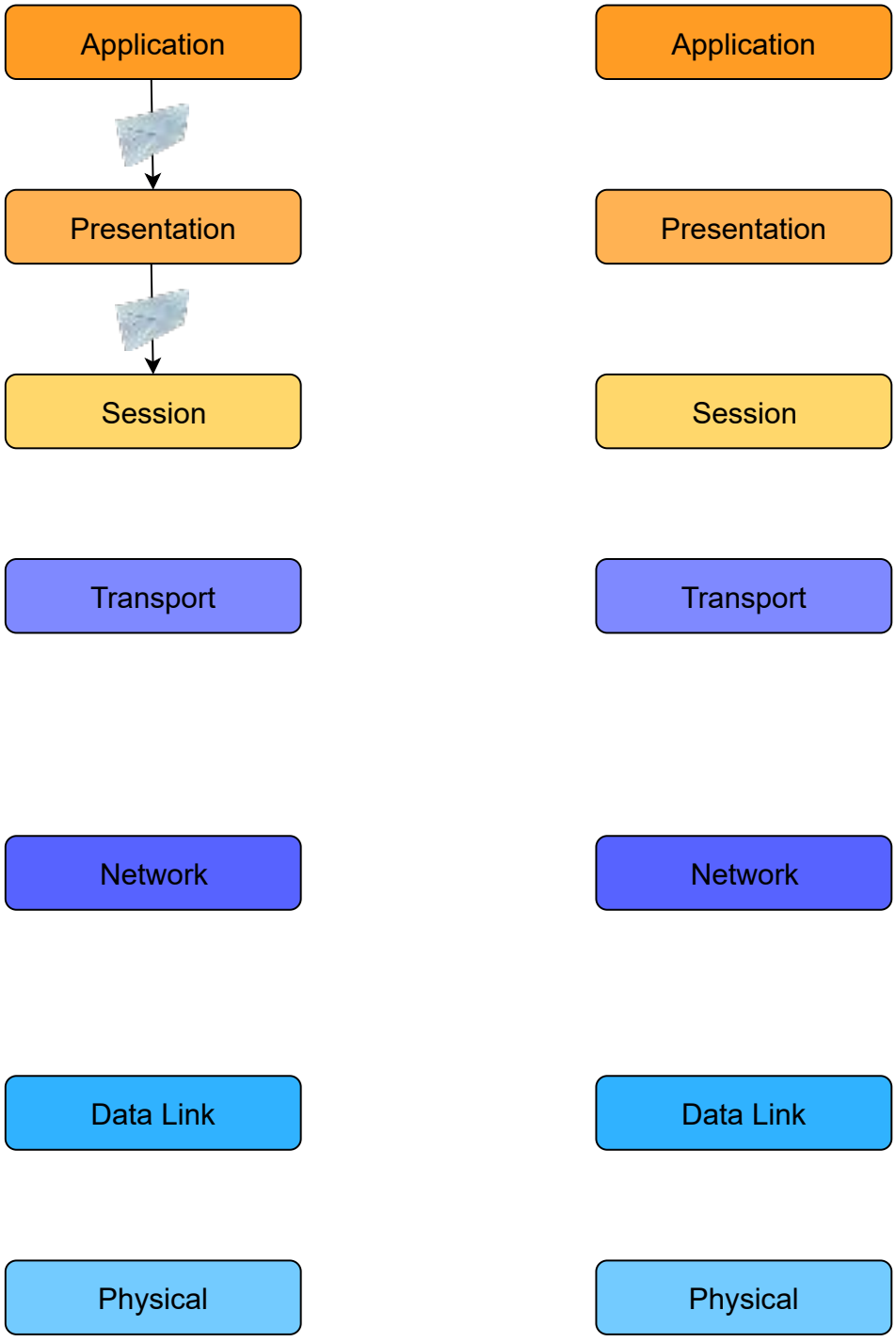
We've mostly already studied what constitutes the physical layer. We don't need to know more than what we've looked at in the Phyical Communication Media chapter.

Have a look at the following slides to understand how data would conceptually travel through the layers.



