IMAGES in PAEDIATRIC CARDIOLOGY

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Publishing on the WWW. Part 5 - A brief history of the Internet and the World Wide Web

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Abstract

This article focuses on the history of the Internet and the World Wide Web, the media that in recent years have created the concept of objects existing ‘on-line’ in a virtual computer environment. These objects naturally include on-line journals such as Images in Paediatric Cardiology.

MeSH: Publishing, Internet

War is unfortunately an invariable impetus for technological development. Vennevar Bush was one of the pioneers of US radar research in the 2nd World War, and was President Roosevelt's top advisor on matters of technology in the war. One of his interests was the potential development of a machine that would augment human memory by linking stored or memorised material and associative links through paths of logical connections, and thus facilitating retrieval. He called this machine a memex and described it as desk and camera that could record anything a user wrote and then link it to other pieces of information indexed in its storage space - does this not remind you of the way we now work? Unfortunately, the idea was way too far ahead of its time, and no such machine was ever built, but Bush wrote up his idea in an article in 1945 for Atlantic Monthly titled “As We Think”.

In 1957, the USSR launched Sputnik, the first artificial satellite to orbit the earth. The idea of such a device orbiting the skies did not go down at all well in the United States, especially when associated with the destructive power of the then recently developed atomic weapons, and hence the possibility of a hostile nation dropping an atomic weapon on the US.

The seed of the Internet was planted in the following year, when President Eisenhower allocated over a billion dollars for US research and development centres, including the Advanced Research Projects Agency (ARPA) which was located in the then new Pentagon building. These funds were to allow the US to regain the upper hand in technological superiority, particularly in the field of weapons research. Survival after an atomic war was given importance, and protecting the nation's modes of communication was given high priority.

Figure 1 Vennevar Bush

Figure 2 Sputnik

Paul Baran, a scientist at the RAND Corporation (a national defence think tank), proposed the creation of a communication network that would have several possible routes between any two points. Disruption of one route would allow information to reach it's destination through other routes automatically. For this method to work, messages would have to be split into blocks, and each would travel to its destination independent of the rest.
“Packet switching is the breaking down of data into datagrams or packets that are labeled to indicate the origin and the destination of the information and the forwarding of these packets from one computer to another computer until the information arrives at its final destination computer. This was crucial to the realization of a computer network. If packets are lost at any given point, the message can be resent by the originator.” *Paul Baran*
http://www.rand.org/publications/RM/baran.list.html

In 1965, Baran acquired funding from the Air Force, but the project was plagued with bureaucratic problems and Baran withdrew his funding request. However, several other scientists were working independently along the same lines. In the United Kingdom, Donald Watts Davies was also working on a block-switching scheme for the British National Physical Laboratory, but Davies called these blocks “packets”, a name retained to this day.

Figure 3 Paul Baran

Earlier, in 1962, JCR Licklider (1915-1990) theorized that computers augment human thinking by increasing the ability to communicate over a network. He proposed that if the whole world could be interconnect through an “intergalactic network” ideas could be shared easily and rapidly. However, he had no ideas as to how to create such a global network.
http://gatekeeper.dec.com/pub/DEC/SRC/research-reports/abstracts/src-rr-061.html

Figure 4 JCR Licklider

In 1965, the Association of Computing Machinery hosted its 20th annual conference. One of the speakers at the event was Theodore Nelson, who gave a presentation entitled “A File Structure for the Complex, the Changing, and the Indeterminate.” His audience were some of the first to hear the word “hypertext.” Nelson theorised the creation of a “docuverse”, where Hyper-links pulled portions of documents and multimedia components across the network,

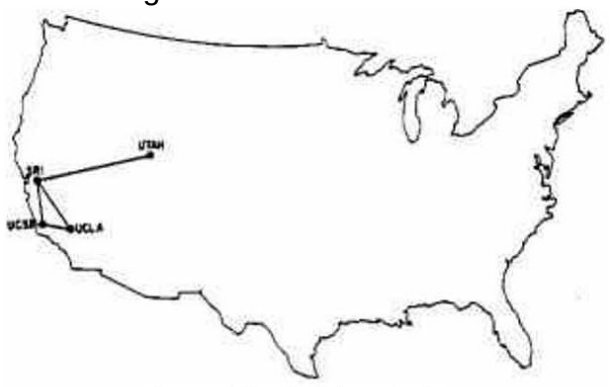
and copyrights were managed to protect the intellectual property of contributors. However, a working model was never built.

