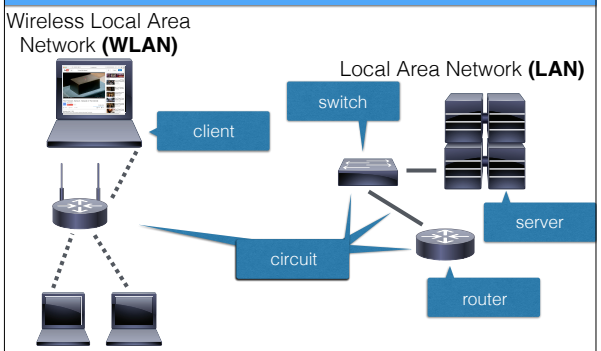
FIT1047 - Week 8

Networks: Introduction, Layers

MONASH University

This is a screenshot from an episode of The IT Crowd on YouTube. For the next three weeks, we will see how we can build networks that connect servers, routers and client computers and enable them to exchange information (such as this web page).

Network components



The main components in a network are clients and servers (the endpoints of communication), and routers, switches, cables (and radio waves) that connect them.

Network components

Client: gives users access to the network

Server: stores data or software and makes it available to the clients over the network

Switch: connects computers in a LAN

Router: connects two or more networks

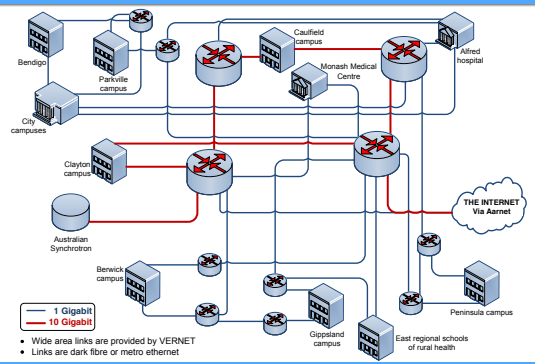
Types of networks

Networks **within** an organisation:

- Local Area Network (**LAN**) (room, building):
  a group of clients and servers that share a circuit
- Backbone Network (**BN**) (< a few km):
  high-speed connection between LANs
- Metropolitan Area Network (**MAN**) (> a few km):
  connect LANs and BNs across locations
- Wide Area Network (**WAN**):
  same as MAN except longer distances

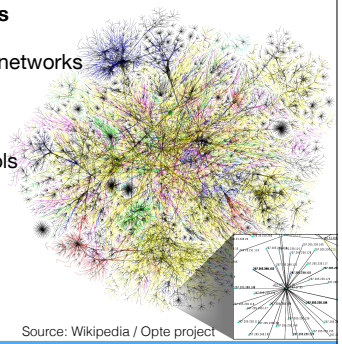
Computers in the same LAN are connected via cables (or wireless radio signals) and switches, and can therefore exchange messages directly. Larger scale networks are built by connecting different LANs using routers (which enable the exchange of information between different LANs).

The Monash Network



The Internet

- A **network of networks**
- Connecting millions of networks and billions of devices
- Based on a common, standard set of protocols



Source: Wikipedia / Opte project

The Internet is nothing special in terms of the networking technology: every lab at Monash, e.g., is not *connected* to the Internet, it is *part* of the Internet! We'll see how this works in the coming two weeks.

Data transmission rates

- Fundamental characteristic of a network: how many **bits per second** can it transmit?
- Typical transmission rates:
  - 1 Mbps (million bits per second) from your home to your ISP (Internet Service Provider), 10-20 Mbps in the other direction
  - 50-500 Mbps within your WLAN (wireless network)
  - 1 Gbps in LANs (local area network, e.g. Monash lab)
  - 10 Gbps in backbone networks
  - Tbps (tera bits per second, 10^{12}) in optical fibre networks

Layers and Protocols

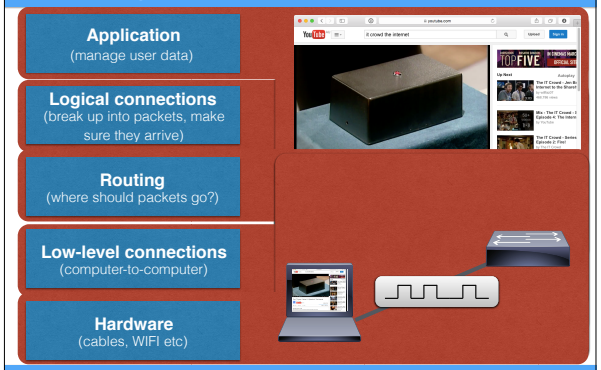
How to transfer messages

- Networks run on very diverse and complex hardware and software:
  How can we make sure they all understand each other?
- Solution:

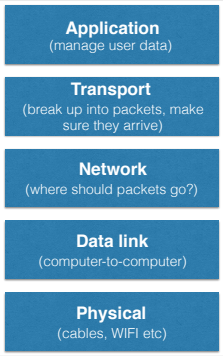
  hierarchical **layers of abstraction**
  each with well-defined tasks and **interfaces**

  formal languages (**protocols**) within each layer
- This is typical software engineering!

