History of the Internet

By Ian Peter

I was fortunate to discover the Internet early on and become involved in its early development. I shared the early excitement as the Net grew from restricted academic origins into a vast global facility. Much of what happened is undocumented. As I looked around the Internet, I found it very difficult to get good history material. A lot of what I found was too technical or academic for public consumption- a lot of the material was too narrow in coverage - and a lot was simply inaccurate!

That's why I compiled this material, started this site, and have released information on some areas of Internet history which have not been previously documented.

I hope you enjoy my personal history of the Internet. If you would like a broadcast quality CD of this material, I would be only too pleased to send it to you - click here for details.
And finally - this site is essentially a labor of love. If you would like to donate to help us with our running costs and future development, please do so here.

Happy reading!

The prehistory of the Internet

Necessity is the mother of invention, and whenever we really need something, humans will find a way to have it.

That certainly seems to be the case with the Internet. There had to be an Internet sometime, because we, as a human species, have always had this deep desire to communicate, and to communicate over distance.

Thus, speech and language, our primary and oldest communication tools, have been with us since very early in our evolution. And, not long after, we developed written forms of communication, and began recording our thoughts and history on stone, papyrus, wood, cave walls, and any other means available. This is perhaps our primary activity as humans; in our essence we are communicating beings.

Well before the age of transport, we were looking at ways to communicate over distance. Some of our early methods were carrier pigeons, smoke signals, and Morse code flags.

Then, as the age of transport, the industrial revolution and the beginnings of the information age came to us, we set about using the new tools and technologies available to us to further our capacity to communicate and to disseminate information.

The Internet as such couldn't have existed without the big inventions of the 19th century - electricity and the telegraph. And, to a lesser degree, there was unlikely to be an Internet as we know it before there were the standard electronic broadcast media of radio and television. So the building blocks were the existing communications and broadcasting technologies. We're not going to go into all of that - there are lots of other sources of information on Marconi, Alexander Graeme Bell, Tesla, and the other pioneers whose inventions the Internet rode on. But let's focus in on the development of electronic networks, because here we begin to see the future shape of the Internet.

Electronic networks began with the telephone, or telegraph system as it was known in the beginning. Here the origins are pretty clear - the first line was built in 1844 from Washington to Baltimore. By 1858 a transatlantic cable was in place, and by 1861 - a mere seventeen years after the first connection - telegraph wires covered the USA.

As Marshall McLuhan notes in his 1960s classic, "Understanding Media"

"It is instructive to follow the embryonic stages of any new growth, for during this period of development it is much misunderstood, whether it be printing or the motor car or TV".

For instance, the early motor car was called the horseless carriage - and most people of that day saw only that the motor vehicle would do what the horse and carriage had done before it. No-one was envisaging aeroplanes, long distance trucks, high speed highways and cars, intercontinental travel, and the other advances that came from this base discovery - people just looked at this as a way to get to town to go shopping.

We see something similar in the case of the telephone system. In the early days, Alexander Graeme Bell thought it would be good for broadcasting music. So we envisaged the early uses as being of a "broadcast" nature - one way communications. Then people thought it would be good for sending Morse code messages.

However, even back then in 1863 we can see the very beginnings of thinking about how this new infrastructure might be used one day. In that year futurist Jules Verne, without a doubt the king of science fiction writing, told us of a future world where

"photo-telegraphy allowed any writing, signature or illustration to be sent faraway - every house was wired".

Now that's as good a description of what was to come as you can get! Jules Verne also anticipated the first trip to the moon, so he often talked of events and inventions well before they happened.

It was some time before people thought the telegraph system would be good for people talking to each other, and the word "telephone" evolved. That idea stuck for quite some time as the dominant purpose of these networks, but by the 1980s we were beginning to see some other uses for networks emerge.

Within 150 years of its first beginnings, the telegraph network infrastructure had become the biggest single connected construction on the planet - and off the planet as well! Just think of it: it wields its way across continents and under oceans in a massive encircling web of fiber, cables, wires, satelliture, and wireless connections. These connections carrying our profound thoughts, our wildest fantasies, our financial transactions, news, music, and just about anything we can express in words or written language.

This is the physical infrastructure on which the Internet was built, and on which it relies. This infrastructure also explains the historical role of telecommunications companies in the Internet. Now they had nothing or very little to do with the early evolution of the Internet, as we shall see in following sections, but they did control the infrastructure the Internet used for distance communication.

The "telephone" network has only come of age since the Internet. Indeed, it's probably only a matter of time before we stop calling it the telephone network. To the children of the digital age, telephone doesn't say much. The Internet is for information, communication, buying and selling, film, exchanging photos and music, sending messages, talking and messaging, all of the above and much more!

The beginnings of the Internet

It will help in discussing the beginnings of the Internet to define what the Internet is. Now you can get as many different definitions of what the Internet is as you can dictionaries. But for must of us, the simple description, a "worldwide system of interconnected networks and computers" is pretty good

and adequate.

But when people get more technical, they tend to add to the definition terms such as "a network that uses the Transmission Control Protocol - Internet protocol" (or TCP/IP).

Many people have heard that the Internet began with some military computers in the Pentagon called Arpanet in 1969. The theory goes on to suggest that the network was designed to survive a nuclear attack. However, whichever definition of what the Internet is we use, neither the Pentagon nor 1969 hold up as the time and place the Internet was invented. A project which began in the Pentagon that year, called Arpanet, gave birth to the Internet protocols sometime later (during the 1970's), but 1969 was not the Internet's beginnings. Surviving a nuclear attack was not Arpanet's motivation, nor was building a global communications network.

Bob Taylor, the Pentagon official who was in charge of the Pentagon's Advanced Research Projects Agency Network (or Arpanet) program, insists that the purpose was not military, but scientific. The nuclear attack theory was never part of the design. Nor was an Internet in the sense we know it part of the Pentagon's 1969 thinking. Larry Roberts, who was employed by Bob Taylor to build the Arpanet network, states that Arpanet was never intended to link people or be a communications and information facility.

Arpanet was about time-sharing. Time sharing tried to make it possible for research institutions to use the processing power of other institutions computers when they had large calculations to do that required more power, or when someone else's facility might do the job better.

What Arpanet did in 1969 that was important was to develop a variation of a technique called packet switching. In 1965, before Arpanet came into existence, an Englishman called Donald Davies had proposed a similar facility to Arpanet in the United Kingdom, the NPL Data Communications Network. It never got funded; but Donald Davies did develop the concept of packet switching, a means by which messages can travel from point to point across a network. Although others in the USA were working on packet switching techniques at the same time (notably Leonard Kleinrock and Paul Baran), it was the UK version that Arpanet first adopted.

However, although Arpanet developed packet switching, Larry Roberts makes it clear that sending messages between people was "not an important motivation for a network of scientific computers". Its purpose was to allow people in diverse locations to utilize time on other computers.

It never really worked as an idea - for a start, all the computers had different operating systems and versions and programs, and using someone else's machine was very difficult: but as well, by the time some of these problems were being overcome, mini-computers had appeared on the scene and the economics of time sharing had changed dramatically.

So it's reasonable to say that ARPANET failed in its purpose, but in the process it made some significant discoveries that were to result in the creation of the first Internet. These included email developments, packet switching implementations, and development of the (Transport Control Protocol - Internet Protocol) or TCP/IP.

TCP/IP is the backbone protocol which technical people claim is the basis for determining what the Internet is. It was developed in the 1970s in California by Vinton Cerf, Bob Kahn, Bob Braden, Jon Postel and other members of the Networking Group headed by Steve Crocker. TCP/IP was developed to solve problems with earlier attempts at communication between computers undertaken by ARPANET.

Vinton Cerf had worked on the earlier Arpanet protocols while at the University of California in Los Angeles from 1968-1972. He moved to Stanford University in late 1972. At the same time Bob Kahn, who had been the chief architect of the Arpanet while working for contracting form Bolt Beranek and Newman, left that firm and joined ARPANET.

In October 1972 ARPANET publicly demonstrated their system for the first time at the International Computer Communications Conference in Washington DC. Following that meeting, an International Networking Group chaired by Vinton Cerf was established.

Bob Kahn visited Stanford in the spring of 1973 and he and Vint Cerf discussed the problem of interconnecting multiple packet networks that were NOT identical. They developed the basic concepts of TCP at that time, and presented it to the newly established International Networking Group. This meeting and this development really rates as the beginning of the Internet.