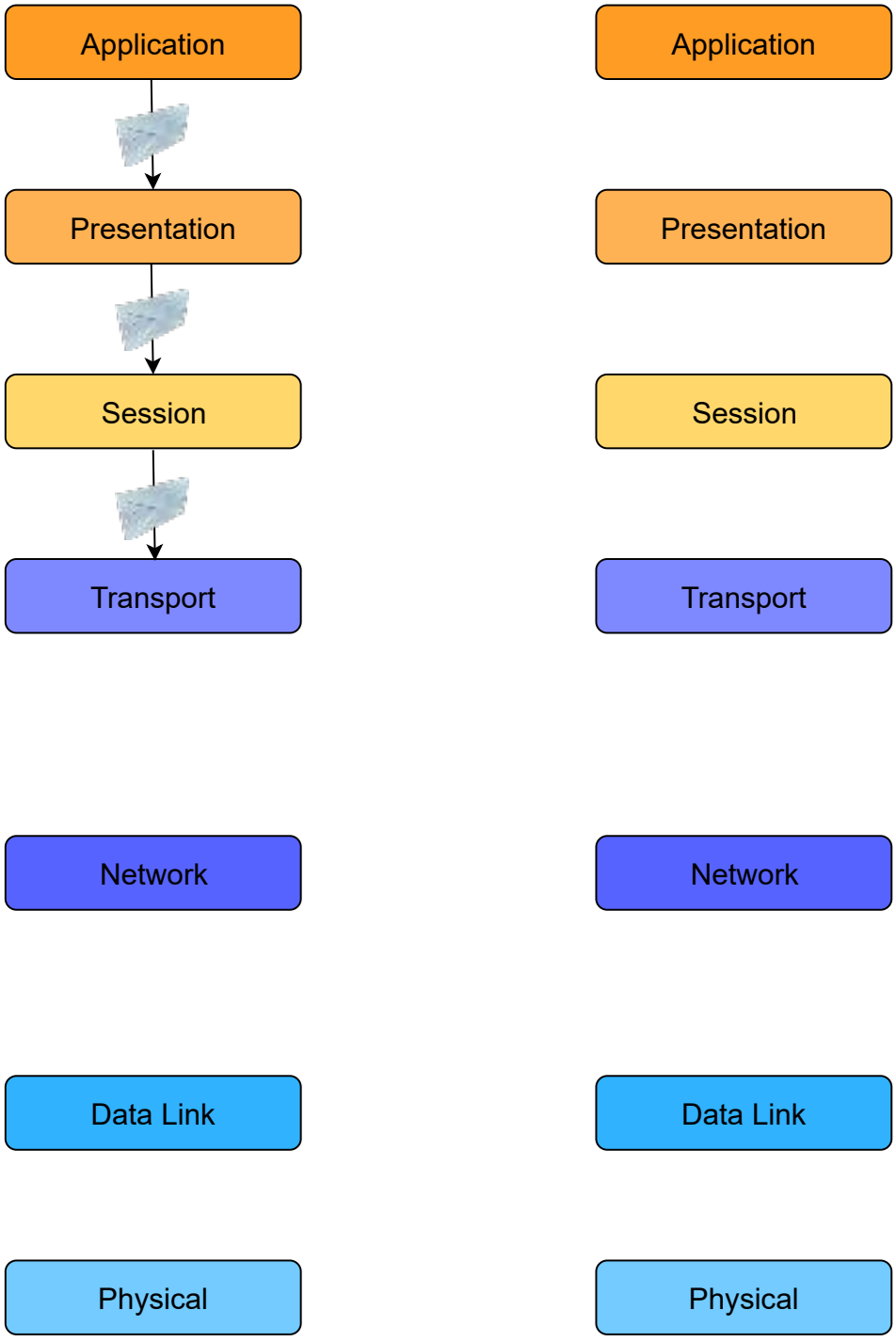
The application layer writes out streams of data to the presentation layer

How data conceptually travels through the layers



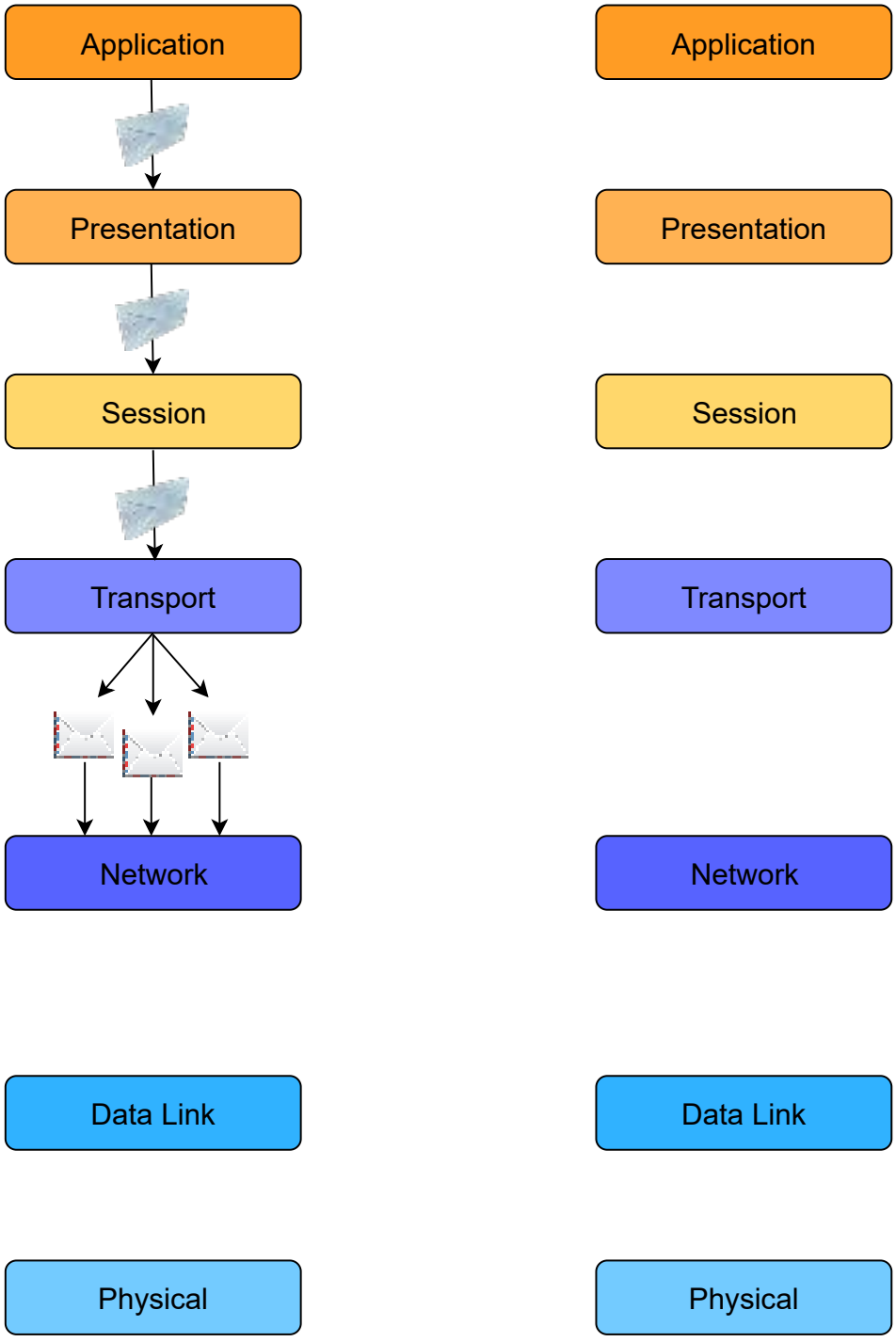
The presentation layer then hands it off to the session layer

