



University
of Glasgow

Introduction to Networks (2)

Networked Systems 3
Lecture 2

Lecture Outline

- Network Protocols
- Protocol Layering
 - OSI Reference Model
- Protocol Standards

Network Protocols

- Communication occurs when hosts exchange messages across a channel
- For meaningful communication, those messages must be in a common language, and obey some common rules – these form a *network protocol*

Network Protocols: Language

- How is the grammar specified? What is the syntax?
 - Are messages textual?
 - What character set? language? How is binary data embedded?
 - Or binary?
 - Big or little endian? 32 or 64 bit? Fixed or variable length? What are the alignment requirements? Etc.
- What do protocol messages mean?

Network Protocol: Rules

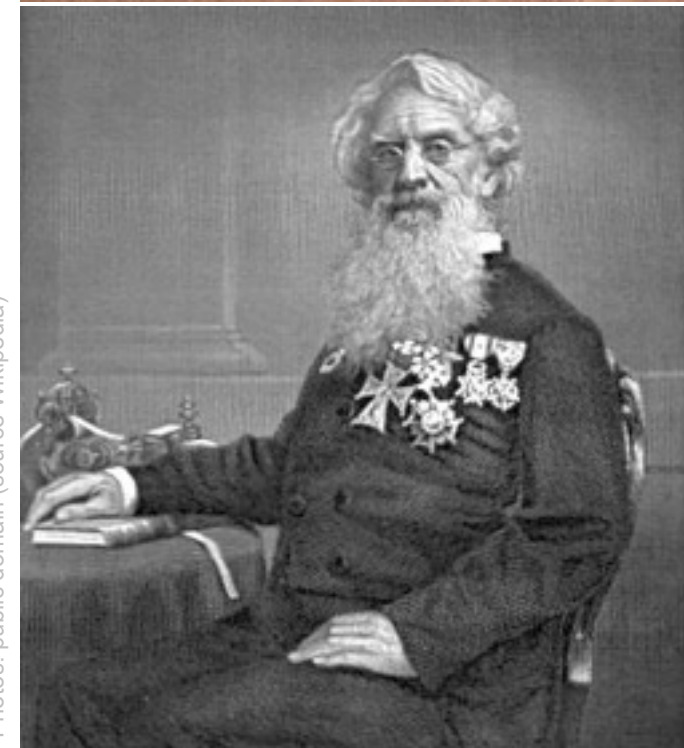
- What are the entities that communicate?
 - Peer-to-peer? Client-server? Broadcast?
 - How are entities named?
- How is access to the channel controlled?
 - How can send messages? When?
- How are errors handled?
 - How do you know if a message was received?

Example: Morse Code

- An simple network protocol: telegraph using Morse code
 - Signal on electrical cable forms channel
 - Patterns of dots and dashes is a protocol:

A	• -	J	• • • •	S	• • •
B	- • • •	K	- • •	T	-
C	- • • •	L	• • • •	U	• • -
D	- • •	M	- -	V	• • • -
E	•	N	- •	W	• - -
F	• • • •	O	- - -	X	- • • •
G	- • •	P	• • • •	Y	- • • •
H	• • • •	Q	- • • •	Z	- • • •
I	• •	R	• • •		