Nobody knows who first used the word Internet - it just became a shortcut around this time for "internetworking". The earliest written use of the word appears to be by Vint Cerf in 1974.

By 1975 the first prototype was being tested. A few more years were spent on technical development, and in 1978 TCP/IPv4 was released.

It would be some time before it became available to the rest of us. In fact, TCP/IP was not even added to Arpanet officially until 1983.

So we can see that the Internet began as an unanticipated result of an unsuccessful military and academic research program component, and was more a product of the US west coast culture of the 1980s than a product of the post-war Pentagon era.
However, is that the only story of how the Internet began? Not really - read on here.

So, who really did invent the Internet?

Fuelled largely by the PBS television series "Triumph of the Nerds" some years ago, and by the earlier writings of Silicon Valley gossip columnist Robert Cringely in the beautifully titled "Accidental Empires - how the boys of Silicon Valley make their millions, battle foreign competition, and still can't get a date" (Penguin, 1992), a popular belief has sprung up that the Internet was invented in the Pentagon in 1969. The theory goes on to suggest that the Internet network invented in the Pentagon was designed to survive a nuclear attack.

This theory survives and is even propagated by individuals who celebrated "the Internet's 35th birthday" in 2004. However, not everyone celebrated, and not everyone agreed.

Perhaps the most serious rebuttal on the theory of Pentagon origins (otherwise known as the big bang theory of Internet origins) came from the person who was in charge of the Pentagon Arpanet project at the time when the Internet supposedly began, Bob Taylor. Writing in reference to a mailing list invitation to attend the 35th anniversary event, Bob Taylor explained.

"In February of 1966 I initiated the ARPAnet project. I was Director of ARPA's Information Processing Techniques Office (IPTO) from late '65 to late '69. There were only two people involved in the decision to launch the ARPAnet: my boss, the Director of ARPA Charles Herzfeld, and me.

Numerous untruths have been disseminated about events surrounding the origins of the ARPAnet. Here are some facts.

The creation of the ARPAnet was not motivated by considerations of war. The ARPAnet was not an internet. An internet is a connection between two or more computer networks."

So then, where and when did the Internet begin? The only thing historians seem to agree on is that it was not 1969, or the Pentagon, (or for that matter Al Gore). From there on, there is a wide divergence of views as to when, where, and by whom the Internet may have been invented.

It will help in discussing the beginnings of the Internet to define what the Internet is. Now you can get as many different definitions of what the Internet is as you can dictionaries. But for must of us, the simple description, a "worldwide system of interconnected networks and computers" is pretty good and adequate. But some people get more technical, and want to add to the definition terms such as "a network that uses the Transmission Control Protocol - Internet protocol" (or TCP/IP). But not everyone agrees that it is TCP/IP which defines the Internet or its point of origin.

The competing origin theories

We have analyzed the literature on this, and over the years had correspondence with most of the pioneers whose names are mentioned in this article. At www.nethistory.info we list a number of the books devoted to early Internet history: some of the most prominent are

- Janet Abbate, Inventing the Internet, Cambridge, 1999
- Katie Hafner and Matthew Lyon, Where Wizards Stay Up Late, N.Y, 1996
- Michael Hauben and Ronda Hauben, Netizens: On the History and Impact of Usenet and the Internet, Los Alamitos, 1997
- Peter Salus, Casting the Net, Reading, MA, 1995.

None of these are definitive or complete. Most focus heavily on the Arpanet developments. On further analysis we come up with at least five distinct theories, each of which can be credibly discussed. We state from the beginning that we do not personally see the theories as mutually exclusive - we have for many years believed in a multiple origins theory rather than a single point of invention one.

But the theories which need to be examined are:

1. Packet switching represents the origins of the Internet
2. The TCP/IP protocol represents the origins of the Internet
3. A range of telco-led activities from the 1960s represents the true origins
4. The birth of the Internet is best explained through a history of applications rather than the protocols
5. The range of inventions and activities emanating from Xerox Palo Alto laboratories, including Ethernet, represent the true beginnings.

Let's explore these various theories further, but first….

Our criteria

By what criteria would we determine what was a (primitive) Internet?

We will examine the various verifiable events according to the following criteria
Was it a connection between networks?
Did it involve computers?
Did it involve humans communicating with each other?
Was it an actual event and not a theoretical document?

If a theory passes all these tests, the final test is - was it the first "Internet"?

These criteria, we suggest, all have to be met before we have the event which could be called "the birthday of the Internet". If not all are met, we are dealing with a different but perhaps closely related species, or with a theory which was at that place and time untested. So, let the games begin!

Theory One - Packet switching represents the origins of the Internet

The Arpanet 1969 claim to Internet origins largely rests on acceptance of this theory and a belief that this was the first ever packet switching exchange. As we are told,

On October 29 1969, UCLA computer science professor Leonard Kleinrock led a team of engineers in launching the first Internet message from UCLA to Stanford Research Institute, as part of the Arpanet project. As Kleinrock is purported to have reflected on the 35th anniversary of this event in 2004,

"When we sent that first message, it marked the birth of a new method of global communications that has forever changed the course of business, politics, entertainment, education and social interaction, Now, 35 years later, the Internet has become so pervasive that even my 97-year-old mother uses it."

Important as this event was, there are several reasons not to regard it as the birth of the Internet. These include:

It was not the first packet switching event
It was not about people communicating over distance
It was not a connection relating to "a network of networks".

Let's explore the flaws in this theory in more detail.
It was not the first packet switching event
In my "History of the Internet", I explain….

"What Arpanet did in 1969 that was important was to develop a variation of a technique called packet switching. In 1965, before Arpanet came into existence, an Englishman called Donald Davies had proposed a similar facility to Arpanet in the United Kingdom, the NPL Data Communications Network. It never got funded; but Donald Davies did develop the concept of packet switching, a means by which messages can travel from point to point across a network. Although others in the USA were working on packet switching techniques at the same time (notably Leonard Kleinrock and Paul Baran), it was the UK version that Arpanet first adopted."

Ronda Hauben writes similarly indicating a 1966 event when Donald Davies in the UK implemented a packet switch connecting a set of host computers.

Kim Veltman goes further in exploring this

"We are almost always told that the Internet began solely in America. This is not really true. The earliest pioneers included a Frenchman, Louis Pouzin, who introduced the idea of data grams and an Englishman, Donald W. Davies, who was one of the inventors of packet-switching. Another of the great pioneers in Britain was Peter T. Kirstein, who went to America at the beginning of the Arpanet in 1969 when it was decided that Davies could not go for reasons of national security. "

And Bruce Sterling adds

"The National Physical Laboratory in Great Britain set up the first test network on these principles [of

packet switching] in 1968. Shortly afterward, the Pentagon's Advanced Research Projects Agency decided to fund a larger, more ambitious project in the USA. Hence an English project of 1968 inspired the beginnings of the US Internet in 1969".

What follows from this analysis is that, if we believe that the first trials of packet switching represents the beginnings of the Internet, the Internet began in the UK, not USA. But does that theory meet all our tests?

Arpanet in 1969 was not about people communicating over distance

Another reason to reject the Arpanet 1969 origins theory is that the Arpanet was not about people communicating over distance at all - something which would be a primary determinant of what we know as the Internet.

Arpanet was about time-sharing. Time sharing tried to make it possible for research institutions to use the processing power of other institutions computers when they had large calculations to do that required more power, or when someone else's facility might do the job better.

Although Arpanet developed packet switching, Larry Roberts (Project Manager and Architect for the Arpanet project) makes it clear that sending messages between people was "not an important motivation for a network of scientific computers".

It seems difficult to stretch belief that timesharing between mainframe computers is the Internet - a point of origin perhaps, but hardly the single point of beginnings for the Internet.

1969 was not a connection relating to "a network of networks"

The last point we need to make in deciding that Arpanet/1969 was not the birth of the Internet relates to the definition of a "network of networks".

What defines the Internet is the capacity to connect networks of different types. It therefore follows that Arpanet as a single network could hardly be described as an Internet - Arpanet would have to connect to something completely different before it could be part of an Internet.

According to Bob Kahn, who we will hear more of in the next section,

"What the ARPANET didn't address was the issue of interconnecting multiple networks and all the attendant issues that raised."

(Kahn, E-mail to Hauben, September 15, 2002)

Similarly, Vint Cerf, who also features strongly in our next theory, explains that the NCP protocol on which internal Arpanet connections took place was inadequate for addressing the problem of interconnecting multiple packet networks which were not identical.

