Introduction to protocol stacks

Student Online Teaching Advice Notice

The materials and content presented within this session are intended solely for use in a context of teaching and learning at Trinity.

Any session recorded for subsequent review is made available solely for the purpose of enhancing student learning.

Students should not edit or modify the recording in any way, nor disseminate it for use outside of a context of teaching and learning at Trinity.

Please be mindful of your physical environment and conscious of what may be captured by the device camera and microphone during videoconferencing calls.

Recorded materials will be handled in compliance with Trinity's statutory duties under the Universities Act, 1997 and in accordance with the University's [policies and](#) [procedures](#).

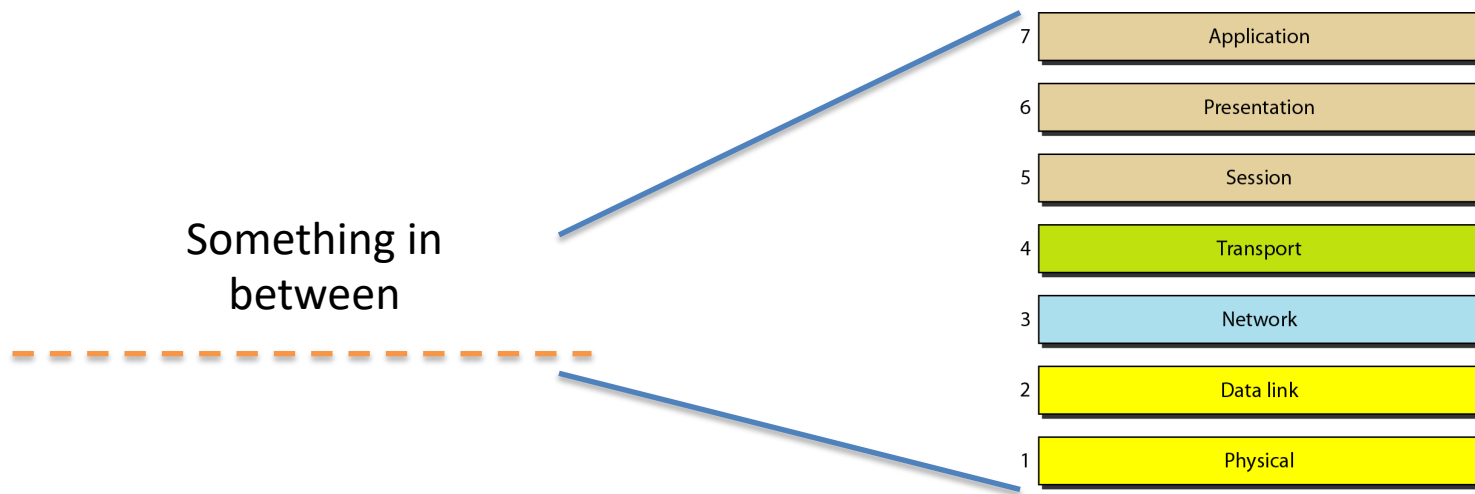**Further information on data protection and best practice when using videoconferencing software is available at https://www.tcd.ie/info_compliance/data-protection/.**

© Trinity College Dublin 2020

Telecommunications: a CSU1031 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

