Networks

Layering Models

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For example, a sublayer describing the physical medium, such as copper or fibre; and a sublayer describing the signals in that medium, such as various kinds of electrical signalling

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For example, a sublayer describing the physical medium, such as copper or fibre; and a sublayer describing the signals in that medium, such as various kinds of electrical signalling

Exercise Reality is complicated. Read IEEE 802 to see how the physical layer can be split into three sublayers; and the link layer can be split into two sublayers

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The Internet Model

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- Link Layer
- Network Layer
- Transport Layer
- Application Layer

Networks

The Internet Model

We shall describe this model, together with its primary instance TCP/IP

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It is possible, though unlikely, that there could be another network protocol, not TCP/IP, based on the four layer Internet model

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The Internet Model: Link Layer

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And pigeons

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The Internet Model: Network Layer

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unreliable $=$ not guaranteed reliable

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Aside: Reliability

Sometimes it is better to deal with an occasional lost packet than to hold up the system while the lost packet is re-requested and resent, e.g., video, where fast delivery is more important than accurate delivery

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A lot of Internet hardware is actually fairly reliable (non-technical sense) these days

But wireless (Wi-Fi, etc.) and some wired (DSLs) are more unreliable than you might think

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In TCP/IP, two protocols are in this layer: the *transmission control protocol* (TCP) and the *user datagram protocol* (UDP)

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The Internet Model: Transport Layer

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Actually, it is reliable as the underlying layer, IP, is reliable

And IP is as reliable as its underlying physical/datalink layer is reliable

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The Internet Model: Transport Layer

UDP was devised long after TCP when it was realised how useful unreliable protocols can be: this is why the protocol set is called “TCP/IP”, as that was the entire protocol set for a fair while

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We shall see packets have a header field indicating what the protocol of the data in the packet is

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Exercise Have a look at “Protocol Numbers” at
`https://www.iana.org/assignments/protocol-numbers/protocol-numbers.xhtml`

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The Internet Model: Application Layer

The application layer covers (roughly) the OSI session, presentation and application layers

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Many forget this, e.g., many programmers forget that not all machines represent integers in the same way and so the bit pattern they use for the number they want to send is (mis)interpreted as a different number by the receiver

Networks

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Anything *above* the transport layer must be done by the application programmer in their application code

Networks

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Originally developed in the context of email, it is now used in other areas like Web page delivery where there are mixed kinds of data to transmit

Networks

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Similarly for the session layer

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Note: if the TCP/IP had session management, applications would get this "for free"

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The Internet Model: Application Layer

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Note: if the TCP/IP had session management, applications would get this "for free"

The counter-argument is that many applications do not want session management, and should not have to pay the overhead of supporting it

Networks

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Of course, libraries of code exist to do these “missing” things (sessions, presentation and so on), but the programmer must write the code to incorporate them

Networks

Example of layering in practice: how an email might be transmitted over an Ethernet

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- Network: IP adds its header (routing)
- Datalink: Ethernet adds a header (local routing) and a trailer (checksum)
- Physical: The bits are transformed using a 4B/5B encoding to smooth the bit patterns and are sent using a three-level electrical coding MLT-3 (physical)

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Going through all these in detail is the content of this Unit

Networks

We have two layering models, ISO and Internet, two approaches to designing a standard

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How do they compare?

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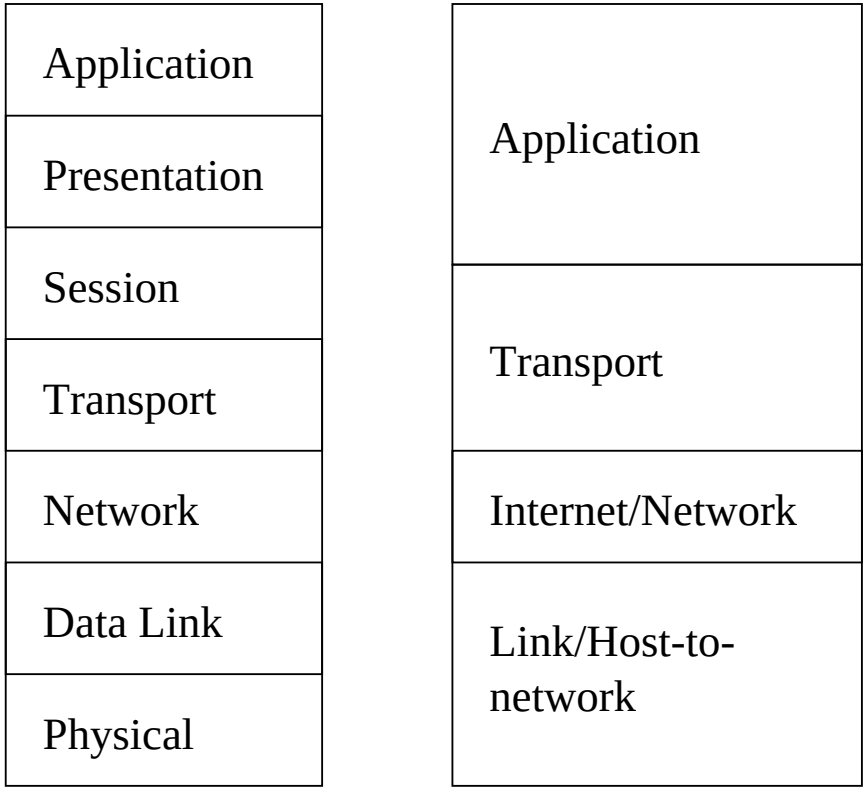
Layering Models