Findings on Arpanet origins theory

For the above reasons, we do not believe that 1969 and Arpanet can claim to be the origins of the Internet. If packet switching is the origins, the Internet was invented elsewhere. If we are looking at some other role Arpanet played, the date is not 1969 and another theory will have to pass our tests.

Theory Two - The TCP/IP theory

Among today's Internet community, this is the most commonly held belief, fed largely by the impressive and ongoing role played by Vinton Cerf in the evolution of today's Internet and its governance structures.

TCP/IP is the backbone protocol which some people claim is the basis for determining what the Internet is. It was developed in the 1970s in California by Vinton Cerf, Bob Kahn, Bob Braden, Jon Postel and other members of the Networking Group headed by Steve Crocker. TCP/IP was developed to solve problems with earlier homogenous attempts at communication between computers undertaken by ARPANET.

Vinton Cerf had worked on the earlier Arpanet protocols while at the University of California in Los Angeles from 1968-1972. He moved to Stanford University in late 1972. At the same time Bob Kahn, who had been the chief architect of the Arpanet while working for contracting firm Bolt Beranek and Newman, left that firm and joined ARPANET.

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By 1975 the first prototype was being tested. A few more years were spent on technical development, and in 1978 TCP/IPv4 was released.

Cerf writes

"We had running code by the middle of 1975 for TCP. We ran this protocol on selected nodes of the ARPANET, the packet radio net and the packet satellite net - all of which were ARPA sponsored. Xerox PARC implemented a version for their Ethernet around 1976 if memory serves - connected it to the nascent Internet by way of packet radio in the San Francisco Bay area".

Among those working on this specification were researchers from Stanford University, a range of other universities, BBN contractors, Xerox Parc employees, and researchers from the United Kingdom, France and Norway.

It would be some time before it became available to the rest of us. In fact, TCP/IP was not even added to Arpanet officially until 1983.

So which date do we celebrate if we adopt the TCP/IP origins theory?

We do not yet have a definitive date, but 1975 seems to be the definitive year in which, for the first time, networks connected to each other. But was the first connection between disparate networks a TCP/IP one? Well, you'll have to read on to find out.

Findings on TCP/IP origins theory

Given the above, the TCP/IP origins theory and a 1975 date remains in our tests. This theory represents to us a far more credible description of the origins of the Internet, passing all of our tests to date. However, although these developments definitely led to the establishment of standards bodies

such as IETF, ISOC and the emergence of ICANN (headed still by Vint Cerf), it is still a stretch to some people to believe this as the single point of origin- and was it the first connection? Let's explore other theories as well before making a final determination.

Theory Three -Telco origins

The primary proponent of this theory would be Kim Veltman of the McLuhan Institute in Holland. As Veltman states,

" Since its beginnings …..there have been many stories about the Internet. One is that the Internet was a US invention. The story that officials in AT&T (a large American telecommunications company) were once adamantly opposed to the Internet led to a received wisdom that telephone or telecommunications companies (telcos or telecoms) and the Internet were unrelated. The telephone companies, we are told, were big monopolies, blind to innovation and the Internet was started on the sly by a few scientists and academics. The Federal Communications Commission (FCC) version is more subtle: The telcos did infrastructure, while those who developed the Internet did applications."

As Veltman points out, the AT&T Bell Labs did some of the first digital transmission and switching in 1962, seven years before the "US Internet" began. When the Department of Defense (DoD) commissioned the Advanced Research Project Agency's Network (ARPANET) to do research into networking, it was AT&T that provided 50kbps lines. In 1969, the year that Arpanet began, AT&T's Bell Labs developed Unix which was "the operating system behind the early Internet, and was one of the key operating systems in the middle and late ARPANET."

Between 1969 and 1972, Bell Labs developed the C programming language basic to much of Internet software. In 1970, AT&T installed the first cross-country link between the University of California at Los Angeles (UCLA) and Bolt, Beranek and Newman (BBN) in Boston. In 1976, AT&T's Bell Labs developed (Unix-to-Unix Copy (UUCP), which was distributed with UNIX one year later."

All of these were important points of origin of the Internet as we know it, so the telco theory, unpopular as it is in Internet circles, should perhaps be explored in more detail. Certainly the physical infrastructure created by the telcos was central, and certainly telcos had worked out protocols for sending voice data between disparate networks early in the piece. In the examples above, they added the component of computers and networked them. Can we completely eliminate the telco origins and contributions to early developments?

Findings on Telco origins theory

We `cannot altogether dismiss this theory either. We see in the telco theory connections between networks at an infrastructure level, involvement of computers, actual networked events earlier than TCP/IP, and at least some indication that human communication was a motivating force.

But then, is a telephone line an Internet? The purists would argue certainly not. But by the same token, is a transport protocol the Internet? No more so than a telephone line, we would suggest, much though both were necessary. The same logic would tend to suggest that neither TCP/IP or the existence of a telephone line can be said to indicate the existence of an Internet (unless you accept the circular argument that internet=tcp/ip and try to redefine what the world has come to know as the Internet).

This set of developments is important, because it brings in commercial origins, as well as the academic research/government funded origins of the more popularly espoused theories. With Unix and UUCP, the telcos played a larger part than many would have us believe.
Theory Four - Applications layer-led

Perhaps answering this line of confusion as to whether the Internet can be represented by either telephony infrastructure or any particular protocol at the transport layer, Mitra Ardron takes it further with another theory altogether. (Internet History newsletter, October 2004)

"I would suggest that defining the history of the internet by the particular protocol that won is only one way to do it. Ask yourself - would it still be the internet if we were using ATM, or X.25 or any of the other competing protocols? Of course it would.

An alternative view of history tracks the history of the Internet as the ubiquitous use of electronic "online" communications. The history belongs at the applications level - with the development of email, with the progression from proprietary databases to Gopher and Wais to the World Wide Web, and from newsgroups and conferencing (eg BITnet and Usenet) through mailing lists and blogs.

One very significant trend which tends to get ignored is the various online systems, the early Source, Compuserve, Dialcom, and of course APC networks, Fidonet etc. If anything, the history of the use of the Internet, at least from the point of view of the public, owes more to that stream of development than the more common version.

From that perspective, the switch from X.25 to TCP/IP around say '92 for the transport was just something that was done when cost/benefit of TCP/IP dropped below that of X.25."

Ardron refers to the existence of an emerging interconnectivity regime between various commercial, non-profit and hobbyist networks which began to emerge from the mid 1980s without necessarily using TCP/IP. During this pre-web era, email began to be exchanged freely between networks according to emerging standards and through various gateways. Newsgroups emanating from academic circles became available on various networks, with only a percentage of the people utilizing the growing global network using TCP/IP.

The "killer app" driving all of these networks was email. Email existed before the Internet, but in those days email could only be used to send messages to various users of the same computer. Once computers began to talk to each other over networks, however, the problem became a little more complex - We needed to be able to put a message in an envelope and address it. To do this, we needed a means to indicate to whom letters should go that the electronic posties understood - just like the postal system, we needed a way to indicate an address.

This is why Ray Tomlinson is credited with inventing email in 1972. Like many of the Internet pioneers, Tomlinson worked for Bolt Beranek and Newman as an Arpanet contractor. He picked the @ symbol from the computer keyboard to denote sending messages from one computer to another. So then, for anyone using Internet standards, it was simply a matter of nominating name-of-the-user@name-of-the-computer. Internet pioneer Jon Postel was one of the first users of the new system, and is credited with describing it as a "nice hack". It certainly was, and it has lasted to this day.

Email drove mass adoption in the pre world wide web era known as the "protocol wars". Governments continued to argue for some time for a completely different set of standards based on OSI; Hobbyist networks maintained the Fidonet system; various efforts such as APC and UFGate software bridged the Unix and PC based network worlds - and a host of commercial systems such as Dialcom, Compuserve, AOL and other email systems with entirely different operating systems were all seeking an answer to the connectivity crisis. But email exchanges across these systems were already working by a variety of means.

Later on, TCP/IP won the protocol wars on costs and simplicity of adoption. Soon after, the World

Wide Web appeared, and the last of the laggards believing they had a separate future began to convert.

Findings on Applications led origins theory

The theory is compelling because it explains clearly the reasons why people started to use the Internet. It creates a more popular understanding of what is essentially a popular phenomenon. It passes all our tests; certainly email was passed between non-homogenous networks not utilizing tcp/ip.