Something in between

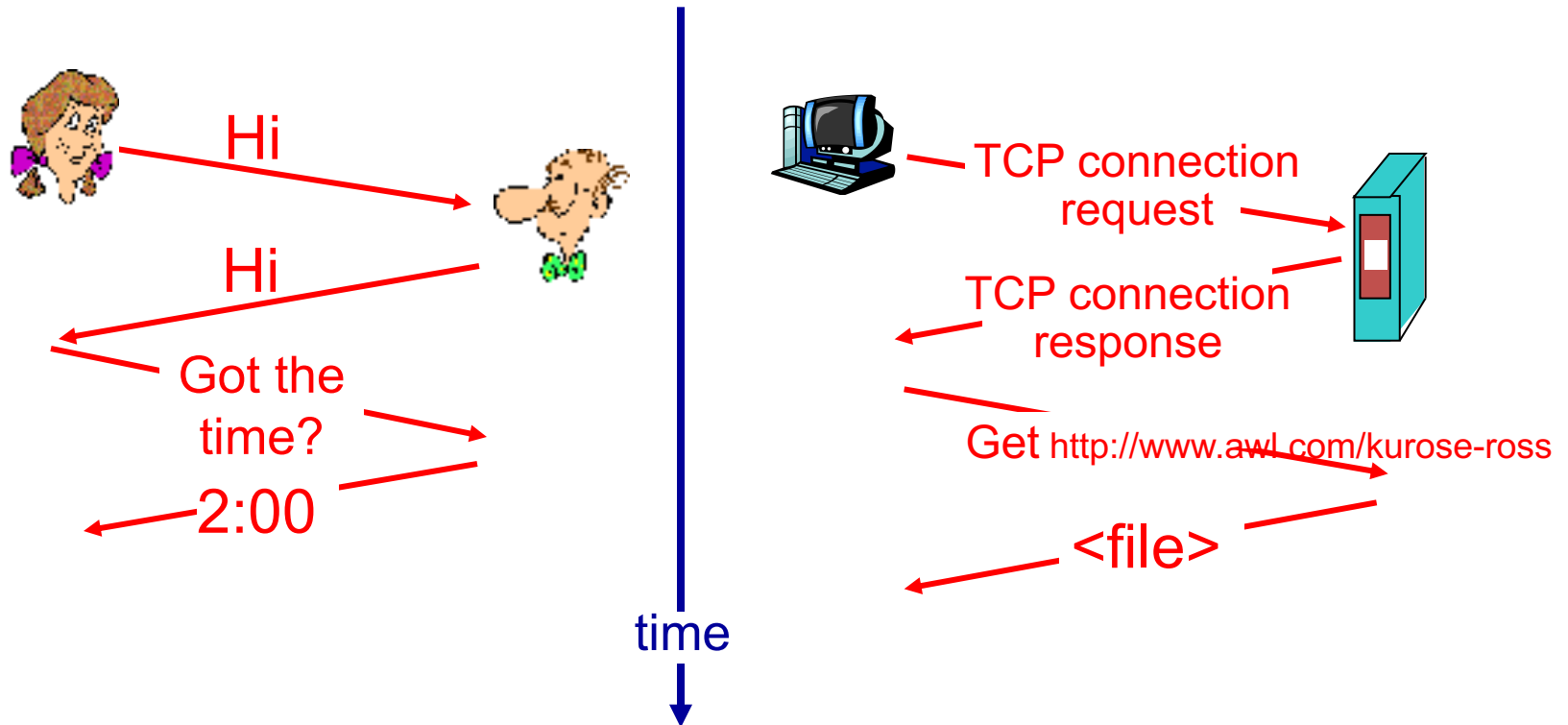|	
7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data link
1	Physical

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 means?...) 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:

Hi

Hi

Got the time?

