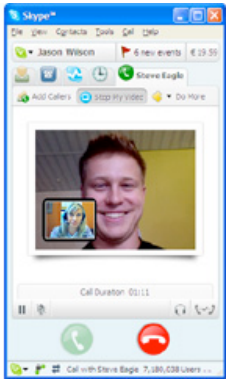
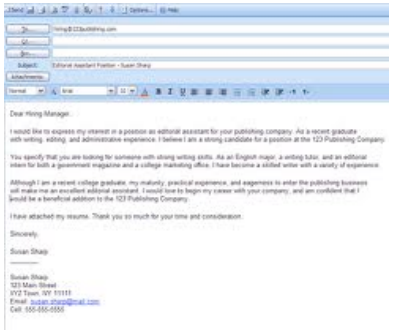
Introduction to protocol stacks

Telecommunications: a user view

- This is a typical user view of telecommunications:



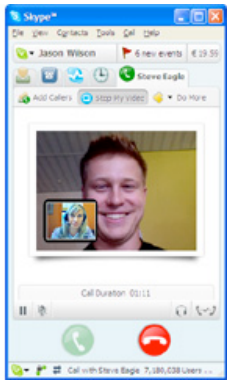
Something in between



Something in between

Telecommunications: a user view

- This is an **advanced** user view of telecommunications:



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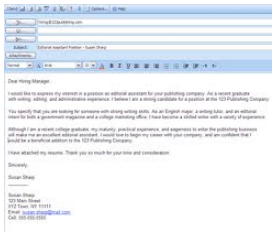

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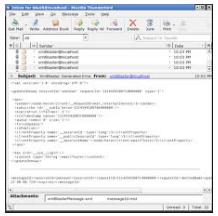
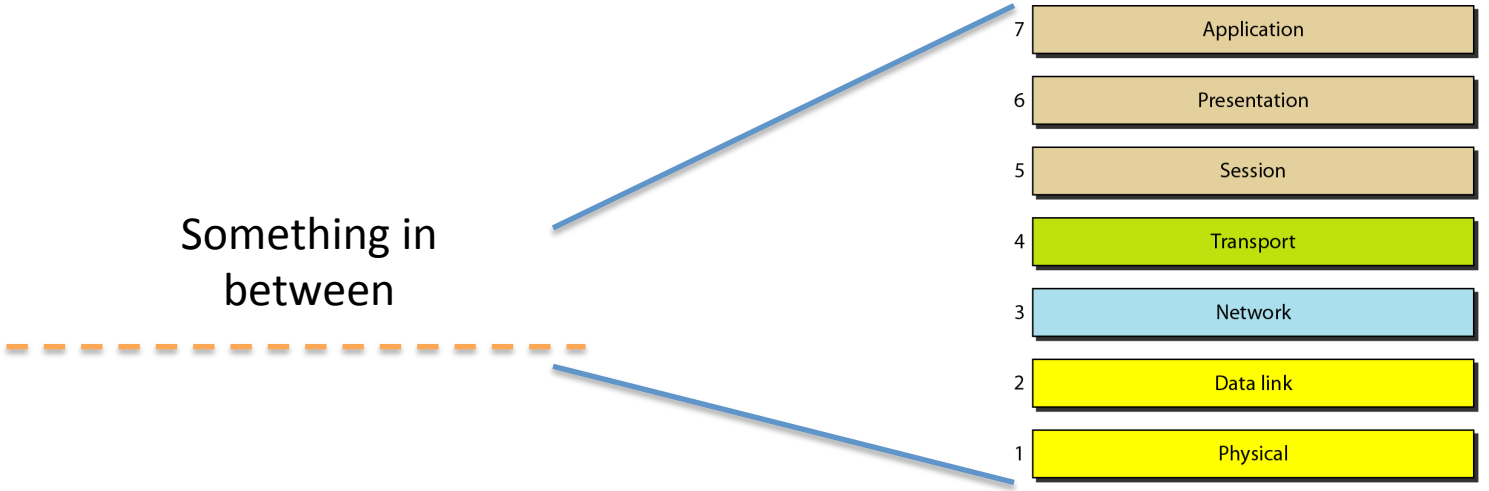


