The OSI Model

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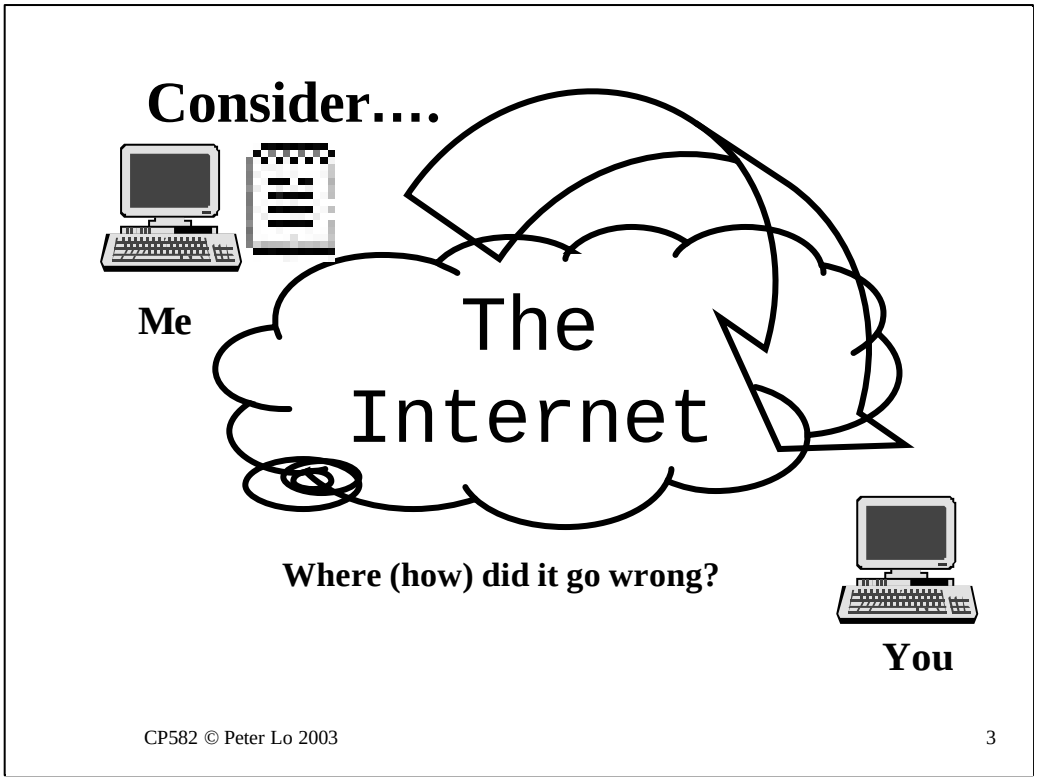
The finale to NPS is a brief tour through the OSI layers.

OSI? ISO?

Open
Systems
Interconnection

International
Standards
Organisation

This slide reminds you of the acronym anguish when we have an S and an O and an I to play with….



You now know a lot about what goes on between "Me" and "You" on the Internet and you also know (even before NPS) that this can go wrong.

The big question - which OSI layers are intended to help us answer - is "Where did it go wrong?"

Was it……?

- Local delivery?
  - Lots of different steps along the way
- Remote delivery?
  - Maybe a routing table error?
- Something to do with “Reliability”?
  - Wrong port used?
- Faulty service
  - FTPD not running?

There are so many possibilities **but** you now know that they fall into quite different logical categories. Another way to put this is that we can inspect the overall communication and **understand** it in terms of layers.

What about….?

- New developments
  - Invent a great new way to connect computers together
    - Does this affect everything else?
    - Do we have to redesign the whole Internet:?
  - Invent a new service
    - Can this be delivered using the same lower levels?
- Hopefully the answer is "yes"
  - Requirement is "encapsulation"

Layering the technology of communication makes it possible to "reinvent" portions of it without upsetting the whole apple-cart. If the layering is done properly, if things are correctly encapsulated, then new additions should interoperate with what is already there.

The Official Division of Networking

The term I used in the first lecture was "black-boxing" and that should now make a lot more sense.