How data conceptually travels through the layers



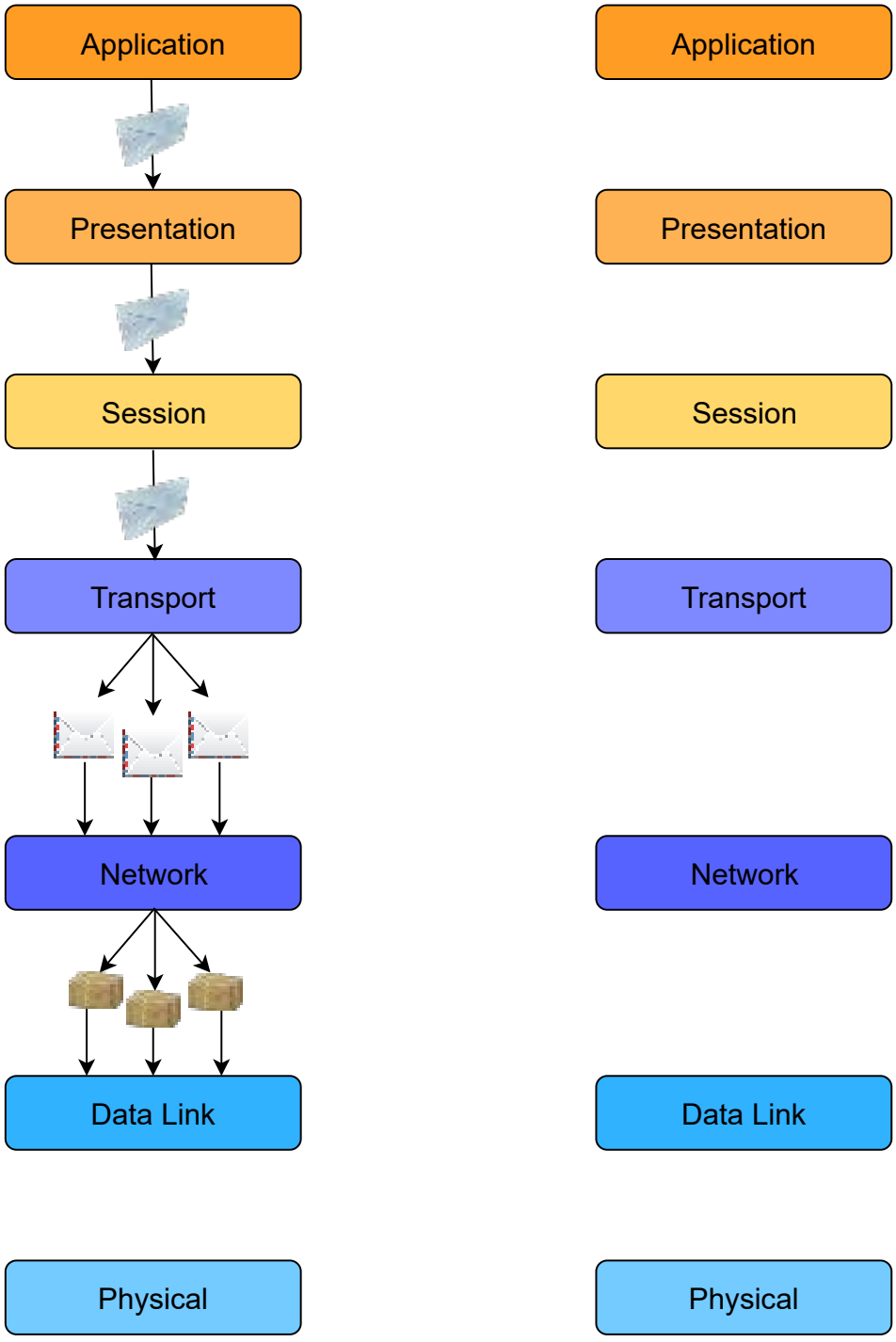
Then the transport layer

How data conceptually travels through the layers



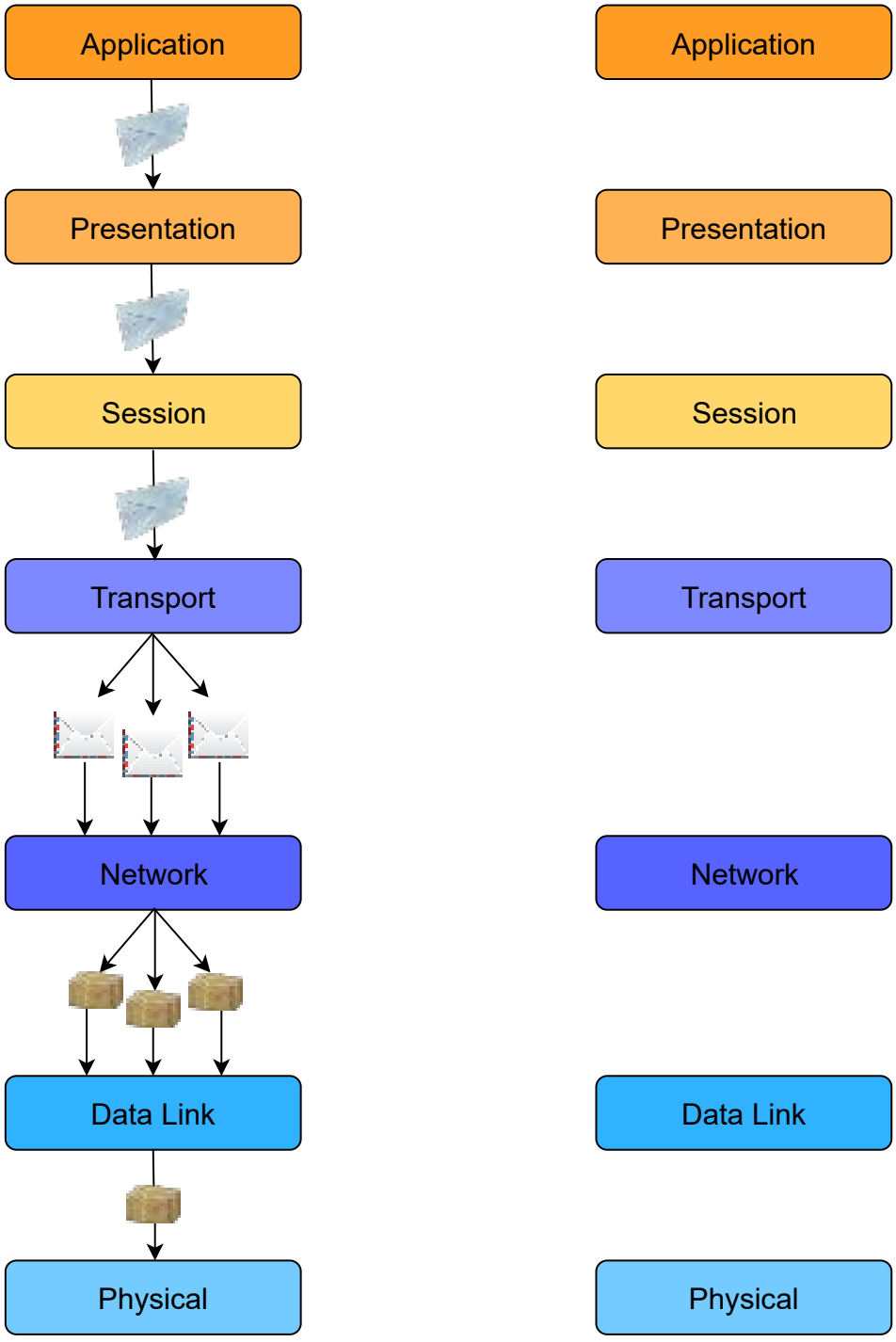