Theory Five - Ethernet and Xerox Palo Alto

And then we come to the theory advanced by the person who headed the Arpanet project itself, Bob Taylor. Quoting Bob,

"I believe the first internet was created at Xerox PARC, circa '75, when we connected, via PUP, the Ethernet with the ARPAnet. PUP (PARC Universal Protocol) was instrumental later in defining TCP.

For the internet to grow, it also needed a networked personal computer, a graphical user interface with WYSIWYG properties, modern word processing, and desktop publishing. These, along with the Ethernet, all came out of my lab at Xerox PARC in the '70s, and were commercialized over the next 20 years by Adobe, Apple, Cisco, Microsoft, Novell, Sun and other companies that were necessary to the development of the Internet."

John Shoch, who worked with Robert Metcalfe on the Ethernet developments at Xerox Parc, and who is at great pains to stay out of debates about who started the Internet, has concluded that PUP (the Parc Universal Protocol) was the first complete, operational set of Internet protocols. Schoch was also involved in the development of TCP/IP at a later date. To quote Shoch,

"Starting around 1974, Xerox PARC designed and deployed an internet architecture called PUP; it was up and running on multiple machines and networks when TCP was just a design for byte stream protocols. Input from Xerox' operational experience helped convince the TCP working group to add the IP packet layer!"

Findings on Xerox Parc origins theory

This might in fact provide another answer for us - the first Internet connection may not have involved TCP/IP or government funding at all, and may be solely the result of commercial research.
Is there a winner?

Examining these various events, we come to some important findings.

- There are a number of valid claims to origins of the Internet.
- Although an original date and place might be obtainable for the first networked transmission that could be called an Internet, the result would need by definition to include more than one party or network, and is unlikely to be a satisfactory or useful conclusion.
- Not only US projects were involved in the beginnings of the Internet.
- Not only government funded US research programs were involved in the beginnings of the Internet.
- Not only telcos and the commercial sector were involved in the beginnings of the Internet.
- Neither Arpanet nor TCP/IP is present in all valid theories.

These findings are important lest any institution or organization lays claim to some proprietary ownership of the Internet. As Kim Veltman puts it,

"It seems false to claim that America invented the Internet and is simply misleading to argue that because America invented the Internet, it is their right to control its governance through organizations such as the Internet Assigned Names Authority (IANA) and more recently the Internet Corporation for Assigned Names and Numbers (ICANN)."

It would appear however that some proprietary ownership has been assumed. To quote from a US Dept of Communications (DOC) memorandum (Karen Rose)

" Purchase Order No. 40SBNT067020 provides that "[ICANN] will perform other IANA functions as needed upon request of DOC. As such, the Department of Commerce requests that, as part of the IANA functions, ICANN undertake administration of the arpa TLD in cooperation with the Internet technical community under the guidance of the IAB, as a limited use domain for Internet infrastructure applications, including the migration of Internet infrastructure applications that currently reside in the .int TLD. Further, as indicated by DARPA, the arpa TLD string should be given a different expansion such as "Address and Routing Parameter Area" to avoid any implication that DARPA has operational responsibility for the domain.

Thus, although distancing from DARPA, the right to determine priorities and request changes is definitely assumed by DOC in this memorandum.

This is not to suggest that the DOC involvement has been anything other than benign and useful. Or that Arpanet wasn't in there somewhere. But current institutions and governance structures must take their validity from the current involvement and endorsement of major stakeholders, not from any assumed proprietary history. They need to justify their future involvement in the Internet similarly, on the basis of current and future usefulness and validity, not on the basis of a Purchase Order.

Nor should this article undermine the significant contributions of a number of individuals to claims as "fathers of the Internet". Most of these individuals, particularly those who are most prominent, are at pains to point out the crucial involvement of others - however, the institutions they represent are often less careful in ensuring that widespread involvement of individuals from commercial and government funded sources in a number of countries are ultimately to be thanked for the origins of the Internet. If this paper does no more than clarify that the Internet really has no owner and no single place of origin, it will have served well.

In the end, the History of the Internet is better understood as the history of an era than that of a protocol. To draw a parallel: we are treating the Internet more like a history of transport, which obviously has several threads and origins and important developments, rather than a history of the steam engine (part of the transport history, for sure, but only a small part). This is why we have problems with the TCP/IP origins theory (or the packet switching theory or the telco/infrastructure theory) and that that alone is the history on the Internet. There is so much more to it!

Multiple events, multiple players, and multiple points of origin need to be mentioned in any sensible understanding of the emergence of the Internet. Any claim by a nation, project, person, or team of individuals, or participants in any single event to "the beginnings of the Internet" is rubbish. Further, any claim that the validity or legitimacy of any structure or arrangement can be justified as Internet governance purely because it arose from one of these events is false.

The history of computers, networks and modems

In this section we are talking about the evolution of personal computers, modems and networks. Computer history

History of the Internet

By Ian Peter

The most ancient processing device humans have invented would probably be the abacus, dating back to about 3000BC. But more realistically we should look to the 1940s for the origins of the computer.

During World War 2, both the UK government, in the form of a computer called Colossus, and the US government in the form of ENIAC (or the Electronic Numerical Integrator Analyzer and Computer) developed precursors of today's computers. The invention of the transistor in 1947 gave these developments a great leap forward.

In the 1960s we saw the beginnings of companies that were to have a major influence in the computing field - Texas Instruments, Fairchild computing, and IBM, whose 360 computer was released in 1964.

The sort of computers ARPANET and the early research networks were dealing with were monsters with very little power by today's standards. Only computer scientists used them. Computers with the power of modern day pocket calculators occupied whole floors of buildings. I think at the time IBM predicted the world would only need 13 of them for planet Earth for all time!

These monsters, or mainframes as they are called where they still exist these days, could only be afforded by large institutions.

Another big event happened in 1963 - the invention of the mouse by Douglas Englebart. Engelbart was a very influential and visionary person, who also helped develop early word processors and hypertext. However it would be almost another 20 years before most of his inventions became popular or much used. These had to wait for the personal computer to appear.

There might have been an Internet without personal computers, but it would have been uninteresting, and probably confined to the research community and computer scientists. The invention that gave the Internet a real chance to reach out to over 600 million people, and to make it the sort of network it is today, was the personal computer. Personal computers, networked over the global telephony infrastructure, is what created the network we have today.

The first personal computer, the Altair 8800, cost 379 US dollars and was shipped in January 1975. Over 1000 were sold. By 1977 The Radio Shack TRS 80, Apple 2, and Commodore PET were also on the market. IBM got the idea by about 1981 and released the first IBM PC.

The company that dominated the market in the early days - at one stage they had 75% of all computers sold - was Apple Computer. Apple was founded by Steve Jobs and Steve Wozniak just outside of San Francisco. Steve Jobs at the time was a long haired vegetarian - Steve Wozniak was to lose a fortune on back-to-Woodstock concerts. So the influences of the San Francisco flower power hippy culture of the time were there.

The early computer programmers called themselves hackers. At one stage Bill Gates would have been proud to be called a hacker. They called the software they created "hacks".

The original Apple operating system was called AppleDOS, but by 1980 the CP/M operating system had become a popular addition to the Apple 2+. It was very like the competitor which was to overtake it and launch Bill Gates on the way to his fortune, MSDOS. In fact, MS-DOS's predecessor was called "Q-DOS" - short for "Quick and Dirty Operating System"..

Early computers featured a thing called a "command line". They didn't yet have a mouse, although

joysticks for games machines were starting to appear. We had to wait for the 1990s before Windows became popular on the IBM operating system.

None of these computers - either the new PCs or the old mainframes - had been designed to be communicating devices (the main objective was thought to be their processing power). So a means had to be found to connect them to networks. Here two more developments became important - the modem, which connected early computers to telephone lines, and Ethernet, a standard which was developed for "Local area networks" or LANs (where computers were really all in the same room or area and could be "wired" together).

Modems and networks

Modem is a term we are likely to forget soon in the digital age, but for most of us modems were where internetworking began. Modem is short for modulate-demodulate - that's where it got its name. Modems enable the digital form of matter that a computer uses to communicate by the analogue form of transmission of old style telephone systems.

There were apparently some early modems used by the US Air Force in the 1950's, but the first commercial ones were made a decade later. The earliest modems were 75 bps (or bits per second). That's about 1/750th of the speed of current modems, so they were pretty slow! But to early networking enthusiasts, modems were 300 bps. Then came 1200, and by 1989 2400 bps modems.