OSI vs. Internet Models

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Layering Models

Comparing the two models:

Networks

Layering Models

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- OSI was developed before an implementation; the Internet Model was created *after* TCP/IP

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Comparing the two models:

- OSI was developed before an implementation; the Internet Model was created *after* TCP/IP
- OSI make a clear distinction between model and implementation; Internet is fuzzy
- OSI is general and can apply to many systems; Internet is specific, namely to TCP/IP
- Implementations following standards following the OSI model were dire; TCP/IP is wildly successful

Networks

Layering Models

Problems with the Internet Model (*not* TCP/IP) include

Networks

Layering Models

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- it is only good for describing TCP/IP

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Layering Models

Problems with the Internet Model (*not* TCP/IP) include

- it is only good for describing TCP/IP
- the physical and data link layers are merged; this makes it difficult to talk about, say, copper vs. optical fibre installations

Networks

Layering Models

Non-problems include

> “OSI is slower as data has to go through more layers”

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Layering Models

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An implementation need not have 7 separate modules: it only needs to *behave as if it did*

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Early implementations of a standard derived from OSI made this mistake

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This is confusing the model with the implementation and ignoring the standard in between them

An implementation need not have 7 separate modules: it only needs to *behave as if it did*

Early implementations of a standard derived from OSI made this mistake

There are good CS reasons why we should do this separation, but practically we have to make tradeoffs between maintainability and speed

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Layering Models

“OSI has larger encapsulation overhead as data has to go through more layers”

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Layering Models

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Layering Models

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As above

And you don't *have* to add a header at every layer: it depends on what the standard requires

The model doesn't *require* anything

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Layering Models

“There are no decent implementations of OSI”

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Layering Models

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If you squint a bit

Networks

TCP/IP

The OSI model is widely used; the OSI protocols never

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The Internet model is rarely used; the TCP/IP protocols are everywhere

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Not brilliant quality, but at least it worked. . .

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TCP/IP

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TCP/IP

Networks before the Internet tended to be closed and proprietary, where you had to pay to get in

But all these failed to get critical mass: even Microsoft failed to get their own alternative to the Internet off the ground and they had (grudgingly) to join with the rest of the world in using TCP/IP

Networks

Layering

Other layering models exist, e.g., *Tanenbaum's Five Layer Model*

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- Data link
- Network
- Transport
- Application

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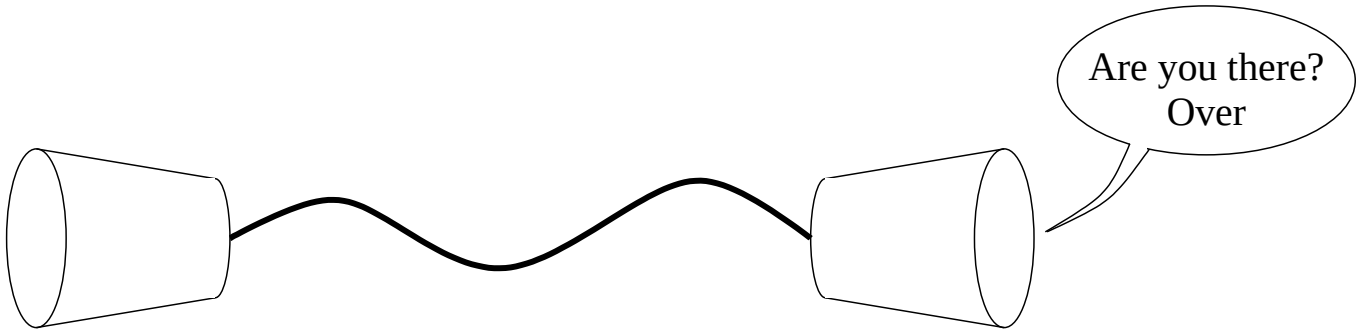
Still missing the essential presentation layer, but a lot more useful in a world where the physical layer is often changed, e.g., 1Gb Ethernet to Wi-Fi

Networks

Layering Models



Cup and string network

Exercise identify the OSI and Internet layers as they apply to a cup-and-string network

Exercise Read section 3 of RFC3439