Telecommunications: a CS1031 view

- This course will mainly focus on signal transmission.
- Here however we give a brief introduction to the entire communications system that makes up the internet.
- The way the Internet works is actually quite complex:
  - Different techniques (called protocols) can be used
  - A lot of different operations are used to accomplish a communication between *applications*

Problem decomposition

- The way engineers have tackled the complexity of the communication systems is by decomposing it in simpler tasks (operated by protocols)
- These tasks were originally decomposed into the OSI (Open System Interconnect) stack



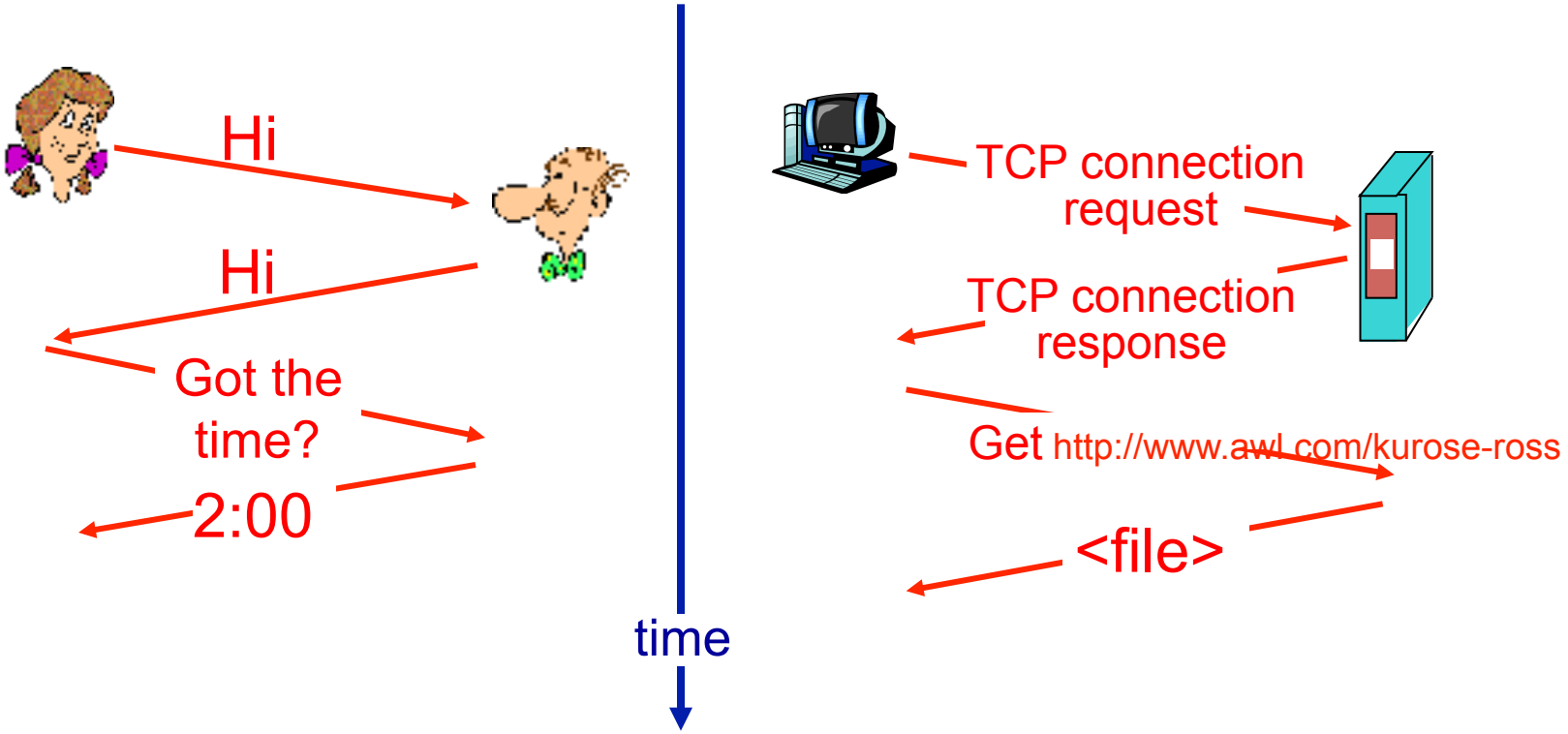
Protocol

- What is a protocol?
  - A **communications protocol** is a system of digital message formats and rules for exchanging those messages in or between computing systems and in telecommunications (from Wikipedia…)

- What does a protocol do?
  - A protocol will execute specific functions to address a sub-task of the communication problem
  - A protocol will follow specific rules and format (e.g, what does bit number 1 mean?...) which will be only understood by its peer entity on the other side of the communication link

What's a Protocol?