The transport layer segments this data

How data conceptually travels through the layers



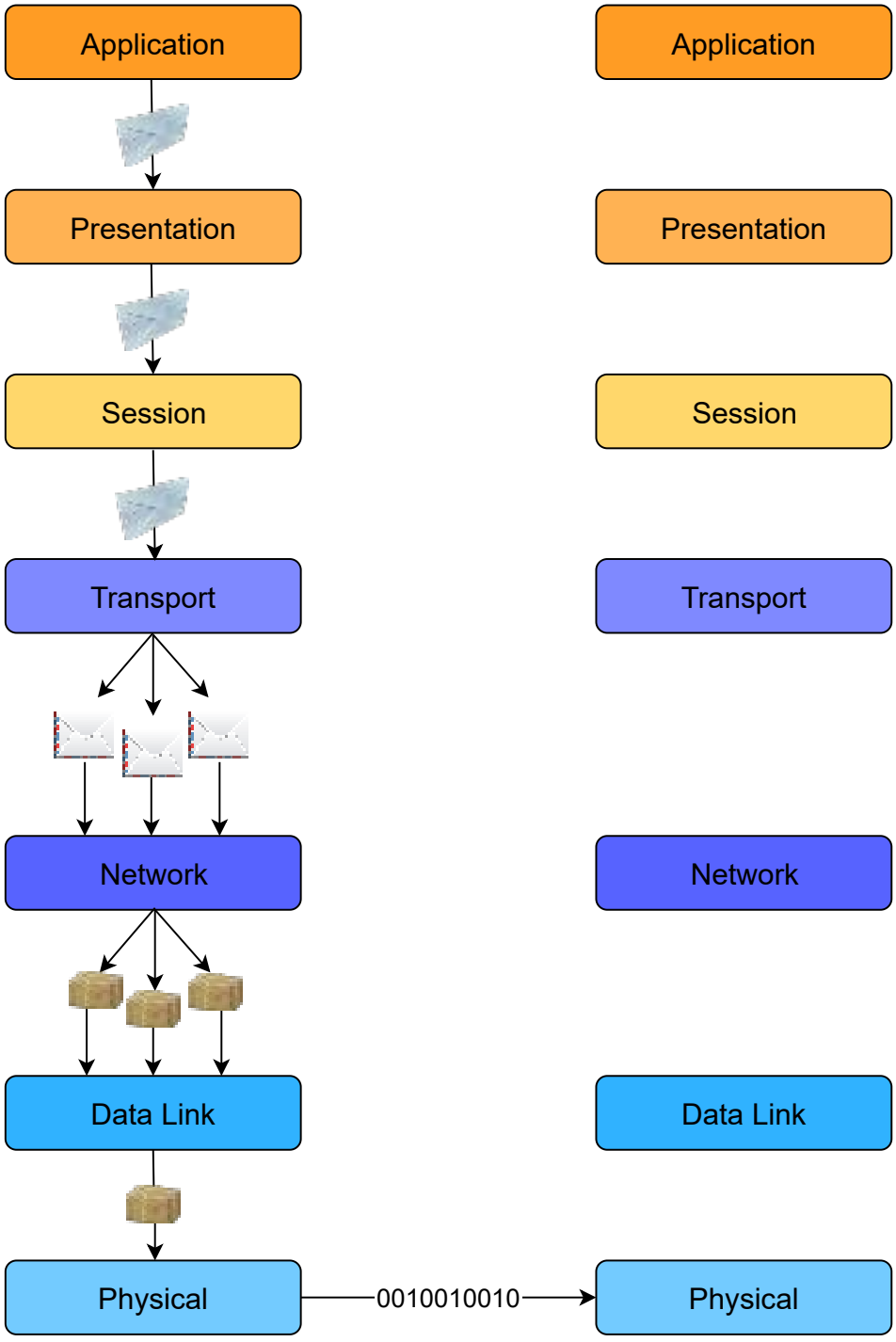
The network layer further packetizes these segments