In 1966, Taylor was appointed managed all of the computer projects funded by ARPA. Taylor proposed networking the different ARPA computers together. The proposal was called “Cooperative Network of Time-Sharing Computers.” Early on, it was decided that network traffic between computers would be broken up into blocks (a packet-switched network), and that a separate computer would act as a gateway to the network for each node. This computer, named an Interface Message Processor (IMP), would be connected to the network All the nodes would have almost identical IMPs, thus creating a standard interface for the network between nodes. The proposal was completed in 1968 and the contract was awarded to the BBN company. The computer chosen to be modified into the IMP was the Honeywell DDP-516, one of the most powerful computers available at the time.

Four university research centres were chosen for the initial test sites for this ARPANET, based on the specialties of each research centre. These were connected, in order:

1. UCLA (September)
2. Stanford (October)
3. Santa Barbara (November)
4. Utah (December).

Figure 5 First four ‘servers’



(Network bandwidth 50Kbps)

Electronic mail (email) rapidly became very popular and Ray Tomlinson at BBN wrote the first email reader and writer for the network in 1971. Tomlinson decided to use the ‘@’ symbol to denote to which computer the message would be sent, a practice used to this day.

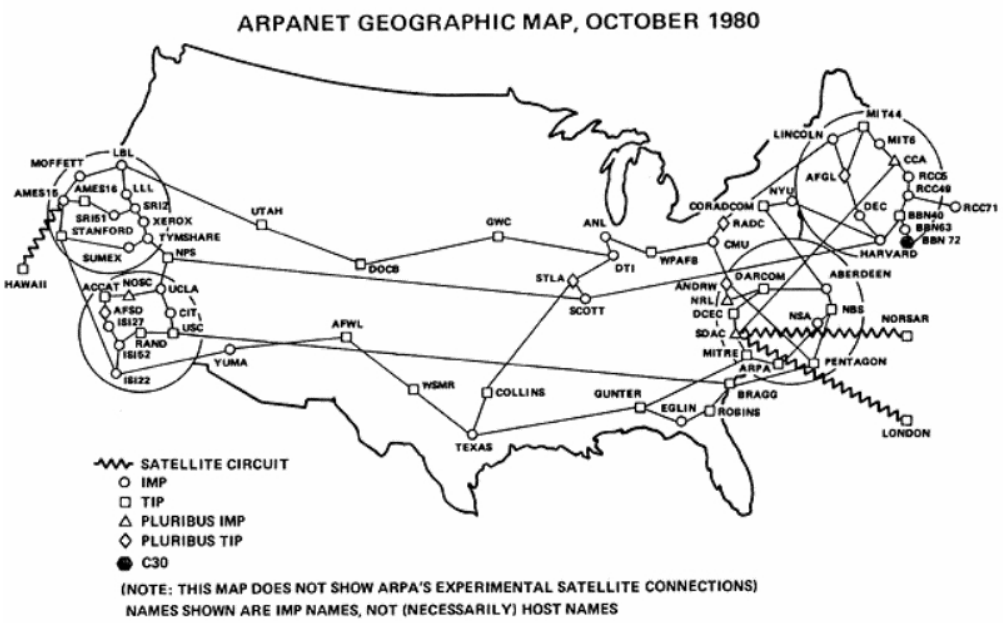
Norm Abramson, a programmer at Stanford, was a keen surfer and frequently visited Hawaii. In 1970, he started work on a radio-based system to connect the Hawaiian islands together. The completed packet-switched network was called ALOHAnet. The following year, ALOHAnet was connected to ARPANET. By 1971, ARPANET was up to 15 nodes with a total of 23 hosts.

Up to this time, the communications protocols used for the network were called Network Control Protocols. However, weakness in this protocol started becoming evident with increasing network traffic. Vint Cerf and Bob Kahn designed a protocol that would improve the efficiency of the network, allow different networks to connect together into one big network (hence Internet:

global group of interconnected networks), and would include error detection, packaging, and routing. The new protocol was called Transmission Control Protocol and was later split into a separate Internet Protocol. Together, the suite of protocols were called TCP/IP. TCP/IP is particularly valuable as it ensures that messages are reliably sent over the Internet over multiple routes in individual packets. Those packets are then reassembled at the receiving system. If there is an error in a packet, a request for a new one is sent to the originating computer.