2:00

TCP connection request

TCP connection response

Get http://www.awl.com/kurose-ross

<file>

time

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
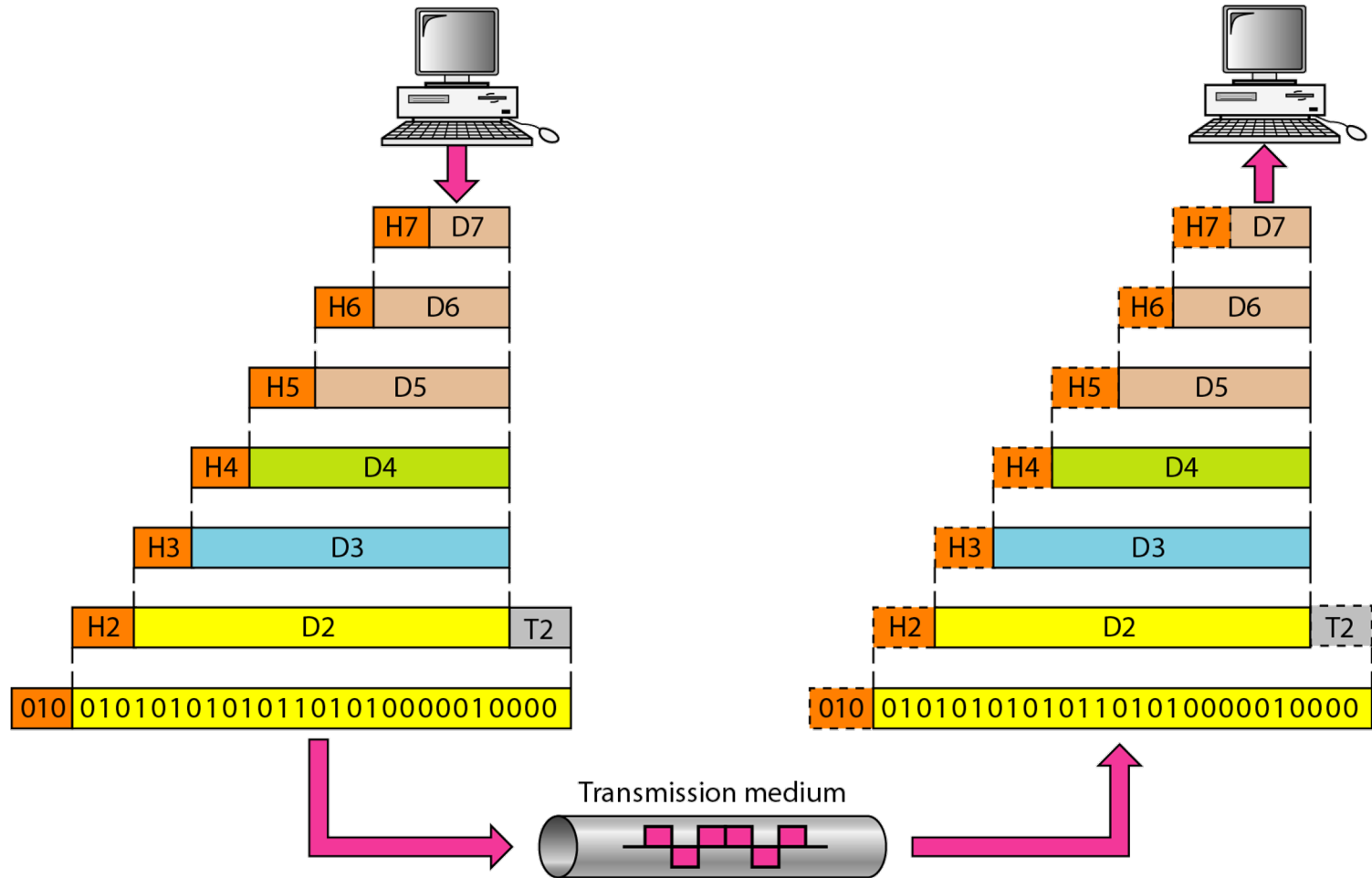
Protocols work in peers

- In a network stack each protocol is designed to only interact with its peer on the other side of the network
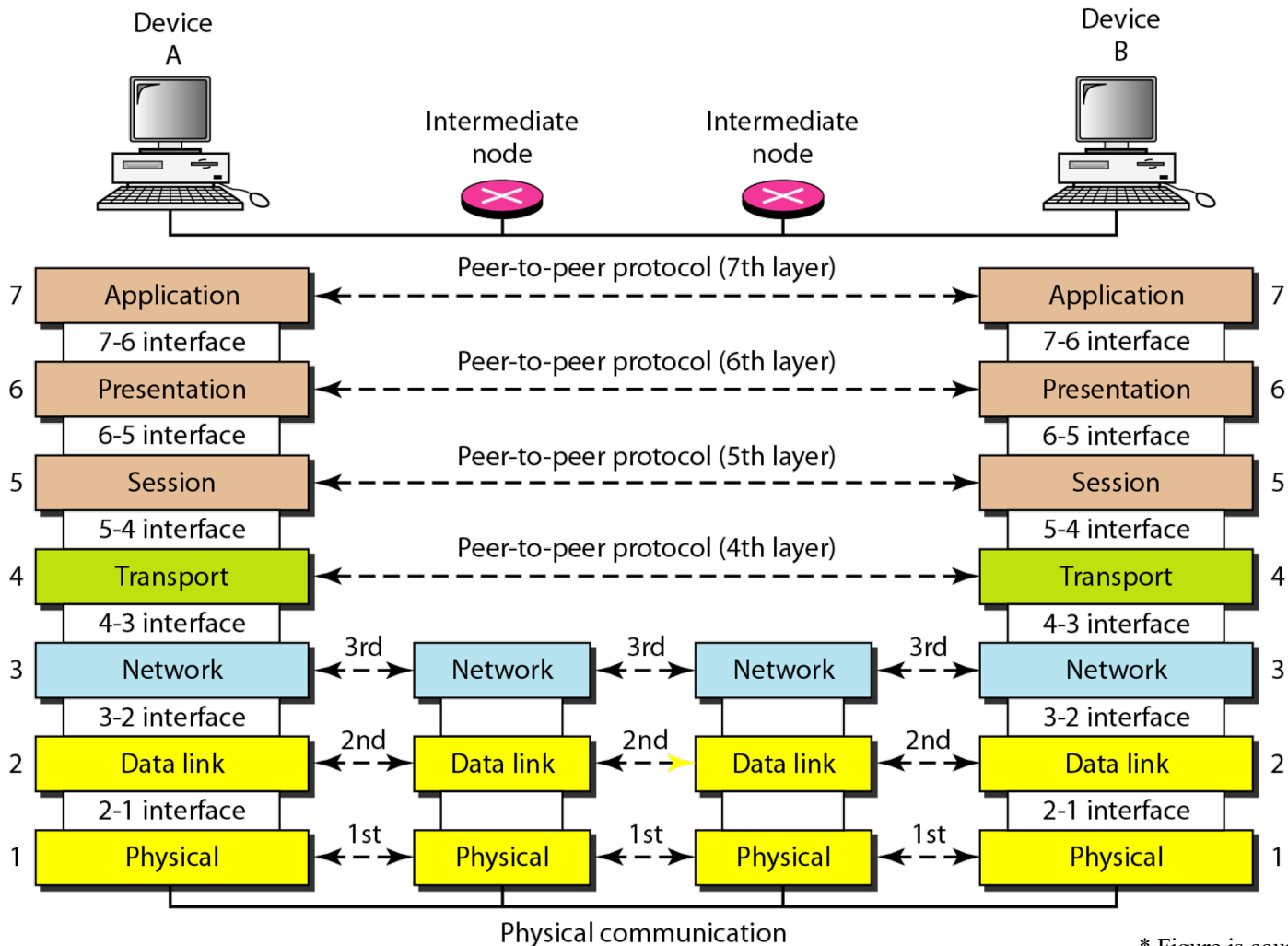
Why intermediate nodes need to operate over layers 1, 2 and 3?