How data conceptually travels through the layers



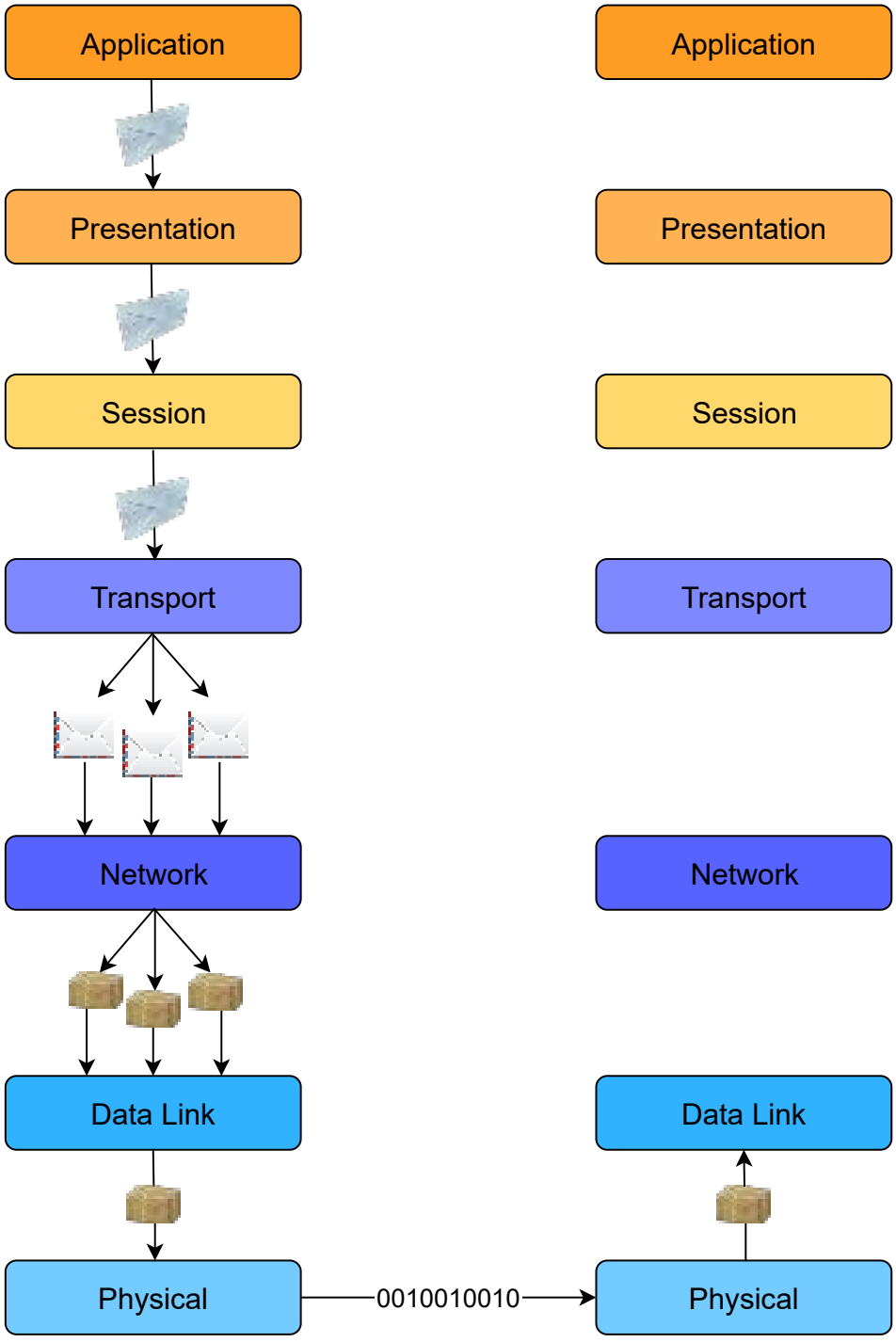
The physical layer then carries these in terms of bits represented physically in a medium

How data conceptually travels through the layers



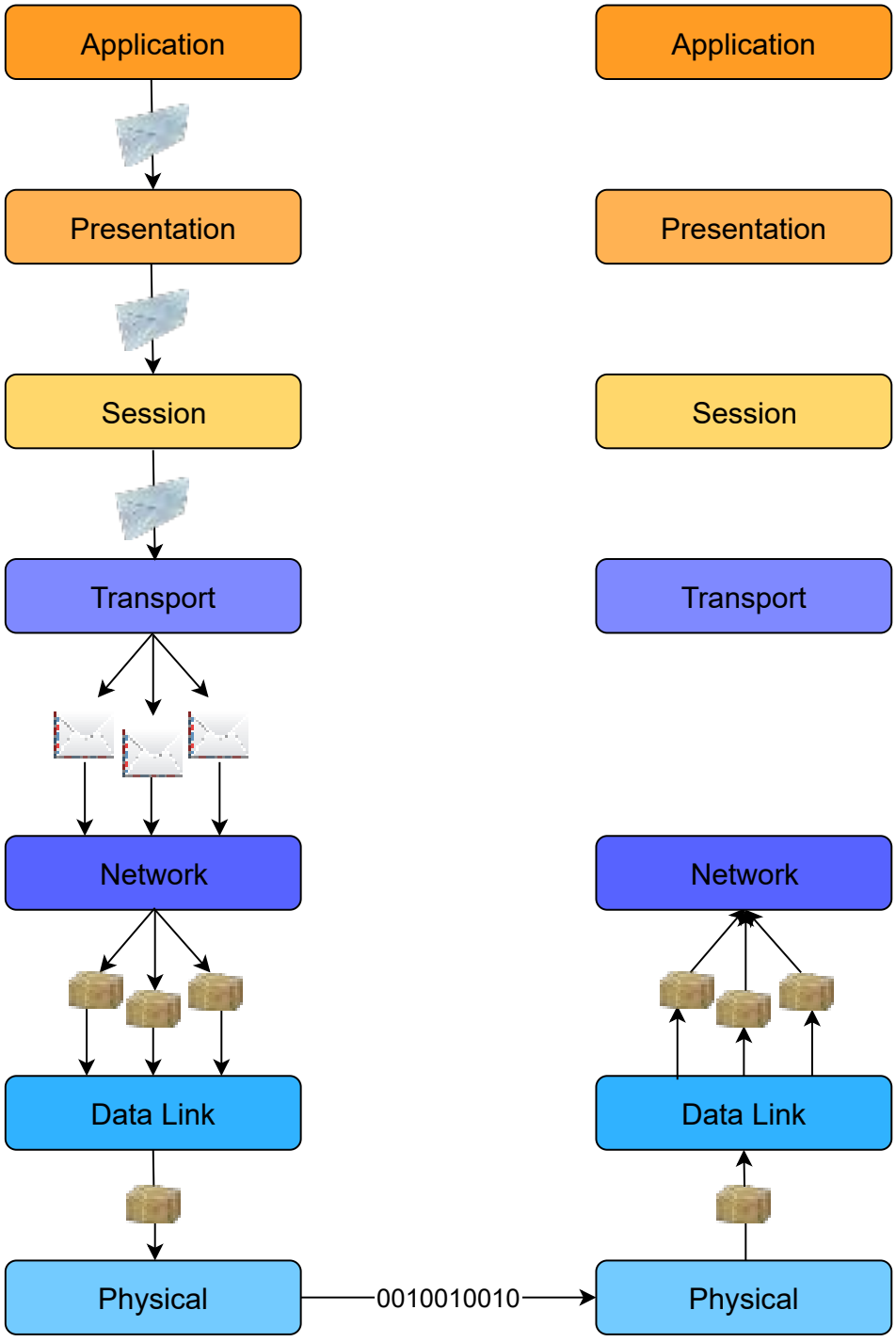
The physical layer then carries these in terms of bits represented physically in a medium