When we understand a layer, how it works, what input it requires, what output it produces, we can put it in a black box and simply use it.

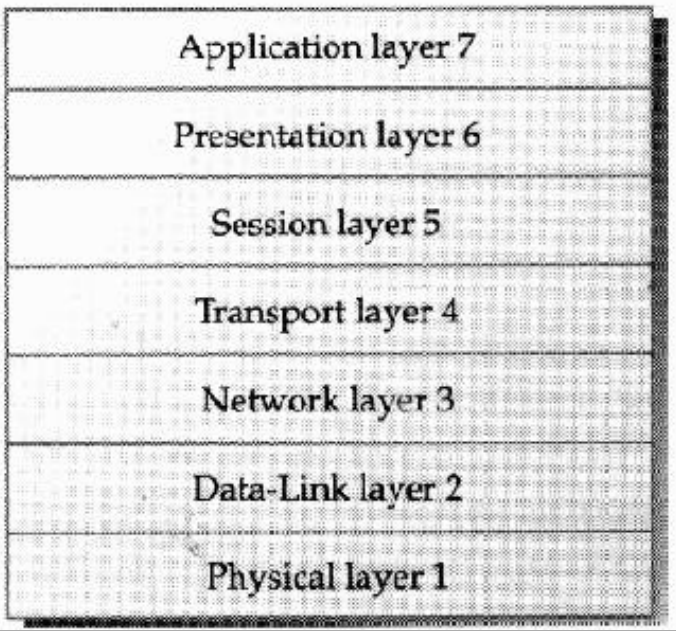
The same is true, of the remote applications that we were looking at in the first half of this lecture - the key to it all was defining the interface - the controls on the outside of the black box.

So this is what we have **not** been talking about throughout this NFS

As you will be aware through your research most introductions to networking **begin** with this stuff - and confuse people.

Seeing the OSI layers set out after a semester of networking the hope is that this will just simple make sense.

The official division of networking



These are the names of the layers - some are new to you but most of them we have already talked about.

How can I remember that?

Please	(Physical)	
Do		(Data-link)
Not		(Network)
Throw		(Transport)
Sausage	(Session)	
Pizza		(Presentation)
Away		(Application)

Physical Layer

- Issues are…
  - Type of cable
  - Broadcast media?
  - Speed
    - 10Mbit/100Mbit Ethernet
- A problem would be…
  - Loose connection
  - Electrical interference

We have barely touched the Physical layer in NPS. The engineers here will be more likely to get to grips with, and understand the issues here.

We are basically talking about electricity here - either flowing in wires or propagating through the air (“wireless”) - although I have a notion of a network that uses string and tin cans!

If the physical layer was the one that was disrupting things it would be something like a loose connection or some electrical interference (maybe someone cut the string!)

Data-Link Layer

- "Local delivery"
- Issues are…
  - MAC Address
  - Frames
  - Broadcast address
- A problem would be…
  - Duplicate MAC address
  - Incompatible frames

The Data-Link layer was where we began in NPS with "local delivery"

Here we need to understand about MAC addresses, frames, broadcast addresses and things like that.

Data-link problems would occur if there were duplicate MAC addresses, if ARP were not working, if frames were incompatible for some reason…

These problems could occur anywhere between "Me" and "You" but they would be localised to one step along the way.

Data-Link Layer...

- Data Unit is…
  - Frame
- Scope is…
  - Local
  - One “segment”

The unit of data that we refer to is the **frame** and the scope of the data-link layer is local to one “segment” of the whole internetwork.

Network Layer

- "Remote Delivery"
- Issues are…
  - Routers
  - Routing tables and protocols
  - Congestion
- A problem would be…
  - "Network unreachable"
  - Time To Live (none left!)

When we studied "Remote Delivery" we were looking at the Network layer. The Network layer is concerned with Routers, their tables, the protocols to control those tables, the management of the flow of data in a complex inter-network. This includes managing congestion when it occurs - making sure that packets get routed around congested regions.

If you see a "Network Unreachable" message when you ping something then you have a Network layer problem.