Layers of Abstraction

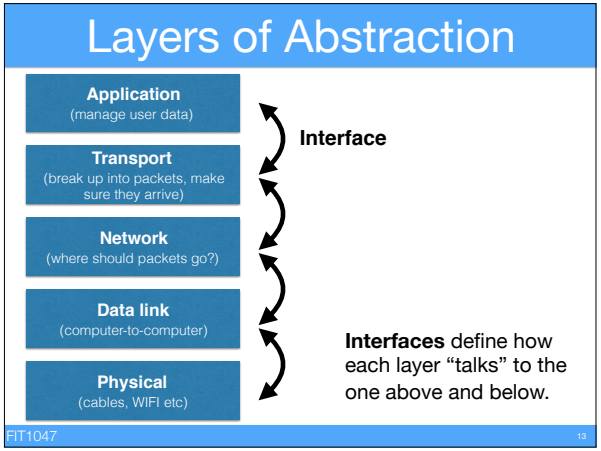


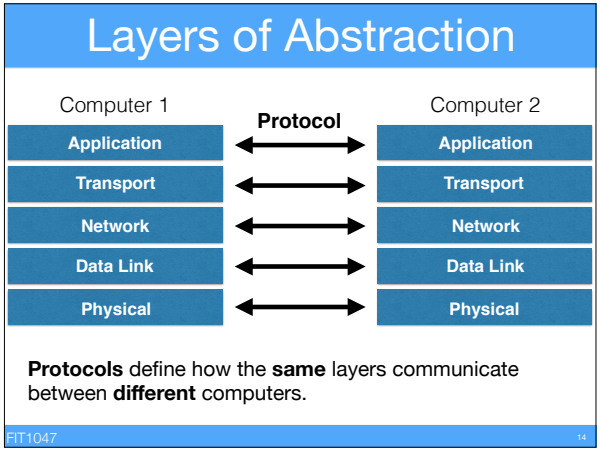
Layers of Abstraction

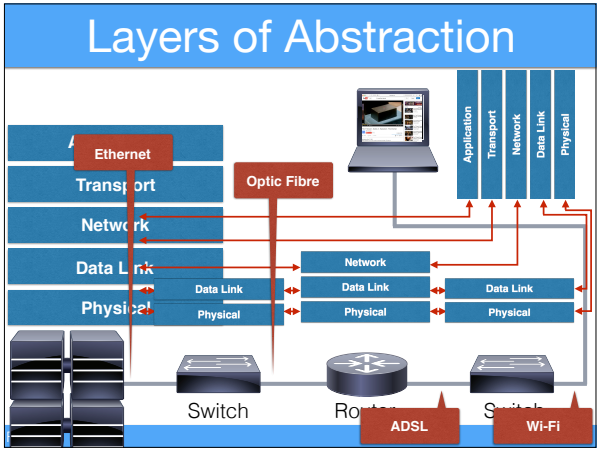


Internet Model

The Internet model describes the technology that is used to connect computers on the Internet. There is an alternative model called the OSI model, which (essentially) has three layers where the Internet model has a single Application layer. You can learn more about OSI in the textbook.







You can see in this picture that neighbouring devices communicate at the data link (and physical) layer. Clients and servers communicate with routers at the network layer, and with each other at the transport and application layer. This is another example of **virtualisation**: to the clients and servers, the transport layer creates the illusion that they talk directly to each other, even though the actual communication happens through all the intermediate devices and at lower layers.

Message Encapsulation

https://youtu.be/4B44hy7BPYk

This video explains how devices use the data link and network layers to communicate, by encapsulating each message with several envelopes.

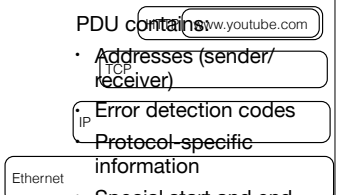
Message Encapsulation

Protocol Data Unit
(PDU)

Application	*Message*
Transport	*Segment*
Network	*Packet*
Data Link	*Frame*
Physical	*Bit*

PDU contains:

- Addresses (sender/ receiver)
- Error detection codes
- Protocol-specific information
- Special start and end symbols



We call these envelopes PDUs, and each layer adds its own PDU.

Summary

- Networks consist of clients, servers, switches, routers, and other circuit hardware (e.g. cables)
- LANs connect computers directly with each other
- The Internet model has five layers
- Each layer encapsulates the message and adds its own PDU