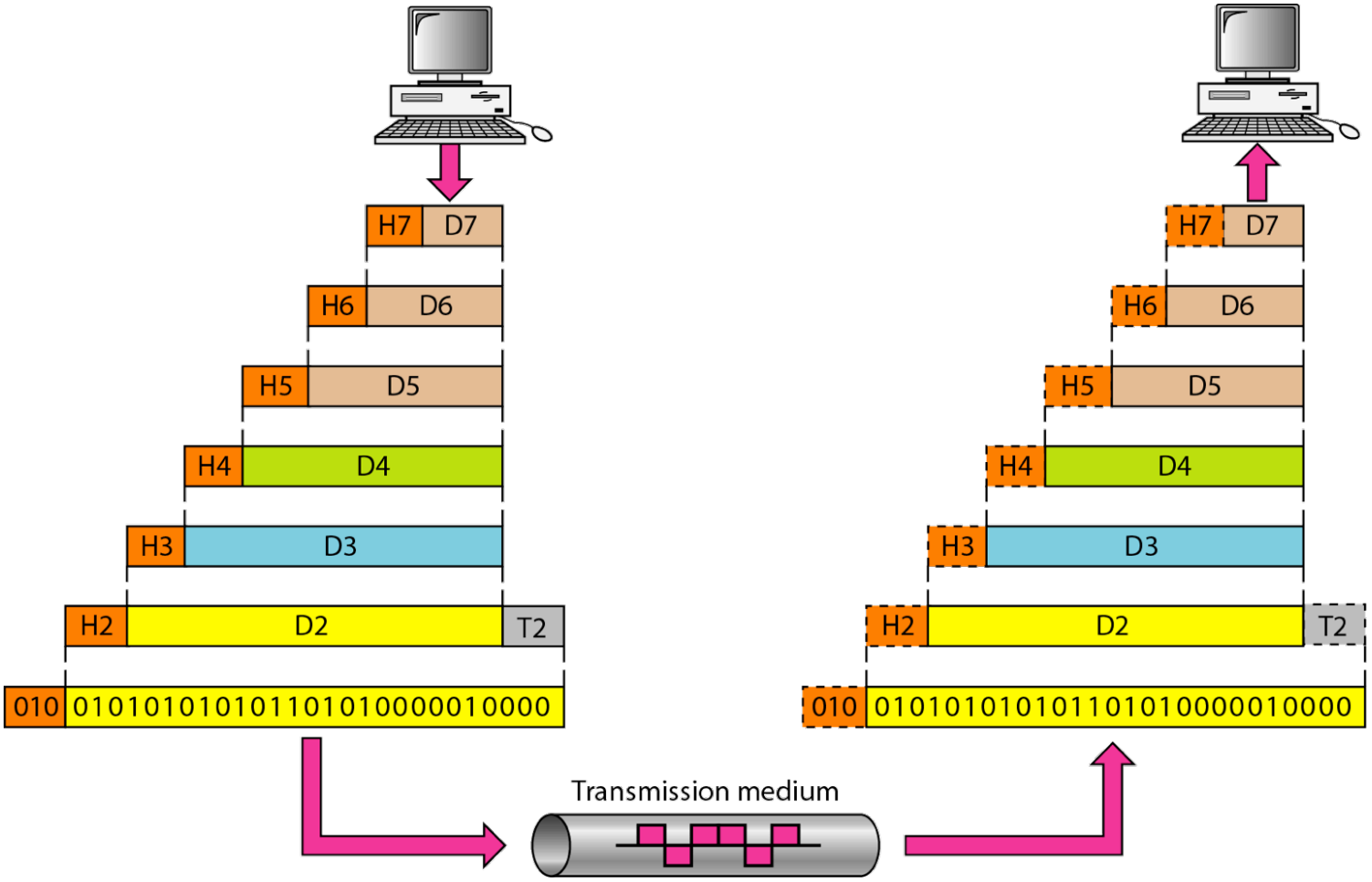
a human protocol and a computer network protocol:



OSI stack

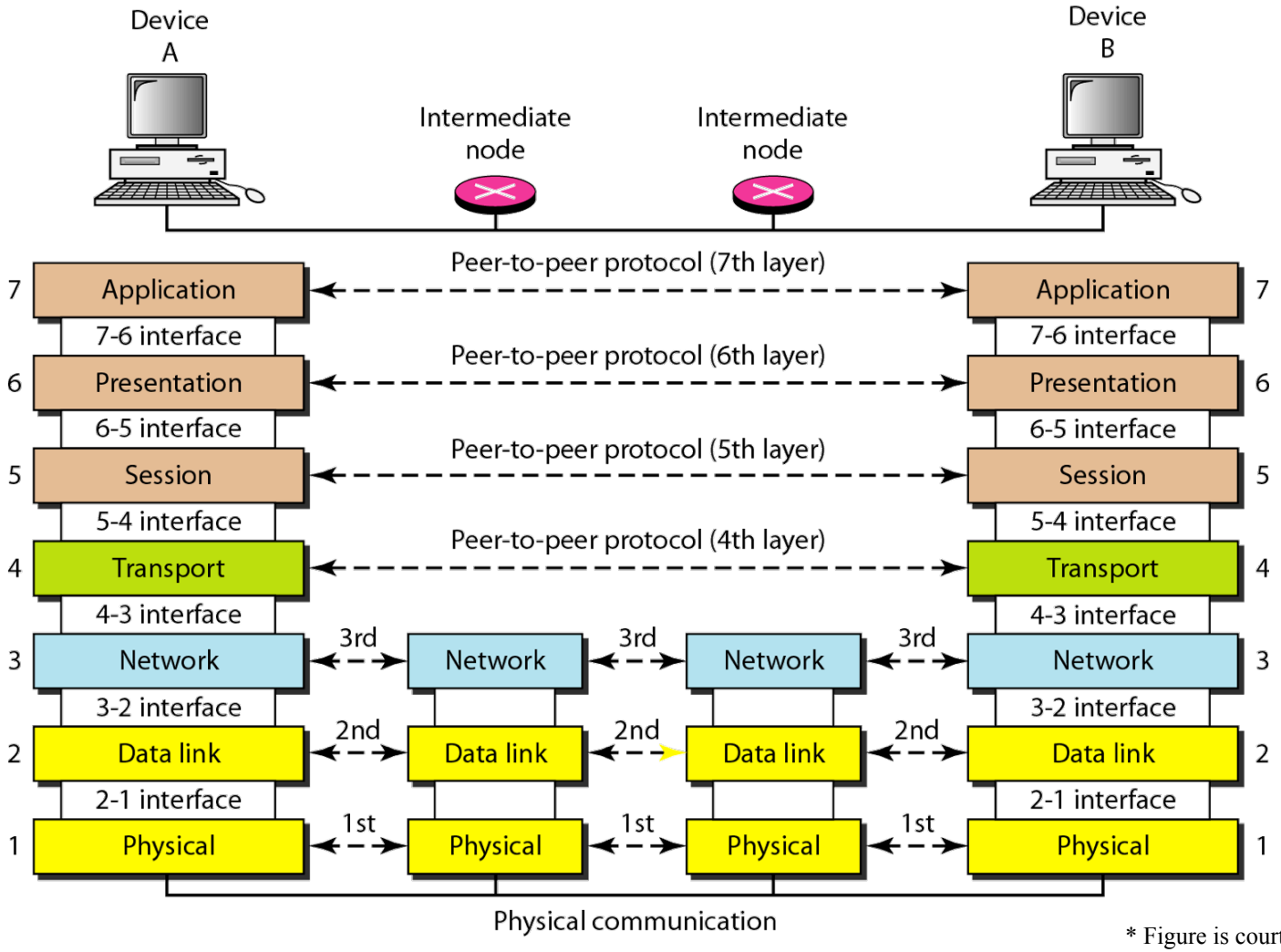
- Each layer of the stack operates some actions on the data that needs to be transmitted or received
- Data is created by the application and sent down the stack to be transmitted
- Each layer operates some function on the data and adds some overhead (header) to the data sent by the layer above.
- This process is called encapsulation