How data conceptually travels through the layers

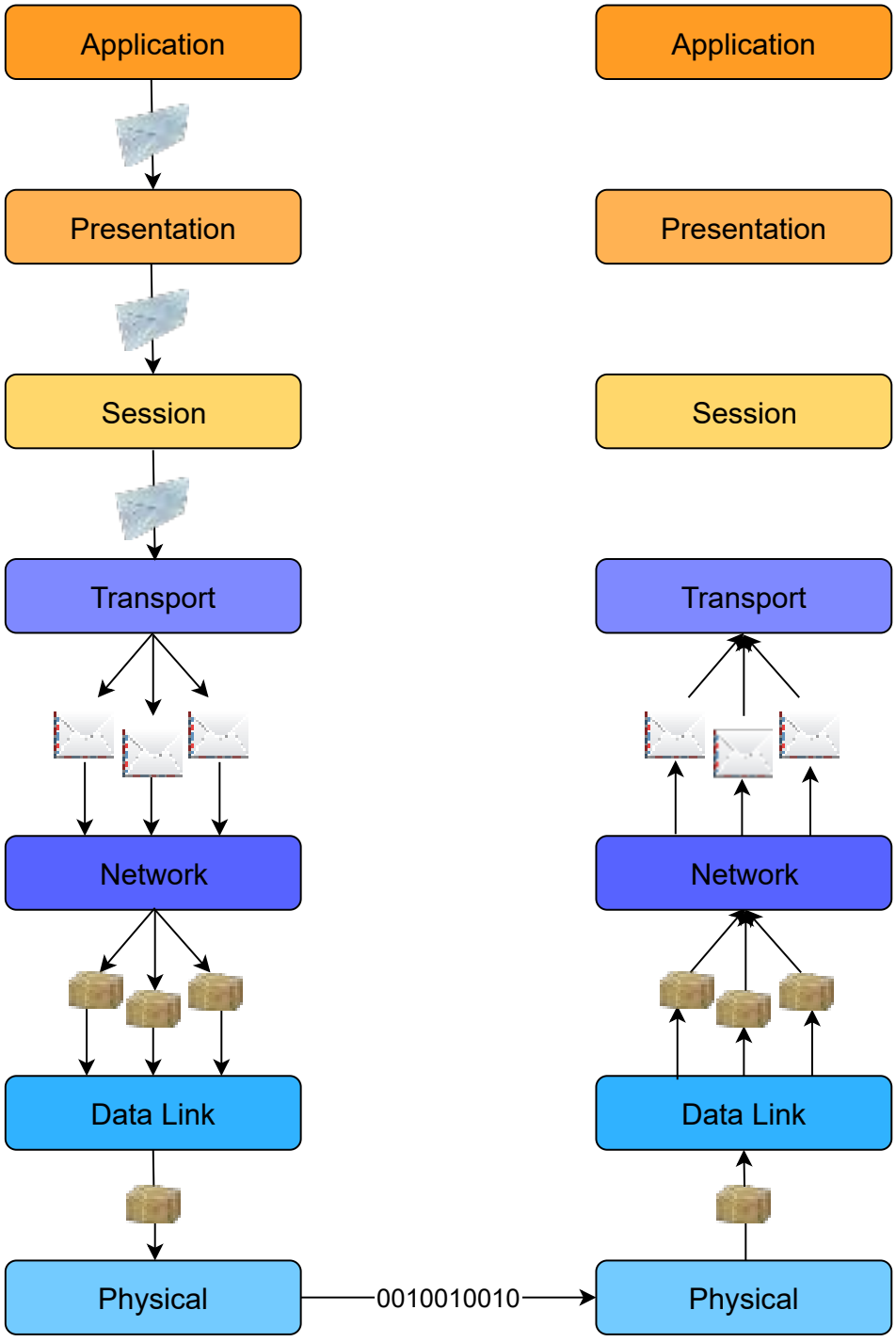


The reverse process happens from here

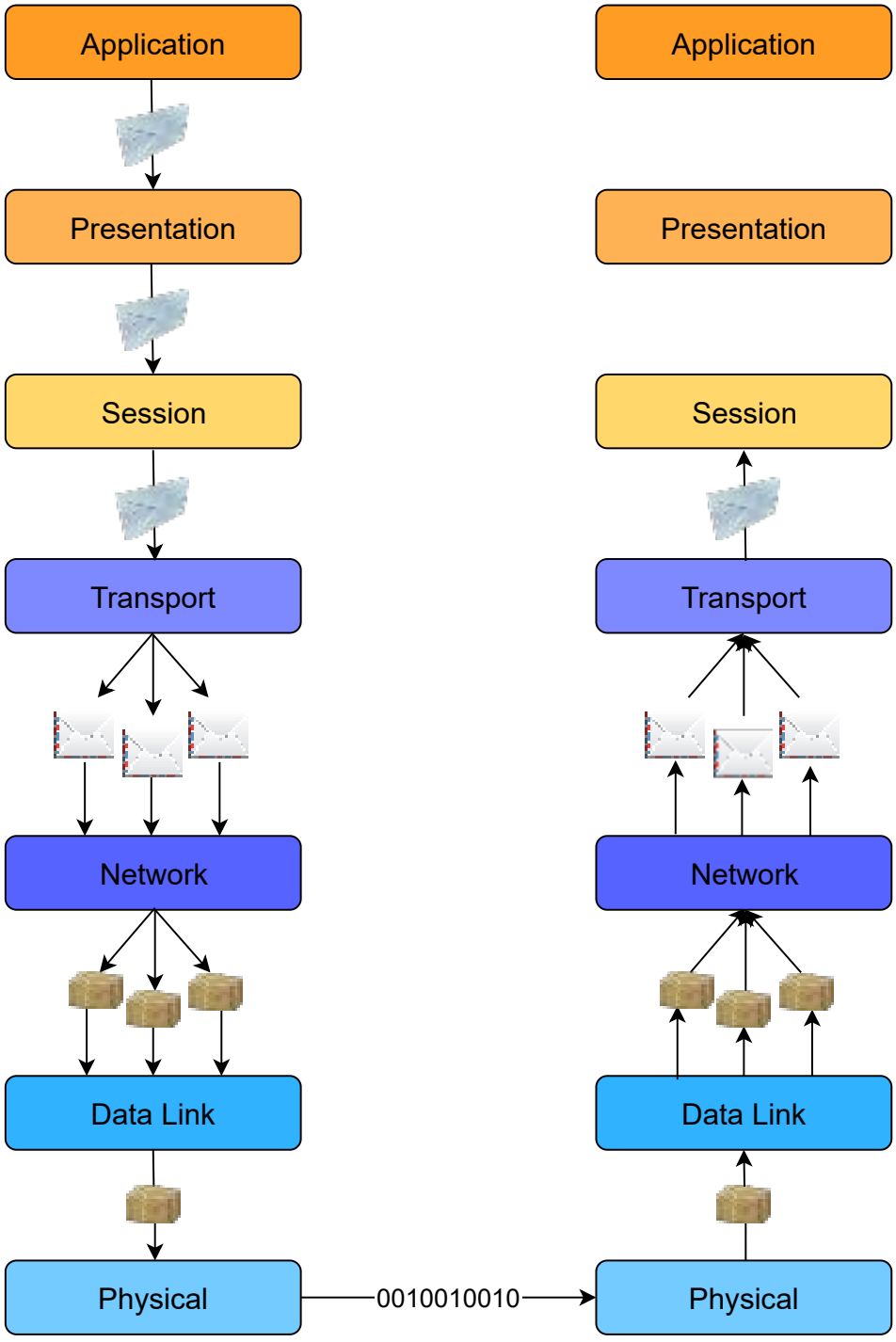