- Gap lengths vary between letters, words

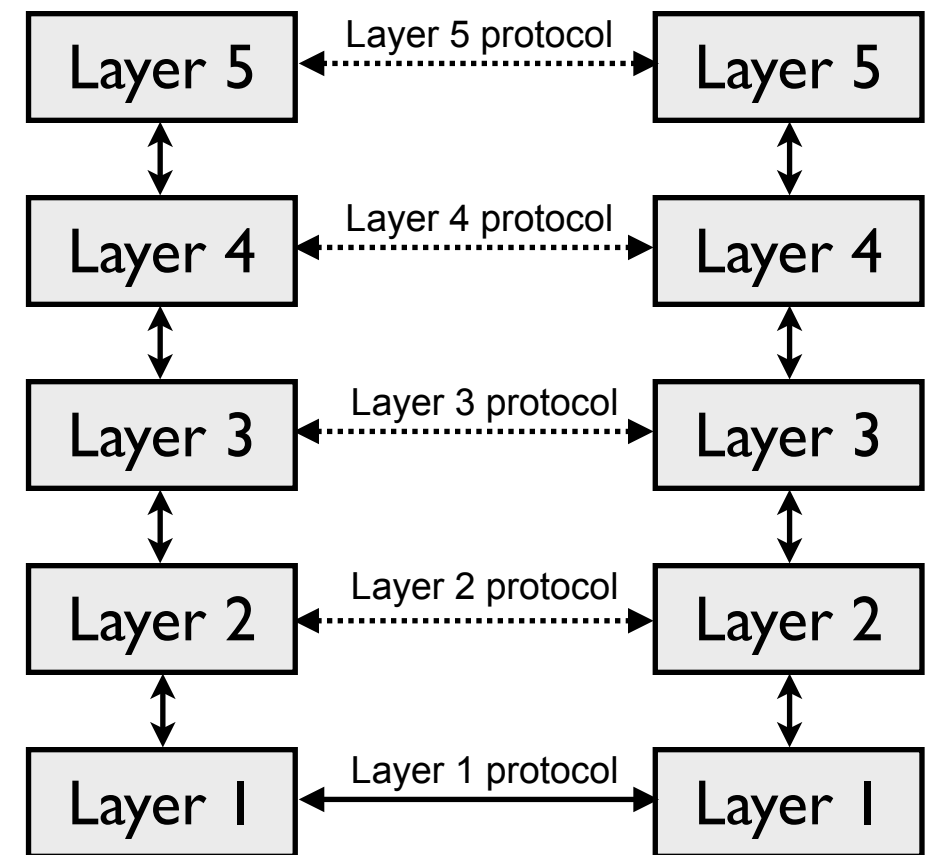


Samuel Morse

Photos: public domain (source Wikipedia)