By 1994, domestic modems had got to 28.8 kilobits per second - which was just as well, because by then we were beginning to send more than text messages over the Internet. This was thought to be an upper limit for phone line transmissions. But along came the 56k modem, and a new set of standards, so the speeds continue to push the envelope of the capacity of the telephone system.

So much so that many of have moved on, into wireless networks, and into "broadband" systems, which allow much faster speeds. But modems made the first critical link between computers and telephones, and began the age of internetworking.

Another of the former Arpanet contractors, Robert Metcalfe, was responsible for the development of Ethernet, which drives most local area networks.

Ethernet essentially made a version of the packet switching and Internet protocols which were being developed for Arpanet available to cabled networks. After a stint at the innovative Xerox Palo Alto laboratories, Metcalfe founded a company called 3-Com which released products for networking mainframes and mini computers in 1981, and personal computers in 1982.

With these developments in place, tools were readily available to connect both old and new style computers, via wireless, cable, and telephone networks. As the networks grew, other companies such as Novell and CISCO began to develop more complex networking hubs, bridges, routers and other equipment. By the mid 1980's, everything that was needed for an explosion of internetworking was in place.

The history of email

Email is much older than ARPANet or the Internet. It was never invented; it evolved from very simple beginnings.

Early email was just a small advance on what we know these days as a file directory - it just put a message in another user's directory in a spot where they could see it when they logged in. Simple as that. Just like leaving a note on someone's desk.

Probably the first email system of this type was MAILBOX, used at Massachusetts Institute of Technology from 1965. Another early program to send messages on the same computer was called SNDMSG.

Some of the mainframe computers of this era might have had up to one hundred users -often they used what are called "dumb terminals" to access the mainframe from their work desks. Dumb terminals just connected to the mainframe - they had no storage or memory of their own, they did all their work on the remote mainframe computer.

Before internetworking began, therefore, email could only be used to send messages to various users of the same computer. Once computers began to talk to each other over networks, however, the problem became a little more complex - We needed to be able to put a message in an envelope and address it. To do this, we needed a means to indicate to whom letters should go that the electronic posties understood - just like the postal system, we needed a way to indicate an address.

This is why Ray Tomlinson is credited with inventing email in 1972. Like many of the Internet inventors, Tomlinson worked for Bolt Beranek and Newman as an ARPANET contractor. He picked the @ symbol from the computer keyboard to denote sending messages from one computer to another. So then, for anyone using Internet standards, it was simply a matter of nominating name-of-the-user@name-of-the-computer. Internet pioneer Jon Postel, who we will hear more of later, was one of the first users of the new system, and is credited with describing it as a "nice hack". It certainly was, and it has lasted to this day.

Despite what the world wide web offers, email remains the most important application of the Internet and the most widely used facility it has. Now more than 600 million people internationally use email.

By 1974 there were hundreds of military users of email because ARPANET eventually encouraged it. Email became the saviors of Arpanet, and caused a radical shift in Arpa's purpose.

Things developed rapidly from there. Larry Roberts invented some email folders for his boss so he could sort his mail, a big advance. In 1975 John Vital developed some software to organize email. By 1976 email had really taken off, and commercial packages began to appear. Within a couple of years, 75% of all ARPANET traffic was email.

Email took us from Arpanet to the Internet. Here was something that ordinary people all over the world wanted to use.

As Ray Tomlinson observed some years later about email, "any single development is stepping on the heels of the previous one and is so closely followed by the next that most advances are obscured. I think that few individuals will be remembered." That's true - to catalogue all the developments would be a huge task.

One of the first new developments when personal computers came on the scene was "offline readers". Offline readers allowed email users to store their email on their own personal computers, and then read it and prepare replies without actually being connected to the network - sort of like Microsoft Outlook can do today.

This was particularly useful in parts of the world where telephone costs to the nearest email system were expensive. (often this involved international calls in the early days) With connection charges of many dollars a minute, it mattered to be able to prepare a reply without being connected to a

telephone, and then get on the network to send it. It was also useful because the "offline" mode allowed for more friendly interfaces. Being connected direct to the host email system in this era of very few standards often resulted in delete keys and backspace keys not working, no capacity for text to "wrap around" on the screen of the users computer, and other such annoyances. Offline readers helped a lot.

The first important email standard was called SMTP, or simple message transfer protocol. SMTP was very simple and is still in use - however, as we will hear later in this series, SMTP was a fairly naïve protocol, and made no attempt to find out whether the person claiming to send a message was the person they purported to be. Forgery was (and still is) very easy in email addresses. These basic flaws in the protocol were later to be exploited by viruses and worms, and by security frauds and spammers forging identities. Some of these problems are still being addressed in 2004.

But as it developed email started to take on some pretty neat features. One of the first good commercial systems was Eudora, developed by Steve Dorner in 1988. Not long after Pegasus mail appeared.

When Internet standards for email began to mature the POP (or Post Office Protocol) servers began to appear as a standard - before that each server was a little different. POP was an important standard to allow users to develop mail systems that would work with each other.

These were the days of per-minute charges for email for individual dialup users. For most people on the Internet in those days email and email discussion groups were the main uses. These were many hundreds of these on a wide variety of topics, and as a body of newsgroups they became known as USENET.

With the World Wide Web, email started to be made available with friendly web interfaces by providers such as Yahoo and Hotmail. Usually this was without charge. Now that email was affordable, everyone wanted at least one email address, and the medium was adopted by not just millions, but hundreds of millions of people.
History of the World Wide Web

Before the World Wide Web the Internet really only provided screens full of text (and usually only in one font and font size). So although it was pretty good for exchanging information, and indeed for accessing information such as the Catalogue of the US Library of Congress, it was visually very boring.

In an attempt to make this more aesthetic, companies like Compuserve and AOL began developing what used to be called GUIs (or graphical user interfaces). GUIs added a bit of color and a bit of layout, but were still pretty boring. Indeed IBM personal computers were only beginning to adopt Windows interfaces - before that with MSDOS interfaces they were pretty primitive. So the Internet might have been useful, but it wasn't good looking.

Probably the World Wide Web saved the net. Not only did it change its appearance, it made it possible for pictures and sound to be displayed and exchanged.

The web had some important predecessors, perhaps the most significant of these being Ted Nelson's Xanadu project, which worked on the concept of Hypertext - where you could click on a word and it would take you somewhere else. Ted Nelson envisaged with Xanadu a huge library of all the worlds' information. In order to click on hyperlinks, as they were called, Douglas Engelbart invented the mouse, which was to later become a very important part of personal computers. So the idea of

clicking on a word or a picture to take you somewhere else was a basic foundation of the web.

Another important building block was the URL or Uniform Resource Locator. This allowed you a further option to find your way around by naming a site. Every site on the worldwide web has a unique URL (such as www.nethistory.info).

The other feature was Hypertext Markup Language (html), the language that allowed pages to display different fonts and sizes, pictures, colors etc. Before HTML, there was no such standard, and the "GUIs we talked about before only belonged to different computers or different computer software. They could not be networked.

It was Tim Berners Lee who brought this all together and created the World Wide Web. The first trials of the World Wide Web were at the CERN laboratories (one of Europe's largest research laboratories) in Switzerland in December 1990. By 1991 browser and web server software was available, and by 1992 a few preliminary sites existed in places like University of Illinois, where Mark Andreesen became involved. By the end of 1992, there were about 26 sites.

The first browser which became popularly available to take advantage of this was Mosaic, in 1993. Mosaic was as slow as a wet week, and really didn't handle downloading pictures well at all - so the early world wide web experience with Mosaic, and with domestic modems that operated at one sixths of current modem speeds at best, were pretty lousy and really didn't give much indication of the potential of this medium.

On April 30, 1993 CERN's directors made a statement that was a true milestone in Internet history. On this day, they declared that WWW technology would be freely usable by anyone, with no fees being payable to CERN. This decision - much in line with the decisions of the earlier Internet pioneers to make their products freely available - was a visionary and important one.

The browser really did begin to change everything. By the end of 1994 there were a million browser copies in use - rapid growth indeed!!

In the same year Marc Andreesen founded Netscape Corporation, and the World Wide Web Consortium, which administers development of Word Wide Web standards, was formed by Tim Berners Lee.

Then we really started to see growth. Every year from 1994 to 2000, the Internet saw massive growth, the like of which had not been seen with any preceding technology. The Internet era had begun.

The first search engines began to appear in the mid 1990s, and it didn't take long for Google to come on the scene, and establish a dominant market position.