How data conceptually travels through the layers



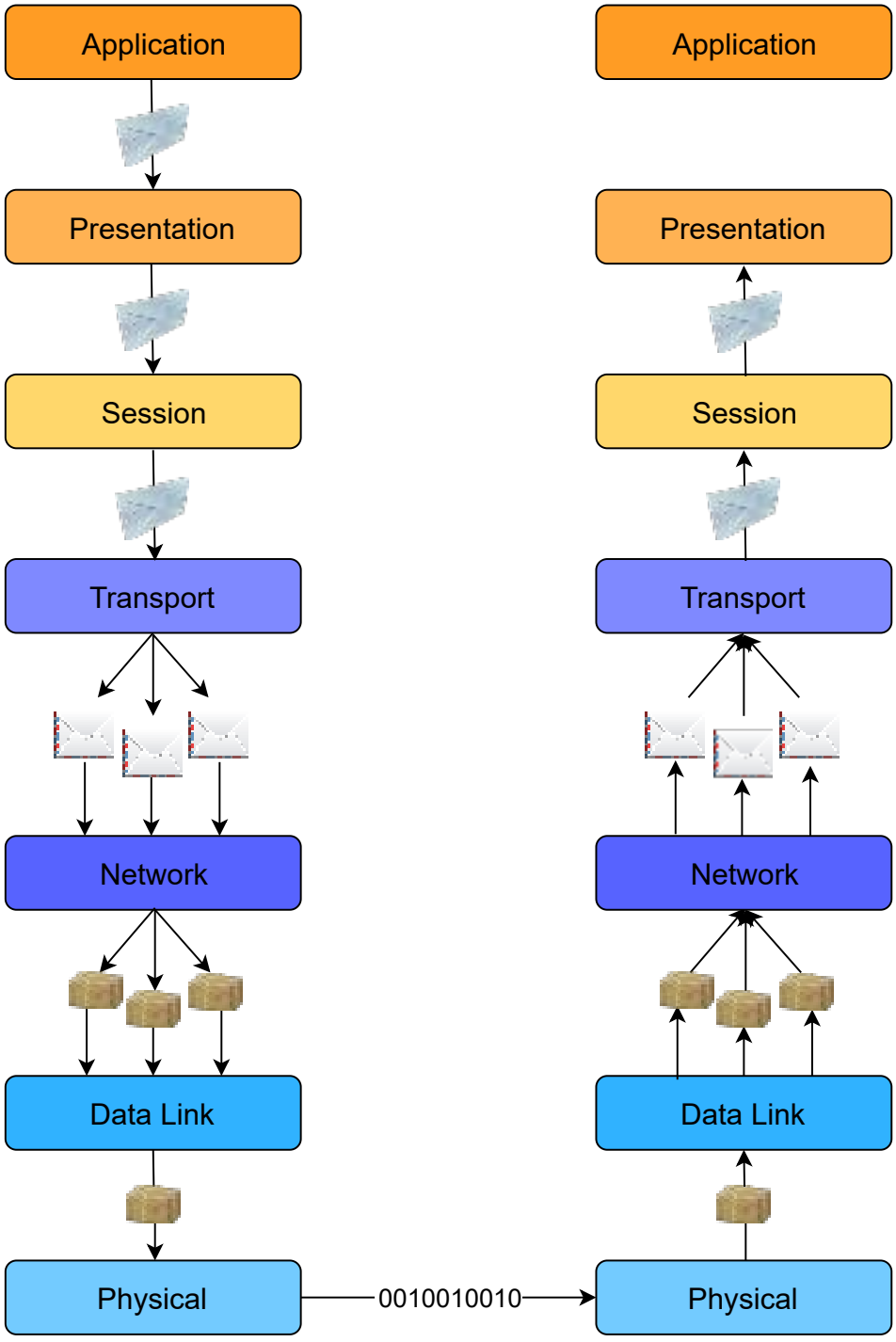
How data conceptually travels through the layers