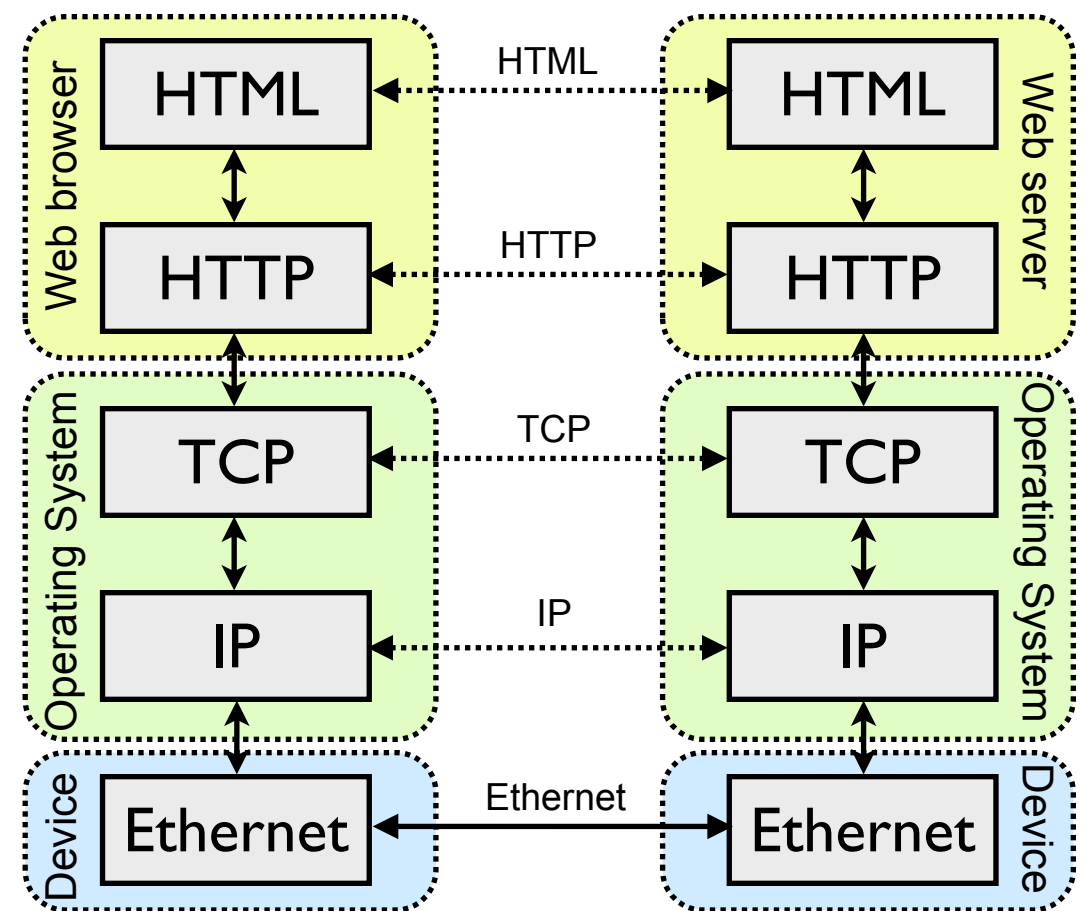
Protocol Layering

- Communications systems are typically organised as a series of *protocol layers*
 - Structured design to reduce complexity
 - Each layer offers *services* to the next higher layer, which it implements using the services of the lower layer – well defined *interfaces*
 - Highest layer is the communicating application
 - Lowest layer is the physical communications channel
- Peers at some layer, i , communicate via a layer i protocol, using lower layer services

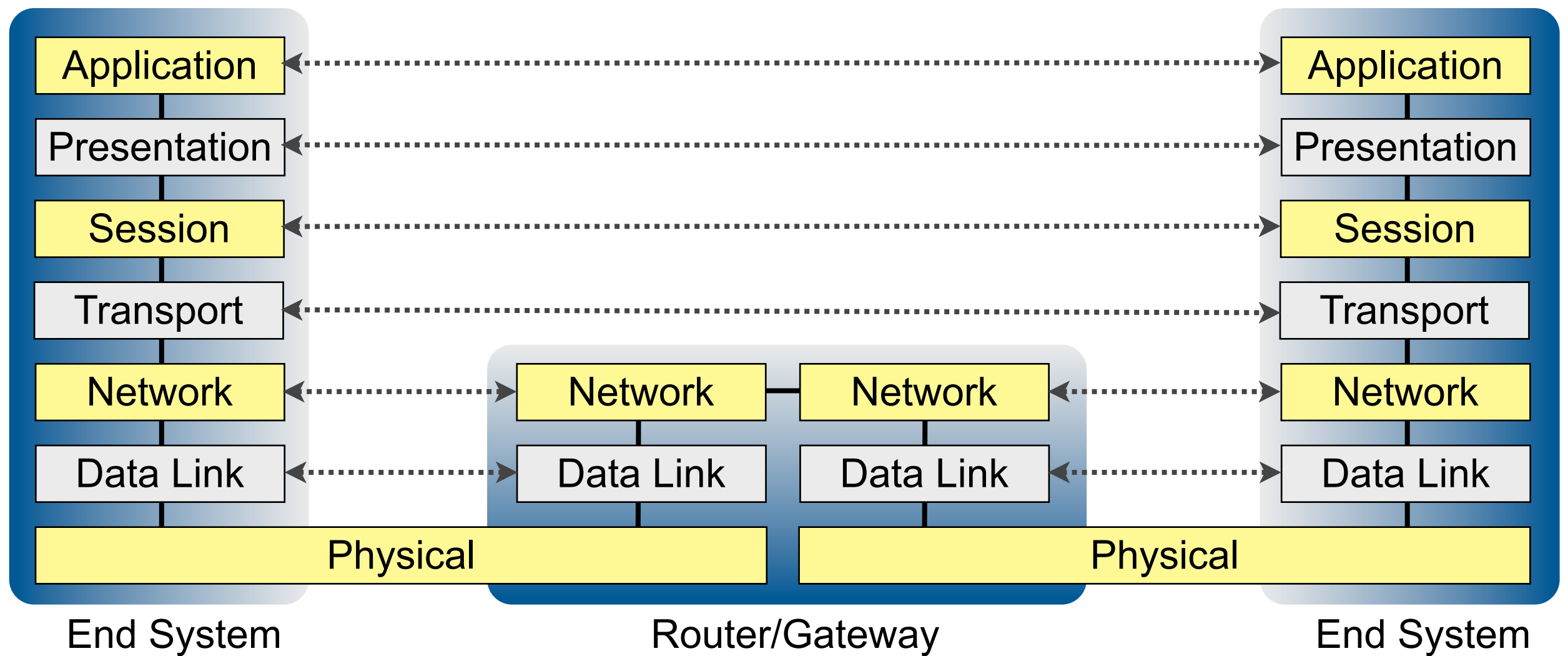


Protocol Layering: Example

- Web browser talking to a web server
- Simplified view with five protocol layers:
 - HTML
 - HTTP
 - TCP
 - IP
 - Ethernet