In the early days, the web was mainly used for displaying information. On line shopping, and on line purchase of goods, came a little bit later. The first large commercial site was Amazon, a company which in its initial days concentrated solely on book markets. The Amazon concept was developed in 1994, a year in which some people claim the world wide web grew by an astonishing 2300 percent! Amazon saw that on line shopping was the way of the future, and chose the book market as a field where much could be achieved.

By 1998 there were 750,000 commercial sites on the world wide web, and we were beginning to see how the Internet would bring about significant changes to existing industries. In travel for instance, we were able to compare different airlines and hotels and get the cheapest fares and accommodation -

something pretty difficult for individuals to do before the world wide web. Hotels began offering last minute rates through specially constructed websites, thus furthering the power of the web as a sales medium.

And things went even further - in some fields of travel, individuals would outline where they wanted to travel to and from, and travel companies would then bid for the business. All these developments rapidly changed the way traditional markets worked. In some industries, the world would never be the same again.
Early Internet - History of PC networking

At the same time as the academic and research communities were creating a network for scientific purposes, a lot of parallel activity was going on elsewhere building computer networks as well.

A lot of the West Coast hackers belonged to the Homebrew Computer Club, founded by Lee Felsenstein. Lee had actually begun networking computers before the development of the PC, with his Community Memory project in the late 1970s. This system had dumb terminals (like computer screens with keyboards connected to one large computer that did the processing). These were placed in laundromats, the Whole Earth Access store, and community centers in San Francisco. This network used permanent links over a small geographical area rather than telephone lines and modems.

The first public bulletin board using personal computers and modems was written by Ward Christensen and Randy Seuss in Chicago in 1978 for the early amateur computers. It was about 1984 that the first bulletin boards using the IBM (Bill Gates/Microsoft) operating system and Apple operating systems began to be used. The most popular of these was FidoNet.

At that time the Internet technologies were only available on the UNIX computer operating system, which wasn't available on PCs. A piece of software called ufgate, developed by Tim Pozar, was one of the first bridges to connect the Fidonet world to the Internet world. An alternative approach undertaken by Scott Weikart and Steve Fram for the Association for Progressive Communications saw UNIX being made available on special low cost PCs in a distributed network.

In the community networking field early systems included PEN (Public Electronic Network) in Santa Monica, the WELL (Whole Earth 'Lectronic Link) in the Bay area of San Francisco, Big Sky Telegraph, and a host of small businesses with online universities, community bulletin boards, artists networks, seniors clubs, women’s networks etc. ..

Gradually, as the 1980s came to a close, these networks also began joining the Internet for connectivity and adopted the TCP/IP standard. Now the PC networks and the academic networks were joined, and a platform was available for rapid global development.

By 1989 many of the new community networks had joined the Electronic Networkers Association, which preceded the Internet Society as the association for network builders. When they met in San Francisco in 1989, there was a lot of activity, plus some key words emerging - connectivity and interoperability. Not surprisingly in the California hippy culture f the time, the visions for these new networks included peace, love, joy, Marshall McLuhan's global village, the paperless office, electronic democracy, and probably Timothy Leary's Home Page. However, new large players such as America on Line (AOL) were also starting to make their presence felt, and a more commercial future was becoming obvious. Flower power gave way to communications protocols, and Silicon Valley just grew and grew.

PEN (The Public Electronic Network) in Santa Monica, may be able to claim the mantle of being the

first local government based network of any size. Run by the local council, and conceived as a means for citizens to keep in touch with local government, its services included forms, access to the library catalogue, city and council information, and free email.

PEN started in February 1989, and by July 1991 had 3,500 users. One of the stories PEN told about the advantages of its system was the consultations they had with the homeless people of Santa Monica. The local council decided that it would be good to consult the homeless to find out what the city government could do for them. The homeless came back via email with simple needs - showers, washing facilities, and lockers. Santa Monica, a city of 96000 people at the time, was able to take this on board and provide some basic dignity for the homeless -and at a pretty low cost. This is probably the first example of electronic democracy in action.

Meanwhile, back in the academic and research world, there were many others who wanted to use the growing network but could not because of military control of Arpanet. Computer scientists at universities without defense contracts obtained funding from the National Science Foundation to form CSNet (Computer Science Network). Other academics who weren't computer scientists also began to show interest, so soon this started to become known as the "Computer and Science Network". In the early days, however, only a few academics used the Internet at most universities. It was not until the1990s that the penetration of Internet in academic circles became at all significant.

Because of fears of hackers, the Dept of Defense created a new separate network, MILNet, in 1982. By the mid-1980s, ARPANET was phased out. The role of connecting university and research networks was taken over by CSNet, later to become the NSF (or national science foundation) Network.

The NSFnet was to become the U.S. backbone for the global network known as the Internet, and a driving force in its early establishment. By 1989 ARPANet had disappeared, but the Information Superhighway was just around the corner.
History of the Internet - early global spread

Let's look at the global spread of networks beyond the USA.

Fidonet, the first large network to connect personal computers, was established in 1983. By 1990 there were 2500 hosts all over the world, although mainly in western countries. A lot of these were for computer hobbyists, but meanwhile we were beginning to see some specific types of network appear.

Community networks were beginning to spring up everywhere. By 1991 Japan had the Watarese Area Network., and Australia had the Ipswich Global Links Network from 1994. These local government based networks were often seen as a catalyst for economic development - lots of areas around the world wanted to be the next Silicon Valley.

FreeNets were another model, with the most prominent being in Ottawa Canada and Cleveland Ohio. The Freenet model gave free access, and the service was paid for by people such as government bodies who wanted to get information out to the general public. FreeNets played a large role in community building, but the financial model was problematic and the cost of upgrades beyond the under-budgeted operators. FreeNets were important pioneers in many areas and the first introduction to networking for many people.

Inevitably experiments began linking regional areas. Some prominent early experiments were Bega and Norlink (Australia) Hometown and New Brunswick(Canada), and Wellington (New Zealand). These developments often combined with the growing telecottage movement, which provided community facilities where people could learn to use computers.

In addition to these more geographically centered activities, global communities of interest (later to become known as virtual communities) were starting to evolve.

One such network, and a major player in the early growth of the Internet, was the Association for Progressive Communications (or APC). Formed by the joining of PeaceNet and Econet in San Francisco with GreenNet in the UK in 1987, by 1989 the fledgling association had seven foundation countries providing major hubs. These connected to other countries with less established facilities, and through association with similar bodies such as Interdoc, and Poptel in the UK, many contacts and connections were coming on board.

The driving minds of the early network were Mark Graham from PeaceNet and Mitra Ardron from GreenNet. They saw that, by creating low cost host computers for social movements in various countries, they could spread the network quickly to a lot of non profit and activist groups who might otherwise not be able to afford to communicate. With the technical help of Scott Weikart and Steve Fram from Community Data Processing, they set out to create some simple messaging and conferencing software, and to make UNIX available on the IBM personal computer so that low cost hosts could be set up.

Meanwhile the Cold War was breaking down, and APC played an interesting part in that as well. By 1992 the US Government changed legislation to allow the export of computer chips and software to the USSR.(before that they were considered to be illegal exports) Very quickly Glasnet sprung up in the USSR, with satellite networks in many eastern European countries.

The Russian coups became a fascinating global event, with eyewitness accounts. "The tanks are coming, the tanks are coming" on the Internet from independent reporters on the scene. The Internet became part of the Russian people's struggle. Glasnet, the San Francisco/Moscow Teleport, and other facilities played an as yet undocumented role in the events which were to follow and change the face of global politics.

By the end of 1992, largely due to the pioneering efforts of people like Carlos Afonso in South America and Mike Jensen and Karen Banks in Africa, close to 100 countries were connected to activist networks - just a few more countries than the more mainstream academic and research networks which formed another strong development arm of the Internet. Major UNIX hubs fed information to smaller systems using Fidonet technologies in smaller countries. The United Nations Development Program (UNDP) played a major role in South American countries, and APC members assisted the development of networks suitable for smaller countries and regions, such as Pactok in the Asia Pacific region.

As governments started to realize that access to the growing net had social advantages, and that the socially disadvantaged should have special initiatives to encourage access, a number of government and charity sponsored initiatives began. HandsNet in the USA looked to address poverty issues. SeniorNet, naturally enough, encouraged access for senior citizens. In Australia, the Community Information Network, the brainchild of Hr Peter Baldwin, looked to provide access for people on low incomes. Most of these experiments became subsumed as the net grew, but they provided important roles in understanding the implications of access to or lack of access to the net.