Encapsulation



Protocols work in peers

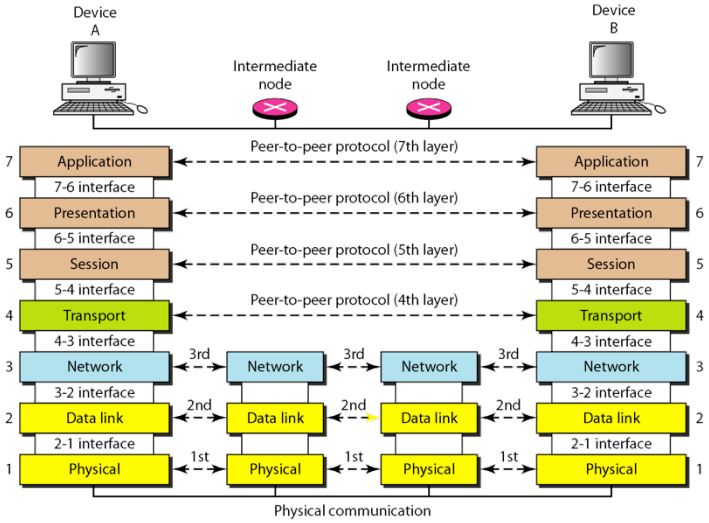
- In a network stack, protocol is designed to only interact with its peer on the other side of the network



* Figure is courtesy of B. Forouzan

Protocols work in peers

- Each protocol can only interpret the overhead header created by its peer on the other side!



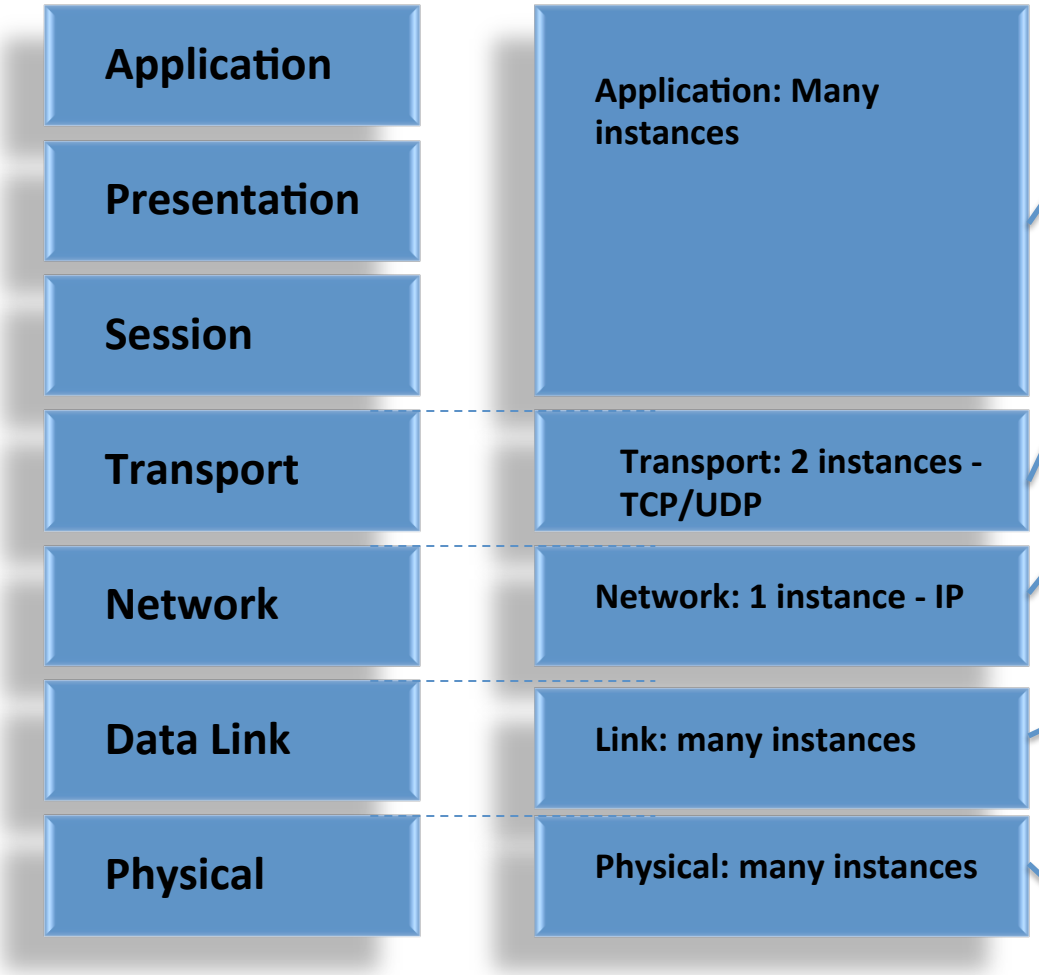
- In addition only protocols of the same type can communicate with each other
- Example: at layer 4 we could use TCP or UDP protocols
  - If I use TCP on one side, I need to use TCP also on the other side
- Example a VoIP protocol (e.g., SIP) cannot process data created by email protocol (e.g., SMTP)