A. Because L3 contains routing information on how to reach the next node

B. Because L3 is the highest layer of the communication stack

C. It doesn't, it needs L3 but doesn't need L1 and L2

63%

19%

19%

Because L3 contains routing information on hoe to reach the next...

Because L3 is the highest layer of the communication stack

It doesn't, it needs L3 but doesn't need L1 and L2
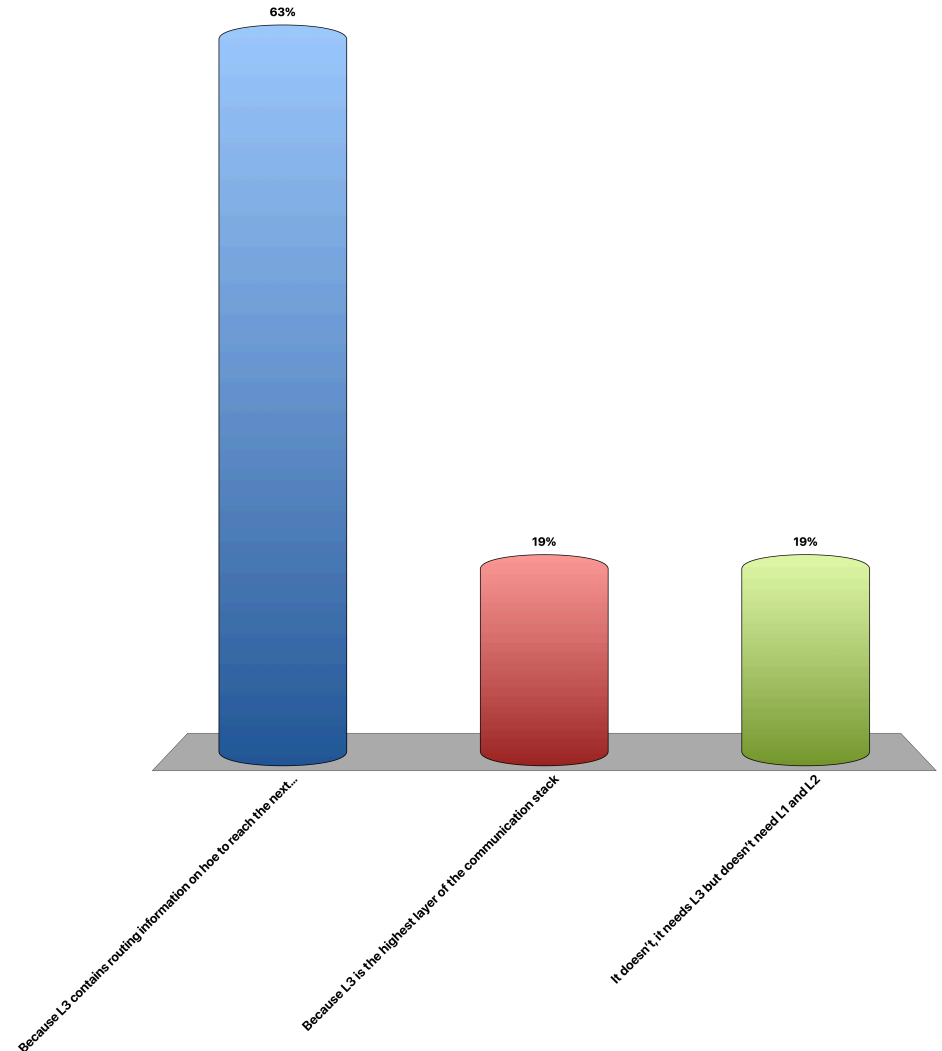
Evolution of protocol stacks