If a packet goes through too many routers its TTL (Time To Live) counter will hit zero and the packet will be…….

Network Layer...

- Data unit is…
  - Datagram
- Scope is…
  - As big as you please

The name we have used for the data unit is the **datagram** and the scope of the Network Layer is the whole world.

Transport Layer

- Reliability
  - "Now that we can send a datagram between our machines let's send a whole lot"
- Issues are…
  - A connection
  - A guaranteed communication (TCP)
    - or maybe not (UDP)
  - Specific ports
    - 20/21

The Transport layer is concerned with Reliability as we have seen.

Here we have the notion of a connection (or not) between "Me" and "You". The connection extends right into the software internals of the two machines - it is a connection between two **ports.**

Transport Layer...

- A problem would be…
  - Wrong port
    - Send data on control
- Scope is…
  - The complete connection
    - “Me” to “You”

A Transport layer problem would be using the wrong port or sending with an unexpected sequence number.

The scope of the Transport layer is the two specific end nodes and the connection between them.

Session Layer

- Logging in
  - "If we are going to send all this data let's make sure you are who you say you are"
- Issues are…
  - ID's and Passwords
  - Dialog Control
    - Who talks first?
- A problem would be…
  - Authentication failure
  - Server logging in to client!

The Session layer is one that we have avoided talking about so far but it is one that you are all familiar with anyway. The Session layer handles the bigger issues of establishing connections - who are you and do you have access?

Session layer protocols, if they exist, manage issues like ID's and passwords and also who is expected to talk first. This is known as dialog control.

Failures might be an authentication failure or maybe a breach of the dialog rules like the server trying to login to the client!

Presentation Layer

- Encoding & Encryption
  - "You have a different type of computer - send it so I can read it"
- Issues are…
  - Security
  - Byte order
    - Little-Endian PC vs Big-Endian MAC
  - Character coding
    - ASCII PC vs EBCDIC IBM
      - **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange
      - **E**xtended **B**inary **C**oded **D**ecimal **I**nterchange **C**ode
  - XDR (eXternal Data Representation)
    - A common protocol for all data

Assuming that we are now within an established session (Session layer) and are sending and receiving data through a number of connections (Transport layer). (This is like having logged into krause through FTP and starting to transfer files)

The next issue that will arise is "can I read the data you are sending me" and the Presentation layer protocols are intended to take care of this. Encryption, if it is required, can also be a Presentation layer issue.

We need to think about byte order (PCs use little-endian representation for numbers - MACs use big-endian representation)

We need to think about character coding (IBM mainframes use EBCDIC - most other computers use ACII)

All these possibilities particularly become a problem if we start to distribute applications between different types of computer so the major Presentation layer protocol, XDR, is designed to establish a common eXternal Data Representation which everyone can use. In the lab this week you will see XDR in action when you inspect the packets between the arithmetic client and its server. Even though the client in on a PC (little-endian) the integers in the packet are big-endian - XDR did this.

