

Chapter 2

Layering Models

Layering Models

- What hardware?
- How to represent bits?
- What standards of service?
- What interface to the computer?
- What protocols?
- And so on

Layering Models

We need standards at each and every level

Layering Models

- International Standards Organisation (ISO)
- Open Systems Interconnection (OSI)
- OSI Seven Layer Model

- *A reference model*
 - Tells us how to approach the design of a system without actually giving a design itself

Layering Models

- Use a *layered* approach
- A layer should be created where a different level of abstraction is needed
- Each layer should perform a well defined function
- The function of each layer should be chosen with an eye toward defining internationally standardised protocols

Layering Models

- The layer boundaries should be chosen to minimise the information flow across the interfaces
- The number of layers should be large enough that distinct functions need not be thrown together out of necessity and small enough that the architecture does not become unwieldy

Layering Models

The magic number is:

7

Layering Models

OSI Layer 1

- The Physical Layer
- Transmission of bits over a channel
- Voltages, colours of light, durations, wires, sockets, cables, radio frequencies, ...

Layering Models

OSI Layer 2

- The Data Link Layer
- Ensuring no undetected errors of transmission
- Flow control

Layering Models

OSI Layer 3

- The Network Layer
- Controlling the network
- Finding routes from source to destination
- Congestion control
- Quality of service
- Accounting

Layering Models

OSI Layer 4

- The Transport Layer
- Managing connections
- Error handling
- Reliability (if required)

Layering Models

OSI Layer 5

- The Session Layer
- Establish, maintain and terminate connections
- Checkpointing, restarting connections

Layering Models

OSI Layer 6

- The Presentation Layer
- Ensuring data is interpreted consistently

Layering Models

OSI Layer 7

- The Application Layer
- The protocols the application needs
 - HTTP for the Web
 - SMTP for email
 - And so on

Layering Models

Fitting the layers together

Encapsulation

Layering Models

Encapsulation

- identifying header or trailer or both
- encoding to avoid corruption
- setting data into a standard form
- some other complicated transformation
- or nothing at all!

Layering Models

Why layers and encapsulation?

- Adds complexity
- Adds overhead
- Reduces effective throughput

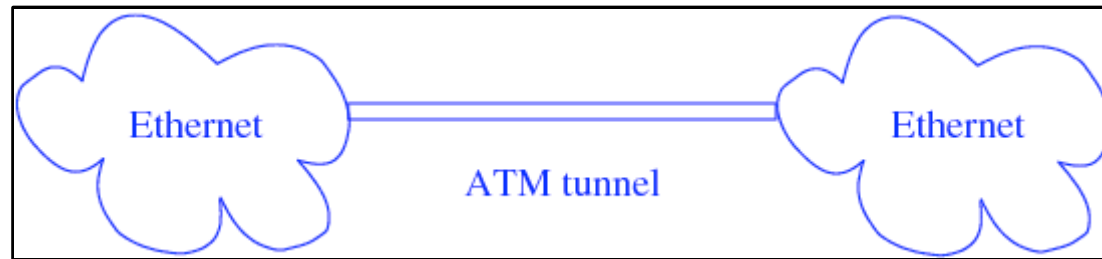
Layering Models

Why layers and encapsulation?

- Actually reduces overall complexity
- Adds flexibility
 - Can update or change layers independently
 - Can use layers for *tunnelling*

Layering Models

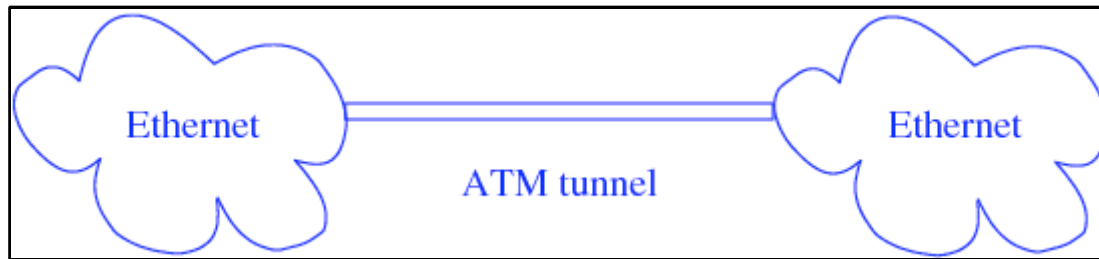
Tunnelling



- Tunnelling Ethernet over some other protocol, e.g., ATM
- Put an Ethernet frame in one end
- Get an Ethernet frame out the other end

Layering Models

Tunnelling



- The frame is encapsulated in ATM (somehow) in transit
- You can tunnel most protocols over most protocols

Layering Models

Tunnelling

- E.g., tunnel IP over a carrier pigeon (RFC1149)
- But it's not always efficient or practical to do so!

Layering Models

The Internet Reference Model

- Four layers
- Based on practice, namely the Internet Protocol
- Also known as
 - The TCP/IP Reference Model
 - Department of Defense Four-Layer Model

Layering Models

Internet Layer 1

- The Link Layer
- Also known as
 - Host-to-network layer
 - Data link layer
 - Network access layer
- Covers both the physical and data link layer from OSI
- Sends and receives packets
- Many realisations, including Ethernet

Layering Models

Internet Layer 2

- The Network Layer
- Also known as
 - The Internet layer
- Handles the movement of packets, including routing
- Realisation as the *Internet Protocol* (IP)

Layering Models

Internet Layer 3

- The Transport Layer
- Also known as
 - The host-to-host layer
- Like the transport layer in OSI
- Realised as
 - *Transmission Control Protocol (TCP)*
 - *User Datagram Protocol (UDP)*

Layering Models

Internet Layer 4

- The Application Layer
- Like the application layer in OSI
missing session and presentation layers

Layering Models

Models vs. Protocols

- A model is a set of guidelines on how to approach a design
- Protocols are the implementation of a design

Layering Models

OSI vs. Internet

- Layers:

Application		Application
Presentation		
Session		
Transport		Transport
Network		Internet/Network
Data Link		Link/Host-to-network
Physical		

- OSI developed before an implementation, Internet model developed after

Layering Models

OSI vs. Internet

- OSI distinguishes clearly between model and implementation, Internet is more fuzzy
- OSI very general, Internet quite specific
- OSI had problems when it came to implement: Internet was already implemented

Layering Models

OSI vs. Internet

- OSI rarely implemented, found widely in textbooks
- Internet implementations are everywhere
- Internet model too specific: doesn't really apply well to anything else
- Internet model merges physical and data link layers

Layering Models

Tanenbaum's Five Layer Model

- Physical
- Data link
- Network
- Transport
- Application

still missing presentation, but a lot more useful in a world where the physical layer is often upgraded