- 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

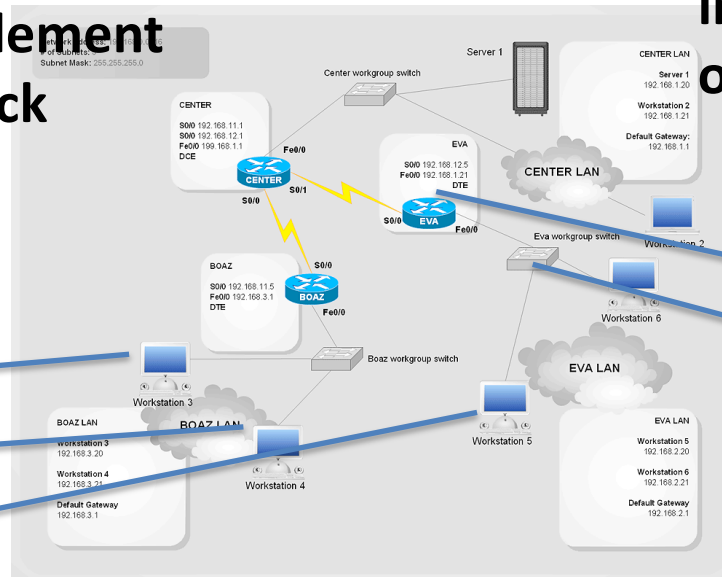|	
Application	
Presentation	**Application: Many instances**
Session	
Transport	**Transport: 2 instances - TCP/UDP**
Network	**Network: 1 instance - IP**
Data Link	**Link: many instances**
Physical	**Physical: many instances**

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

Allows multiple application flows 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)
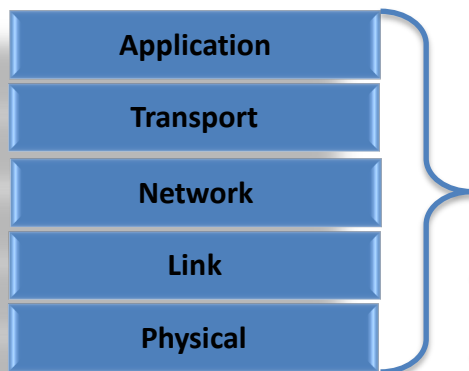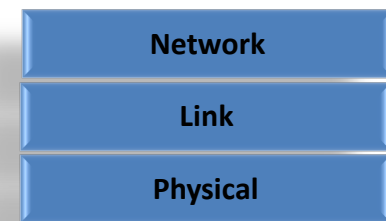
Where are these protocols implemented?

- A network can be viewed in terms of end user devices and network nodes

- The network nodes are used to rely data from source to destination

Network nodes only implement some parts of the lower stack

End users need to implement the entire network stack

Some nodes only implement the Physical layer

Road analogy

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

Data

Road

Data
Application
Transport
Network
Link
Physical

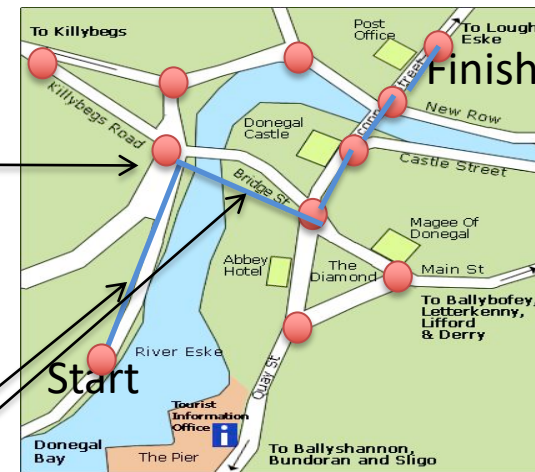**I want to go shopping**

Indicates the shop I'm going to within a shopping centre

This tells me the overall route from source to destination

The map showing my starting point and end point and all road junctions

Each individual road segment between junctions

My shoes… (+feet and legs)

