HISTORY OF COMPUTING

Internet and Email

Packet Switching

Overview:

This lesson looks at how the Internet works as a collection of networked computers sending and receiving data using packet switching.

Computing National Curriculum Attainment Target:

- KS3: Understand the hardware and software components that make up computer systems, and how they communicate with one another and with other systems
- KS3: Explain how instructions are stored and executed within a computer system
- KS3: Explain how networks such as the internet work
- KS4: Develop knowledge in computer science,
- KS4: Develop computational thinking skills.
- KS5: Understand the role and function of a router or network switch
- KS5: Understand the difference between circuit switching and packet switching
- KS5: Know how packets are framed with extra binary which contains IP addresses, port numbers, message sequence numbers etc.
- KS5: Understand the TCP/IP protocol stack and what each layer does

Lesson Objectives:

- Understand how the internet works using packet switching
- Know what IP addresses are and how they are used by computer networks
- Understand how the TCP/IP protocol allows emails to be split up into packets to be sent using packet switching and re-assembled at their destination.

Lesson Outcomes:

- All: Be able to say what an IP address is and how it is used. Be able to explain how a message is broken up into packets and reassembled at the destination.
- Most: Be able to explain packet switching in simple terms.
- Some: Be able to explain the advantages of using packet switching over circuit switching. Have researched the TCP/IP stack and be able to explain what each layer does.

Lesson Resources:

- Email and Internet - **Video**

- Email Packets (used in the video) – **Worksheet**
- **Email Packets (not used in the video)**
- **IP email game** PowerPoint
- **People IP labels –** Worksheet

Technical Background

A web server is a computer that is designed to be always switched on and which has a fixed IP address. It allows incoming connections so that it can host websites.

An IP Address is a unique address which identifies a computer on a network. Internal network IP addresses usually look like 192.168.x.x where x is an integer between 1 and 255. External IP addresses usually look like a.b.y.y where a, b and y are numbers between 1 and 255, and a and b aren't 198 and 168 respectively.

The IP4 system uses 32 bits for an IP address, so theoretically there are 2^{32} possible computer servers which can host websites around the world. As the Internet grows the system is running out of unique numbers, so IP6 will gradually take over. In IP6 an IP Address looks like a.b.c.d.e.f where a, b, c, d, e and f are all numbers between 0 and 255. This gives a theoretical 2^{48} possible computers which make up the Internet.

The Packet Switching Video explains packet switching and shows how an email is split up into small chunks (packets) when it is sent. It clearly shows what extra data is added by the TCP/IP protocol so that the message can be reassembled correctly when it arrives at its destination IP address. Using TCP/IP packets are sent randomly from computer to computer in any order until they happen to arrive at their destination. They can follow any route and arrive in any order. The TCP/IP application layer makes sense of the messages when they arrive.

Some aspects on the video are simplified. In reality, packets are also given a port number (a security number which allows access through Internet firewalls) and often MAC addresses (hardware ID numbers for source / destination computers).

Keywords

- Packet Switching
- Router / Switch
- IP Address

Lesson Summary: This lesson will concentrate on modelling what happens when emails are sent over the Internet. It models packet switching. The resources include the version used on the Video (using Fred) and another version of the same simulation, using Sue.

Main/Development:

1. Show **Video 7 – KS5 S7 – Part 1 - How the internet works**. Pause and discuss if necessary.

2. Explain about IP addresses to the students by asking how the postman knows where to deliver their Christmas cards. An IP address uniquely identifies a computer on a network.

3. Explain the packet switching game. Show **Video KS5 S7 – The packet switching game** .

4. Assign one student as the router, one person as Google and one student as the BBC. Then assign the internal IP addresses (starting with 192.168) to individual students. Finally hand out the packets so that each student can pass them round to any other student.

   It is recommended that each student wears a label showing their IP address.

   The student playing the part of the router hands packets directly to the correct destination. All of the other students if they receive a packet only keep the packet if it has their own IP address as the destination IP address written on it. If not they forward the packet on to anyone else.

   Have everyone seated round the room (next to a computer).
   Allocate each student an IP address in the range of...

   192.168.1.1 to **192.168.1.30** (or beyond if needed)

   One student should role-play the router **192.168.1.1**
   (which routes out to the Internet if needed)
   If they get given an Internet address they pass the packet out the door (out the gateway onto the Internet).

   One student should role-play the BBC **212.58.246.91**
   One student should role-play Google **74.125.132.94**
   These two students could actually be outside the door (on the Internet)

   Instructions: Hand out the random packets (see slide 8) randomly to each student.

   Read the instructions carefully so you know when to release the packets to the person replying to Fred (as on the video) or Sue (on the other version).

5. Once the simulation has finished everyone should have decoded their message or be able to tell you what went on. Get the students to recap what Packet switching is and ask them how taking part in the simulation helped them understand how emails are sent.

- Extension Tasks: Research the role and function of a router or network switch. What is the difference between them?
- How are long distance video conference calls made with a secure line? (hint: use Wikipedia)
- KS5: The Video shows that each packet (payload) of data is framed up with binary containing source and destination IP addresses, message ID and message sequence numbers and a checksum. Using Inernet research explain how a checksum works.
- KS5: The Video shows that each packet (payload) of data is framed up with binary containing source and destination IP addresses, message ID and message sequence numbers and a checksum. What else is added to the packet as well as this to allow security through firewalls and ensure reliability?
- Research packet keep-alives. Why are they needed?
- Research the TCP/IP protocol stack and what each layer does.