Programming for GCSE
Topic 7.2: Internet Components
Aims

• Explain the main ideas of the Internet
• Why is it call the Internet?
• How is it run? Is anyone in control?
• What's the Internet architecture?
• What's a router?
Teaching Issue

• As with other network topics
  • Principles not just description
  • ... not overwhelming complexity
THE INTERNET
Hardware of the Internet

get a.mp3

http://www
Three Main Components

• Hosts: computers running programs
  • Client: makes requests to ...
  • Server: provides a service; waits for requests
    • Email, Web, iTunes

• Transmission lines
  • Copper wire, optical fibre, or radio

• Routers: specialized computers that connect multiple transmission lines
Packet Switching

- Split a message into chunks
- Add a header to each chunk
- Send packets independently
- Combine received packets
Routers in Packet Switched Network

- Each router is a specialized computer that receives, stores and forwards packets.
Multiplexing

- Link can be shared between different data streams
  - Division in time – as needed, not fixed
Remarkable!

• Internet could have traffic jams
  • Shared communication lines
  • No central co-ordination

• Polite behaviour (particular in TCP) prevents traffic jams (network congestion)
  • ... but no delivery guarantees
NETWORKS ARCHITECTURE

Lots of protocols
Protocol

- Agreement on how to communicate
- Defines:
  - format of a message
  - actions when data sent & received,

- E.g. TCP, IP, UDP, HTTP, SMTP, Ethernet, ...
One Protocol for the Internet?

- Too many machines in the Internet
- Too many problems to solve/implement.
  - How to request/receive web pages?
  - How to split and combine packets?
  - How to find a route to the destination?
  - How to send data over physical cables?
  - ...
- Hard to introduce new applications
Layered Architecture

• Build a stack of layered protocols, each:
  • solves only a few (not all) problems
  • defines abstraction of the Internet
Layered Architecture

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End Hosts vs. Routers

HTTP message

TCP segment

host

HTTP

TCP

IP

Ethernet interface

router

IP packet

router

IP packet

host

HTTP

TCP

IP

Ethernet interface

SONET interface

SONET interface

Ethernet interface

Ethernet interface
Remarkable!

- No one knows how many Internet computers
- Decentralised organisation
- Many link standards
  - Ethernet
  - Wifi
  - ... fibre optic
- Internet evolves: new applications
Internet Analogy: Post

• **Address**: town + house – IP address
  - Network + host

• **Mail sorting** – router
  - Letters find their way: you do not know where the sorting offices are

• **Various data links**
  - Post by train, van, bike

• **Shared infrastructure**
  - You post a letter when you want – capacity?
IP Addresses
Internetworking

- Internetwork
  - Interconnected networks
  - \( \rightarrow \) network address
  - Host-host to packet delivery
  - \( \rightarrow \) host address
IP Address

- For computers (hosts) on the Internet
  - Globally unique
- Consists of 4 bytes. Written as “aa.bb.cc.dd”
  - Hierarchical: network + host
  - Router: multiple addresses
- E.g. (Real)
  - www.amazon.co.uk : 87.238.85.129
  - www.facebook.com : 204.15.20.80
  - www.eecs.qmul.ac.uk : 138.37.95.150
  - frank.eecs.qmul.ac.uk : 138.37.88.242
How Are Addresses Allocated?

IANA The Internet Assigned Numbers Authority
ICANN Internet Corporation for Assigned Names and Numbers

- IANA
  - manages the IP address space allocations globally
  - delegates five regional Internet registries (RIRs)
- IANA is managed by ICANN
  - under contract to the US Department of Commerce
- Regional Internet Registries
  - allocate IP address blocks to local ISPs
Regional Internet Registries

- Réseaux IP Européens Network Coordination Centre (RIPE) for Europe, the Middle East, and Central Asia
Who Got the Addresses?

- 25.0.0.0/8 UK Ministry of Defence (RSRE)
- 51.0.0.0/8 UK Government Department for Work and Pensions

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CONFIGURATION

DNS – an example
Remarkable!

• No centralised configuration

• Automatic configuration
  • Granny takes laptop to coffee shop
  • ... IP address allocated
  • ... connected to Internet
  • ... can send mail
Domain Name System (DNS)

- Translate URL $\rightarrow$ IP
  - Yellow pages of the Internet

- Decentralized management

- Hierarchy of DNS servers
  - Root servers
  - Top-level domain (TLD) servers
  - Authoritative DNS servers
DNS Root Servers

• 13+ root servers (see http://www.root-servers.org/)
• Labeled A through M

A Verisign, Dulles, VA
C Cogent, Herndon, VA (also Los Angeles)
D U Maryland College Park, MD
G US DoD Vienna, VA
H ARL Aberdeen, MD
J Verisign, (11 locations)
K RIPE London (also Amsterdam, Frankfurt)
I Autonomica, Stockholm (plus 3 other locations)
E NASA Mt View, CA
F Internet Software C. Palo Alto, CA (and 17 other locations)
B USC-ISI Marina del Rey, CA
L ICANN Los Angeles, CA
m WIDE Tokyo
Top Level Domain (TLD) Servers

• Top-level domain (TLD) servers
  • Generic domains (e.g., com, org, edu)
  • Country domains (e.g., uk, fr, ca, jp)
  • Typically managed professionally

Nominet www.nic.uk
the Internet registry for .uk domain names
Authoritative DNS Servers

- Authoritative DNS servers
  - Provide public records for hosts at an organization
  - For the organization’s servers (e.g., Web and mail)
  - Can be maintained locally or by a service provider

- **START-UP** register a new .com?
  - Add to the .com TLD
  - Add a new domain to myco.com
    - Add to the myco authoritative server
SUMMARY
Summary

• Internet – connected networks
  • Independently run
• Agreed protocols
  • 'IP' for an Internet address
• Decentralised control