Evolution of protocol stacks

- The OSI standard was created in 1984, when computer networks were not widespread and what we now call the Internet was only one of the networks

- As the Internet spread to be by far the most dominant network technology, the dominant network stack is now the Internet stack

The Internet protocol stack



Protocols that are used directly from the applications: e.g., http for web browsers; FTP for file-transfer applications,…

Allows multiple applications flow to be transmitted to/from the same machine; TCP also adds reliability to the link.

Routes packets to the correct destination from source machine to destination machine, through the entire Internet.

Regulates access to a shared transmission medium; allows to send information through one link, from one node to the next.

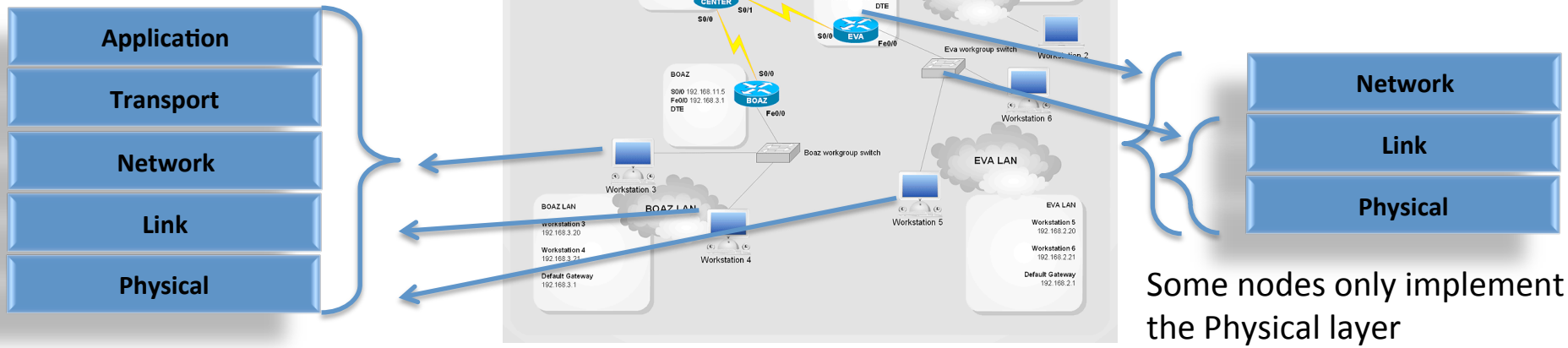
Takes care of the physical transmission of the signal, either through air (wireless), through a copper cable (guided electronic transmission) or through optical fibre (guided optical transmission)

Where are these protocols implemented?