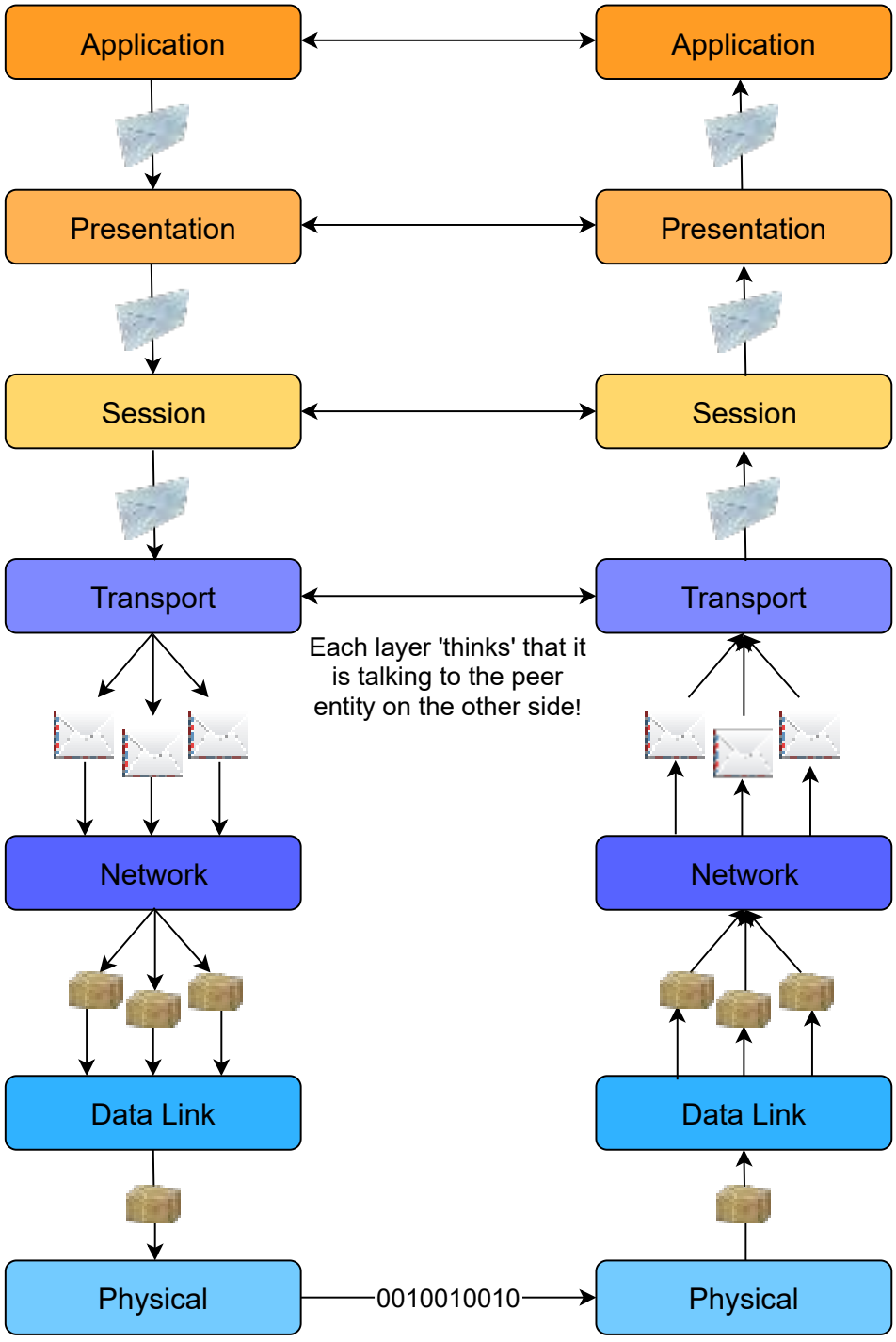
How data conceptually travels through the layers



How data conceptually travels through the layers



How data conceptually travels through the layers



How data conceptually travels through the layers

Quick Quiz!

1 How many layers does the OSI model have?

Conceptualizing networks into layers like this had a significant impact on networking education, which is why it's still taught as the primary model in a lot of courses. However, now that protocols have matured, a better way to teach networks is to take a more protocol-oriented approach. This is where the **TCP/IP model** comes in which is what we'll look at in the next lesson.