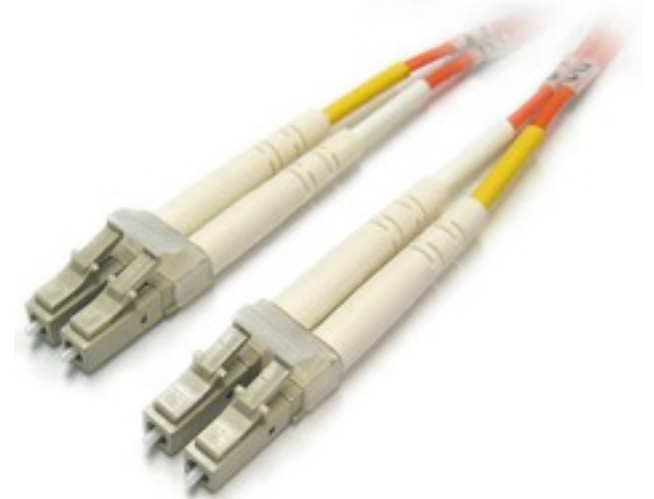


OSI Reference Model



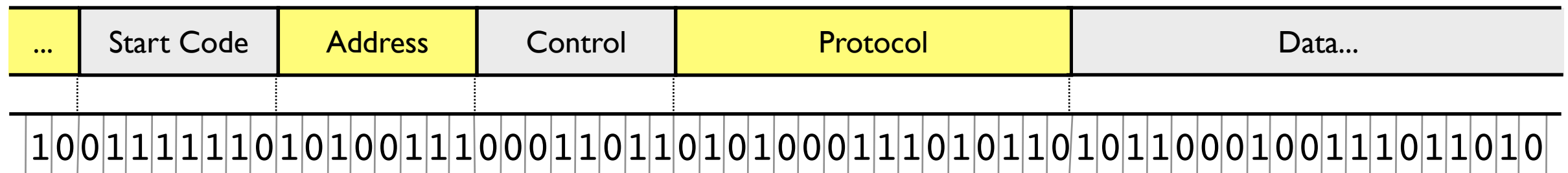
Physical Layer

- Defines characteristics of the cable or optical fibre used:
 - Size and shape of the plugs
 - Maximum cable/fibre length
 - Type of cable: electrical voltage, current, modulation
 - Type of fibre: single- or multi-mode, optical clarity, colour, power output, and modulation of the laser
- For wireless links:
 - Radio frequency, transmission power, modulation scheme, type of antenna, etc.



Data Link Layer (1)

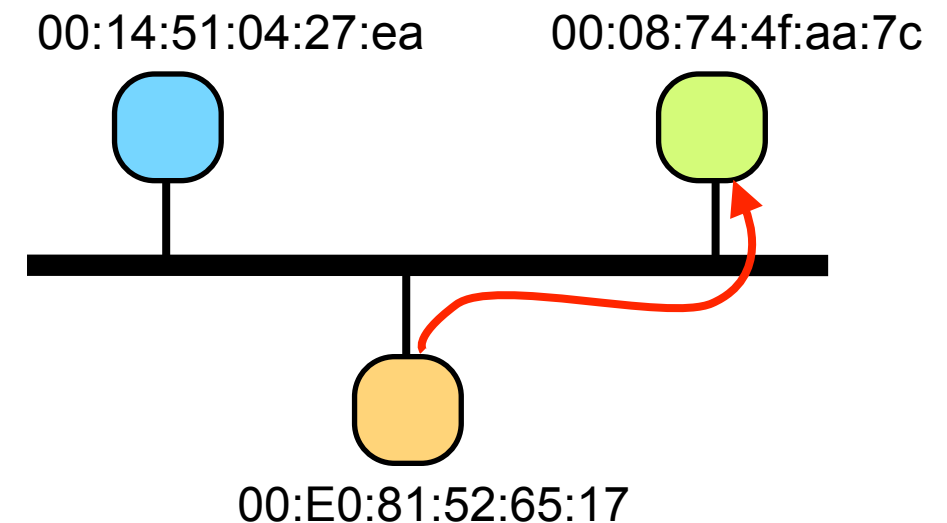
- Structure and frame bit stream provided by the physical layer