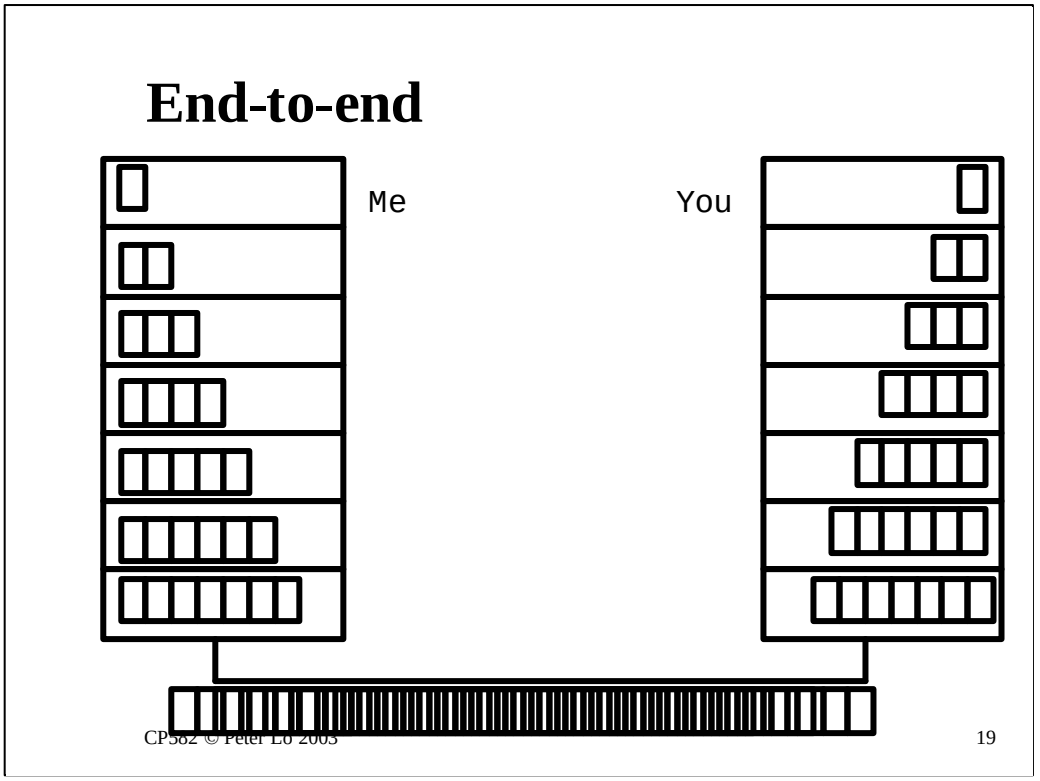
Presentation Layer

- A problem would be…
  - Garbled text
    - Wrong encoding
    - Wrong password!

Application Layer

- Services
  - File transfer
  - Mail
  - etc..

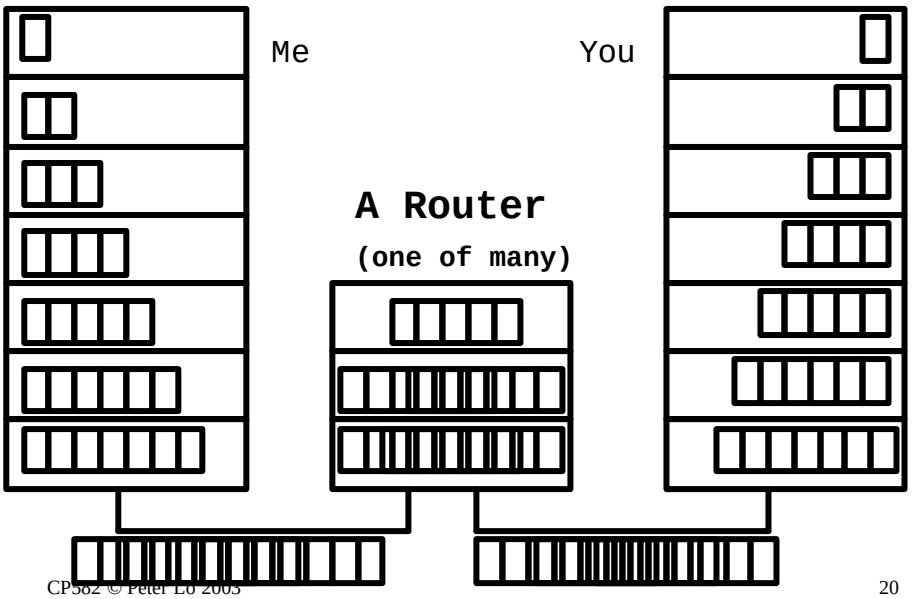
The Application layer is where it all comes together in terms of getting some actual work done - this is where we define services that do actual work that we want like transfer of files or sending of mail.



So the final thing to look at is the seven layers in action, encapsulating and encapsulating as the data is passed down through the layers by the sender, passing - as an electrical signal - along the wire and then getting unwrapped. layer by layer by the receiver.

This is end-to-end communication in action.

End-to-end with router



The only thing to add to this is a reminded of the role of the router - one of many along the way - which will unwrap the bottom three layers (Network layer is layer 3) and then re-encapsulate for the next step along the way.