Thus, even as early as 1994, there were significant forums arguing the case for universal access, and for access to the powerful information and communication features of the Internet to be regarded as a basic human right. In an age where a powerful communications media existed, the argument went, lack of access was denial of a fundamental human right - the right to communicate. These early

initiatives provided the foundation for the digital divide initiatives which began in the late 1990s in an attempt to address the global imbalance in Internet usage.
History of the Internet - the Dotcom bubble

The dotcom bubble started without the world wide web, and indeed in the beginning it didn't even recognize the Internet as important. Once Al Gore began talking about the "information superhighway" in the early 1990s, however, the "big end of town" - Hollywood, Silicon Valley, telecommunications carriers, cable companies, and media conglomerates, all began investing.

Between April 1992 and July 1993 all of the major US business magazines had published major features on new communications and the "Information Superhighway". It's worth analyzing what these magazines and feature articles talked about. The first thing I noticed - not one of the feature articles I picked up mentioned the Internet. It wasn't on the business horizon of this brave new converged world of Silicon Valley and Hollywood. They were more interested in interactive television.

Business Week's July 12 1993 edition had a cover story "Media Mania… digital - interactive - multimedia - the rush is on". Time Warner's Gerard Levin talked of switching home televisions to "anything, anywhere". Electronic books and magazines were about to change the world. Interactive TV would get to 20% of US homes by the turn of the century.

Gerard Levin was also in Newsweek's edition of May 31 1993. The cover story was a zillion dollar industry. The dotcom indifference to the number of zeroes in monetary figures seems to have had its origins about this time. Levin was going to get his bank balances on TV. Couch potatoes would be able to individualize the endings of movies and select camera angles for sporting events. Intelligent agents in the refrigerator would tell the car to remember that it was out of milk. (Strangely, we are still talking about these things a decade later).

California Business in April 1992 had Silicon Valley meeting Hollywood in a 100 billion market as its cover story. And Forbes Magazine on April 13 1992 featured cable companies beating the phone companies to wire homes for the digital age. And touted the ultimate convergence device, where the television telephone and computer would merge in to a single intelligent box - a telecomputer.

Anyone reading all of this and missing the plot of the imminent arrival of the Internet could be completely forgiven. None of these articles gave the Internet a mention.

This helps us to realize that the Internet didn't catalyze the dotcom bubble. It was merely latched on to as a vehicle when other avenues for investment did not appear to be going anywhere. The bubble was the second California Gold Rush and digital convergence before it became dotcom. The Dotcom mania was really about something that didn't happen and didn't have a dot anyway. Because many of the original dreams didn't look like happening, the arrival of the World Wide Web and an attractive Internet caused all of the above parties to shift gear.

Prior to 1994, telecommunications companies were mainly interested in producing smarter phones, which would be like computers. It probably took another 10 years before we started to see the sort of developments they envisaged appearing in the mobile phone arena.

TV and cable companies were into interactive television with 500 channels plus, interactivity, and video on demand. Choose your own angles for sports, choose you own plots for movies. Even Microsoft thought this was likely to be the main game, and Microsoft turned up at cable shows touting new navigation screens for the about-to-be 500 channel television set. However TV has been the couch potato of the digital age. It looks the same, largely does the same, as 10 years ago.

History of the Internet

By Ian Peter

If TV is the couch potato of the digital age, the non-networked computer is not far behind. It really is hard to argue that computers as stand alone devices have improved much since, despite the engineering evidence of increased power and functionality. Personal computers remain as lousy and confusing as they were a decade ago. The last great advances in standalone computing were the mouse and Windows. Reliability does not seem to have improved. Speed for common tasks (such as opening a word processor) does not appear to be any faster, although some added functionality is available.

The networked computer however stands as the phenomena which has most affected our lives and caused changes. The shift of the computer from a computational to a communicating device is perhaps the most significant change of the information technology age so far. The growth of the Internet as a medium for connecting these communicating devices is, I suggest, the major change that happened.

And so the net grew. For the next five years we were to be bombarded with sometimes realistic and often unrealistic visions of the future; we heard of information superhighways, internet refrigerators and cars, knowledge economies, internet time and internet years, which were vastly different to any time known before, and the dotcom frenzy.

Not since the South Sea Island bubble in the 1700s had western economies experienced anything like the dotcom economic bubble. Suddenly everyone wanted a piece of the action; normally astute investors went crazy, and mums and dads added to the frenzy. For some, the dotcom era saw an amassing of great wealth. But almost overnight it disappeared during 2000 and 2001. The information age prophets of great things to come disappeared along with the monetary profits, and we all began to adjust to a more normal life, albeit one greatly enhanced by the large scale adoption of the Internet in western countries.

It may take a few years before we know how much wealth was lost in the dotcom era; some companies are still adjusting to post dotcom reality. But the losses are certainly in the billions, and with a few more years distance might be seen to be the major factor in the recent decline in the US economy. However dotcom is still too close to us to be able to fully understand.
History of the Internet - the Browser wars

By mid-1995, popular culture had begun to notice the web, and Netscape Navigator was the de facto standard for web browsing at that time. An ex-colleague of Tim Berners-Lee called Mark Andreesen founded the Netscape Corporation, which built on the previous Mosaic browser to establish the first mass-market browser, the Netscape Navigator.

In August 1995 Netscape became a public company, fuelled by the success of the world wide web, and, to many minds ushered in the Dotcom boom (see our article here which traces the dotcom bubble to earlier non-Internet origins, however)

To that point of time, Microsoft had thought the future action would be in multi channel interactive cable television. However the success of Netscape caused it to release Internet Explorer 1.0 as part of the Microsoft Windows 95 Plus Pack in August 1995. Internet Explorer 2.0 was released three months later, and by then the race was on.

New versions of Netscape Navigator (later Netscape Communicator) and Internet Explorer were released at a rapid pace over the following few years. Features often took priority over bug fixes, and therefore the browser wars were a time of unstable browsers and lots of user headaches. Internet

Explorer only began to approach par with its competition with version 3.0 (1996).

In 1997 Netscape still held 72% of the browser market. But in October 1997, Internet Explorer 4.0 was released and changed the tides of the browser wars. It was faster and it adopted the W3C's published specifications more faithfully than Netscape Navigator 4.0.

A lot was at stake for these two companies involved in the browser wars. A popular web browser could earn a lot of money: search engine companies would bid to be the default tool used in the web browser, and other companies with a web presence would bid to be listed in the default set of bookmarks which was preinstalled with the browser. Since a web browser is a powerful gateway to a great deal of information, the company which controlled this gateway could conceivably have a lot of influence over its users.

Microsoft had two strong advantages in the browser wars. One was simply an issue of resources: Netscape began with a nearly 90% market share and a good deal of public goodwill, but as a relatively small company deriving the great bulk of its income from what was essentially a single product (Navigator and its derivatives), it was financially vulnerable. Netscape's total revenue never exceeded the interest income generated by Microsoft's cash on hand.

The other, more important, advantage was that Microsoft Windows had a monopoly in the operating system marketplace that could be used to leverage IE to a dominant position. IE was bundled with every copy of Windows; therefore, even though early versions of IE were markedly inferior to Netscape's browser, Microsoft was still able to enlarge its market share. And IE remained free while the enormous revenues from Windows were used to fund its development and marketing, resulting in rapid improvements until it was so similar to Netscape feature-wise that users had no desire to download and install Netscape.

Other Microsoft actions also hurt Netscape, such as:

Netscape's business model was to give away its browser but sell server software. Microsoft understood this and attacked Netscape's revenue sources, bundling Microsoft's Internet Information Server web server "free" with server versions of Windows, and offering Microsoft customers workalike clones of Netscape's proxy server, mail server, news server, and other software free or at steep discounts. This didn't have much effect at first, as much of Netscape's revenues came from customers using Sun Microsystems servers, but the gradual result was to make Windows NT more popular as a server for Internet and intranet while cutting off Netscape's income.
Microsoft created licensing agreements with computer manufacturers requiring them to provide desktop icons for IE, while penalizing them for shipping Netscape on their computers.
Microsoft made it very easy for small and medium ISPs to release branded versions of Internet Explorer, and with few exceptions they did, meaning that users of many ISPs were encouraged to use Internet Explorer and not Netscape.
Microsoft created a licensing agreement with AOL to base AOL's primary interface on IE rather than Netscape.
Microsoft purchased and released a web authoring tool, FrontPage, that tended to create pages that looked better in IE.
The effect of these actions were to "cut off Netscape's air supply," as stated by a Microsoft executive during the United States v. Microsoft case (which resulted in Microsoft being prosecuted for having used its monopoly status to manipulate the market). This, together with several bad business decisions on Netscape's part, led to Netscape's defeat by the end of 1998, after which the company was acquired by America Online for USD $4.2 billion. Internet Explorer became the new dominant browser, attaining a peak of about 96% of the web browser usage share during 2002, more than

Netscape had at its peak.