- Detect and correct errors on the link
 - Parity and error correcting codes
 - (Negative) acknowledgements + retransmission

Data Link Layer (2)

- Media access control
 - Some physical links (e.g. Wi-Fi) shared between multiple hosts
 - Requires link layer addresses
 - Hosts have addresses on the link
 - Messages include source and destination addresses
 - Arbitrate requests for access to the media; resolve collisions
 - Ensure fair access to the link and provide flow control



Example: Ethernet with CSMA-CD

Network Layer

- Interconnects multiple links to form a wide area network from source host to destination host
 - Data delivery
 - Naming and addressing
 - Routing
 - Admission/Flow control
- Example: IP

Transport Layer

- End-to-end transfer of data from the source to the destination(s)
 - Transfers data between a session level service at the source, and corresponding service at the destination
 - May provide reliability, ordering, framing, congestion control, etc.
 - Depends on guarantees provided by the network layer
- Example: TCP

Session Layer

- Manages (multiple) transport layer connections
- Example session layer functions:
 - Open several TCP/IP connections to download a web page using HTTP
 - Use SMTP to transfer several email messages over a single TCP/IP connection
 - Coordinate control, audio and video flows making up a video conference

Presentation Layer

- Manages the presentation, representation, and conversion of data:
 - Character set, language, etc.
 - Data markup languages (e.g. XML, HTML)
 - Data format conversion (e.g. big or little endian)
 - Content negotiation (e.g. MIME, SDP)
- Common services used by many applications

Application Layer

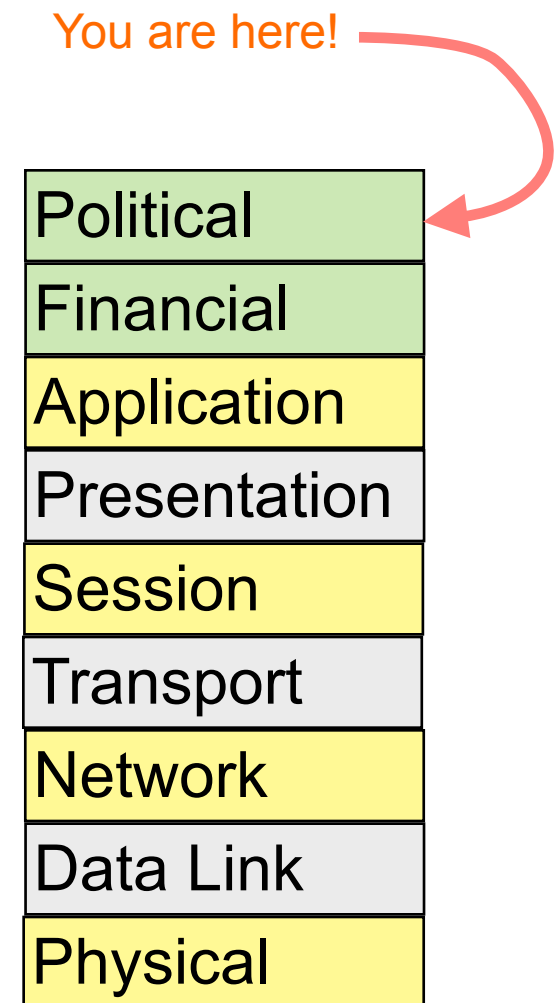
- User application protocols
 - *Not* the application programs themselves
- Examples:
 - Flickr API, Facebook API, Google Maps API, etc.
 - Web services
 - Grid computing

OSI Reference Model

- Definition of OSI model was *extremely* political
 - None of the layers or layer boundaries should be considered sacrosanct
 - Doesn't reflect *any* deployed system architecture
 - But... very useful to guide thinking about systems architectures and implementations

Protocol Standards

- A (mostly) formal description of a protocol
- To ensure interoperability amongst diverse implementations
- Variety of standards setting procedures:
 - Open or closed standards development process
 - Free or restricted standards availability
 - Individual vs. corporate vs. national membership
 - Lead technical development or document existing practice



Key Standards Organisations

- Internet Engineering Task Force
 - <http://www.ietf.org/> and <http://www.rfc-editor.org/>
- International Telecommunications Union
 - <http://www.itu.int/> (part of the United Nations)
- 3rd Generation Partnership Project
 - <http://www.3gpp.org/>
- World Wide Web Consortium
 - <http://www.org/>



Questions?