- A network can be viewed in terms of end user devices and network nodes
- The network nodes are used to relay data from source to destination

End users need to implement the entire network stack

Network nodes only implement some parts of the lower stack



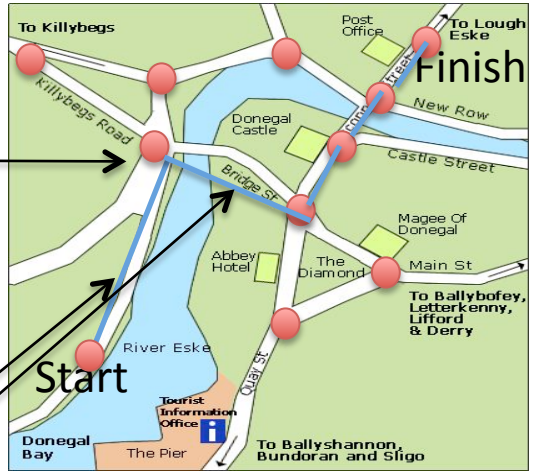
Some nodes only implement the Physical layer

Road analogy

- Let's try an analogy between data transport and road transport…

Data	Road
Application	I want to go shopping
Transport	Indicates the shop I'm going to within a shopping centre
Network	The map showing my starting point and end point and all road junctions
Link	Each individual road segment between junctions
Physical	My shoes… (+feet and legs)