Example

iTunes

Application: FTP

Transport: TCP

Network: IP

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

Application: FTP

Transport: TCP

Network: IP

Network: IP

Network: IP

Network: IP

Network: IP

Link: 4G

Link: 4G

Link: Ethernet

Link: Ethernet

Link: Ethernet

Link: makes sure data reaches the next hop

Physical: Wireless

Physical: Wireless / Optical

Physical: Optical

Physical: Optical

Physical: Optical

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

Why layers 4 and above only operate at the end points?

A. Because it makes the middle network nodes simpler

B. Because the information is not needed for packet routing purposes

C. Because otherwise the system would not scale to billions of users

D. All of the above
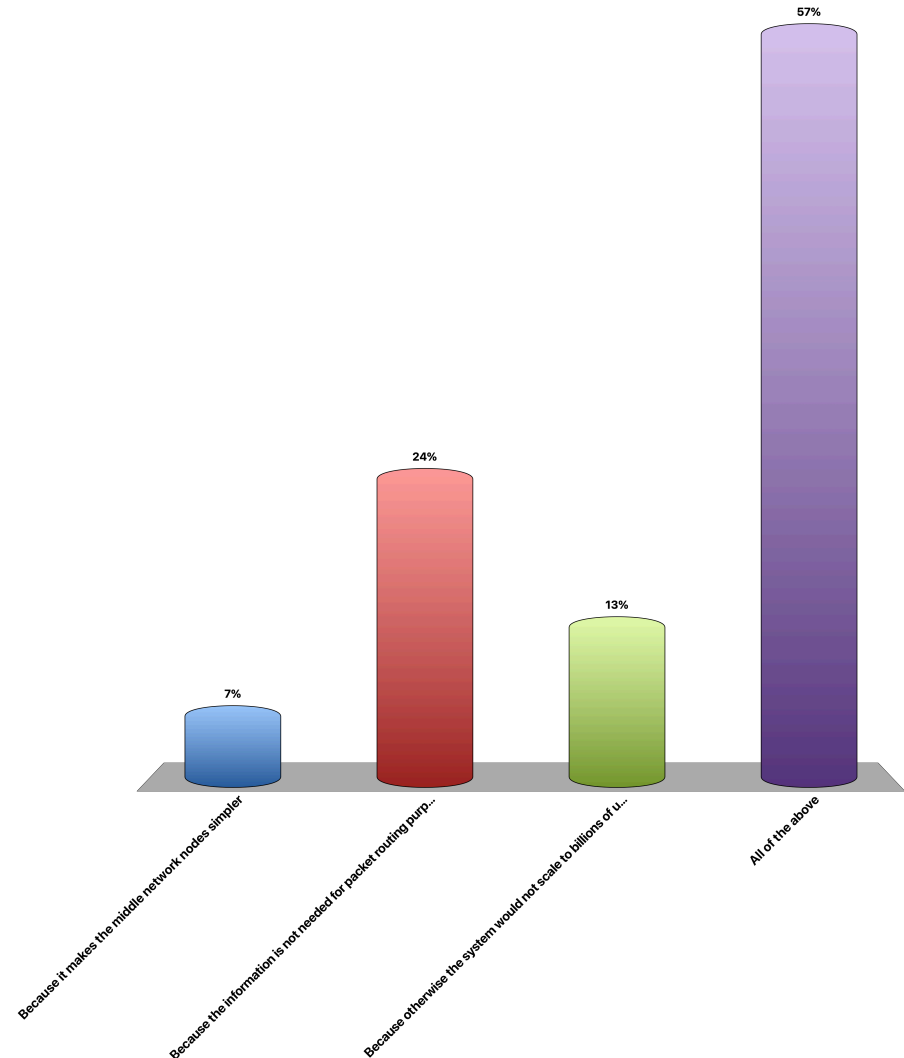
Aim of the CS1031 course

- 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