Thus ended the pioneering era of web browsers, with the dominant software company dominating the market. Microsoft might have been a late entry, but to this day it has remained dominant in the browser market, challenged only recently by the excellent Mozilla browser.

Lovers of legal battles and supporters of the free software movement can see in the browser wars classic examples of what began to happen as the Internet began to move towards mass markets. And that move to mass markets most closely finds a birthday in August,1995.
History of the Internet protocols

In this section we are talking about the central systems and protocols that make the Internet run - and I'm going to try and do this without sounding too technical! So wish me luck!

The Internet base protocols and systems were mainly devised in the 1970s and 1980s. Many were established initially as a means to connect mainframe computer systems for timesharing purposes. The system introduced for this fairly trivial purpose has expanded to become a global multimedia information and communications system, connecting PCs, phones, and tens of millions rather than the few devices foreseen by the original inventors.

Parts of the system are now over 20 years old, and the Internet is required to perform a number of important functions not included in the original design. Various patches have been applied to base protocols and systems, not always evenly. How well does it perform these tasks? Well that's a matter of some debate, and we may need another series of tapes to examine those issues. But for now lets look at the core systems and how they evolved.

And we should start with the mother of all systems, the world's largest database, the Domain Name System or DNS.

Each host on the Internet has a range of IP (or Internet protocol) numbers. The Domain name system (DNS) maps the numbers to names of hosts or websites (eg www.google.com, www.hotmail.com). Thus, when a user enters a name, the Internet knows which number to send the query to by looking up the DNS database.

The DNS was introduced in 1984, several years before commercial traffic was able to be part of the Internet.

Associated with the DNS is the WHOIS database, which stores details of the names and addresses of domain owners and technical contacts. It was named after a UNIX operating system command (whois) which gave basic details about system users. Whois was established essentially to allow technical managers of hosts to contact their peer . In those days, there were no privacy issues or privacy laws to think about. However that's changed, and some problems associated with the current system include the ease with which contact details could be used for spam mailing lists, and the nuisance domain name renewal business which exploits the openness of the database. These factors in particular are leading to calls for changes to WHOIS so that certain personal details are kept private.

But on another level, DNS in its current state is proving unsuitable for multilingual domain names. Now as the Internet spreads, the 80% of people on Planet Earth who don't use English as their primary language want to use the Internet to communicate. It currently works well for some similar European languages, but when we start to use Japanese and Arabic character sets, for instance, a whole lot of problems emerge.

This is because the DNS uses a system called ASCII, or the American Standard Code for Information Interchange. ASCII doesn't accommodate these other languages well, thus one of today's current internet problems emerges. It will be interesting to see how it is resolved.

The protocol which they say determines what the Internet is, is TCP/IP, or Transmission Control Protocol-Internet Protocol. Essentially, TCP/IP describes a protocol which will work on any sort of computer and operating system for transportation of data across the internet between different systems.

Invented in the 1970's, largely adopted in the late 1980s, TCP/IP hit its first big problem in the early 1990s when it became apparent that the numbering system was going to run out of numbers in the foreseeable future. Therefore in 1995, after several years of work, TCP/IP Vs 6 was released to solve this problem. Adoption has been very slow. TCP/IP has proven to be remarkably robust, but is very basic.

SMTP, or the Simple Message Transfer Protocol, is the basic standard for email, and again exists since the 1980s when the Internet was small and honest.

Perhaps more than any other system on the Internet, email has seen a number of improvements and different protocols, each of which has been adopted by only part of the Internet email community. This capacity not to adopt standards is a feature of the Internet, making dealing with change more difficult than it otherwise might be.

There is another thing about SMTP that stands out. SMTP comes from an innocent age, and no-one thought it would be necessary to prove that the person sending a message was who they said they were. The basic flaws in SMTP authentication are now causing significant problems, particularly the ease with which email sender details can be forged. This helps the transfer of some viruses and a lot of the worst spam, and makes Internet fraud a lot easier than it might otherwise be. Now not all viruses and spam can be attributed to problems with protocols, but better protocols sure would help.

Another important protocol which dates from pre 1972 is FTP, or the file transfer protocol. This simply is the way to upload or download a file from an Internet computer. Just about everyone who owns a website uses this one.

With the coming of the World Wide Web, we see another powerful protocol - http, or hypertext transfer protocol. HTTP allows us to click on the name of a site and visit it. Simple, but very powerful.

So there you have it - some of the base set of protocols that make today’s Internet work. In fact there are thousands of standards, each carefully worked out by engineers from all over the world to make various functions on the Internet work. Some of them are over 20 years old now - given their origins, it's remarkable they have lasted this long. Will they last long into the future? In our next and last segment, the future history of the internet, we will start to examine this.
Future history of the Internet

In this closing segment, we are going to look at the future of the Internet, but through the eyes of what we have learnt about its past.

Now predicting the future is a dangerous thing to do! As we have seen, the history of the Internet is filled with the wrecks of prophets who thought they knew what would happen. But we are armed with a lot more information. By knowing the past, we can more happily predict the future. So, with a bit of

risk, here goes.

Earlier on we talked about digital convergence, and that's definitely on the future agenda still. One interesting development in this area is called ENUM - which is a new standard that allows every telephone number to become a world wide web address. So one day, in the not too distant future, we will have worked out easy ways to send instant messages from mobile phones to computers and back again. Messaging, and particularly instant messaging, something of a new genre for the Internet - are here to stay, and are only going to get better.

The other thing which will grow through ENUM and related developments is what they call voice over ip - or internet phones. Already we are seeing these being adopted both by large corporations in internal networks and by hobbyists in networks such as SKYPE - this isn't going to go away either, because at this point of time it offers very significant savings as compared with old fashioned telephony costs. It will take a while because telecommunications companies aren't exactly nimble, but one day the convergence of Internet and telephone futures will arrive.

Talking of mobile phones, wireless and mobility are again trends we can expect to see more of in tomorrow's Internet. We are already seeing the growth of wireless hotspots for mobile travelers in airports, hotels and other places, and of course we are seeing a growing range of mobile devices. We have talked about "anywhere, anytime" access for a long while - we can certainly expect to see that grow.

Another thing we can expect to see is a lot of new developments in what is called the 'peer to peer' space. If you know what Napster was, you can see what peer to peer is. Peer to peer is unlike a traditional network with a central computer through which all traffic passes - peer to peer allows almost direct communication on the network with any other computer, for tasks such as trading music and files. Napster spread like wildfire across the Internet, and since then we have seen many other similar developments. Applications like this will continue.

But there are a couple of broader issues out there as well. One of these is multilingual domain names, which we learnt about in a previous section. As 80% of the people on this planet don't speak English as their first language, there is a natural desire to be able to use their own language on the Internet. Now that's difficult at present, because the core of the Internet finds all those difficult foreign characters hard to handle. But it's unlikely this issue will go away. It may involve some significant changes to the Internet, but most people believe that will happen.

Some of the things people would like to control are illegal software, music piracy, and pornography. They're bound to continue, as are worms, viruses and spam. Now worms and viruses simply exploit weaknesses in the Internet to be able to proliferate freely.

Remembering again that the Internet was built for another purpose altogether, and has been patched up like a quilt over the intervening years, its inevitable that some work will be done to give the Internet greater security and stop the spread of fraud. Similarly, those spam messages that use fraud (they pretend to be someone else sending the message) can be fixed. I suspect that it's only a matter of time before we have a more trustworthy and secure Internet.

Another thing that will become apparent as this all happens is the necessity for access for all people in all countries, at affordable rates. Once a medium goes so far with penetration of usage, it starts to become an economic necessity - and at the same time, a human right to have access. That's starting to happen with the Internet, and growth won't go away for a long time.

All this means that our future Internet, rather than having 600 million users, may have close to 6 billion. So we are about 10% of the way there, and there is a lot of growth to come.

What does that say for the protocols and for governance? Well, the only thing that is for sure is that things will continue to change. We can expect to see a larger role for the United Nations - we can expect some major protocol changes - but, to the end user, all of this should be able to happen without much fuss or concern.