This tells me the overall route from source to destination

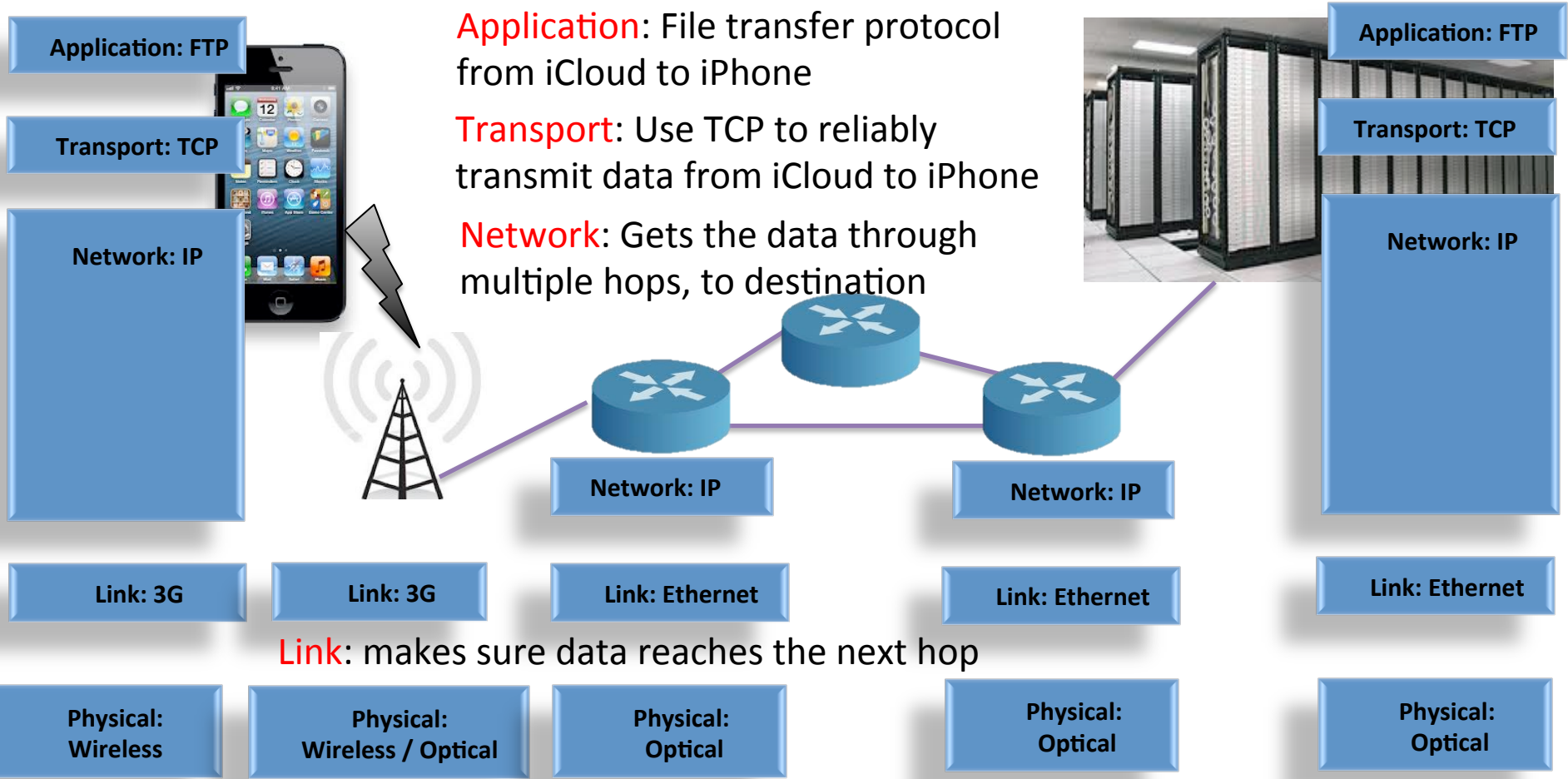


Example

Application: File transfer protocol from iCloud to iPhone

Transport: Use TCP to reliably transmit data from iCloud to iPhone

Network: Gets the data through multiple hops, to destination



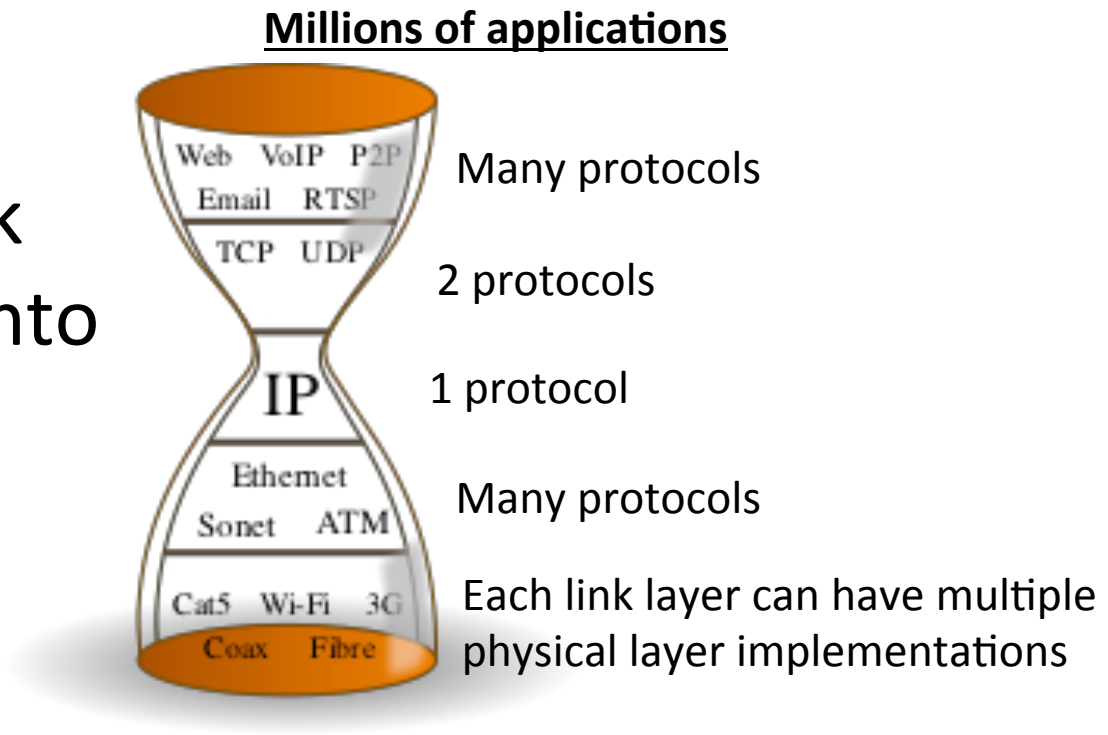
Link: makes sure data reaches the next hop

Physical: converts the digital bits of data into a signal that is transmitted over the transmission medium (air, optical fibre, copper cable)

The Internet hourglass

- The OSI stack shows classes of protocols. Within each class <u>often</u> many different protocol implementation could be used

- The Internet protocol stack has evolved into an hourglass-shaped stack



Aim of the CS1031 course

- In this course we will focus on the physical layer:
  - How is information transmitted between two nodes
  - How can we characterize these signals
  - Analog and digital modulation
  - A bit of information theory
  - Signal transmission