Figure 7 Norm Abramson

Figure 8 ARPANET status in 1980



Transfer Control Protocol (TCP) is a connection-oriented transport protocol that controls the sending of messages as a collection of individual, sequential data packets and reorganises the received packets into whole messages. When data is lost in transit TCP retransmits the data until either a timeout condition is reached or until successful delivery is achieved. TCP also recognises duplicate messages and will discard as appropriate. If data from the source is being sent at too fast a rate, TCP employs control mechanisms to slow down the data transfer.

Internet Protocol (IP) is the primary protocol in the Internet suite of protocols. It provides internet routing, error reporting, data fragmentation and reassembly. IP addresses are globally unique 32-bit numbers assigned by a central body (Network Information Center - see below). These unique addresses permit IP networks anywhere in the world to communicate with

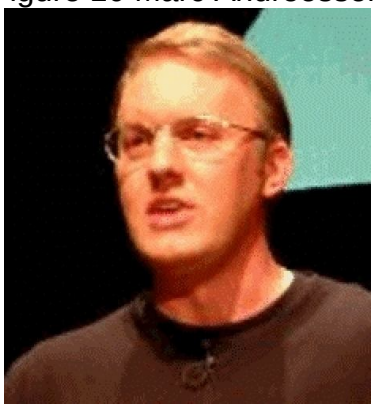
each other. IP addresses are divided into three parts. The first part designates the network address, the second designates the subnet address, and the third part designates the final host address.
With the advent of TCP/IP, the ‘global network’ became a reality. Universities and government offices and agencies increasingly used the network for communication. Up to this time, the Internet was, by law, for strictly official use. However, personal email addresses became commonplace and games began to be played over the network. Unofficial use of the Internet gained impetus in the 1980's when personal computers by Apple and IBM became common in both offices and in homes.
In 1984, The Domain Name System (DNS) was introduced. This is a global network of servers that translate intuitive host names (Uniform Resource Locators – URLs) like www.hotwired.com into numerical IP addresses, like 204.62.131.129, which computers on the Net use to communicate with each other. In this year, the number of hosts exceeded 1000.
In 1990, Tim Berners-Lee at CERN in Switzerland commenced work on a system for distributing information across a network of different computers and operating systems which he called ‘the World Wide Web’.

Figure 9 Tim Berners-Lee

Hypertext thus came into use. This was a form of a document formatting that allows documents to be linked by making certain words or phrases ‘clickable.’ The web is therefore the sum total of the many many ‘hyperlinked’ documents (called web pages) or other files that are stored on computers around the world over the Internet. Hypertext Markup Language (HTML) is used to create web pages and tells browsers how to display pages.
The ‘Hypertext Transfer Protocol’ (http) is the communications protocol that enables the transfer of web pages. Http runs on top of TCP/IP and defines how different types of hyperlinked data (text and multimedia) are transmitted and accessed. It supports a ‘client/server’ mode of communications between remote computers where a ‘client’ is a computer that requests data from a ‘server’ computer.
This first text-based browser was completed in 1991. In 1992, Marc Andreessen wrote the first graphical browser - Mosaic, and by 1993, this was used by over one million people. Further versions of Mosaic became Netscape.
Up to 1992, it was technically illegal for businesses or private individuals to operate on the Internet. In this year Rep. Frederick Boucher from the 9th district of Virginia drafted a bill in the U.S. Congress that would amend the

National Science Foundation Act of 1950. This ‘authorises National Science Foundation to support the development and use of computer networks which may carry a substantial volume of traffic that does not conform to the current acceptable use policy.’ By this time, the Internet bandwidth had increased to 45Mbps.

Figure 10 Marc Andreessen



InterNIC was set up in 1993. This is a collaborative project by Network Solutions, Inc., and AT&T (supported by the National Science Foundation) which provides four services to the Internet community. A “white pages” directory of domain names, IP addresses, and publicly accessible databases, domain name and IP address registration, support services for the Internet community, and an online publication summarising information of interest to the online community.

In 1994, the ARPANET/Internet celebrated its 25th anniversary. The bandwidth had increased to 145Mbps.

It is estimated that the Web has greatly surpassed one billion pages and that individuals, companies, educational institutions, and all other types of organisations are putting Web pages online at the rate of 65000 per hour. The Web is supported by backbone networks that are comprised of major, high capacity, long-distance computer networks with very high data transfer capacity, typically in the hundreds of Mbps (Megabits-per-second or million bits per second) to 2Gbps (Gigabits-per-second or billion bits per second). This capacity permits the transmission of real time or packaged video and other large files. There is no end in sight to the capacity of the Web.

Figure 11 Frederick Boucher

Figure 12 A backbone router

Figure 13 The Internet

Further reading

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