Case #01 — Mosaic Browser

Today, the volume of traffic on the Internet is a veritable torrent, churning constantly and at breakneck speed, but in the early '90's, it was "...a barely discernible trickle," (Gillies and Cailliau, 2000: 233) though many of the core networking technologies that support the Internet as we know it today had been in place since the mid-1980's. The introduction of IPV4 in 1983 extended the maximum possible number of IP address allocations allowing for a much larger network to develop. In 1983-4, Jon Postel's Domain Name System was instantiated. The TCP/IP network protocols, designed by Robert Kahn and Vinton Cerf circa '73-'74, were also at this time to emerge ahead of the competition (Appletalk, Xerox's XNS, DECNet, IBM's SNA), benefiting as they had from the advantages of an open specification, platform independence and the endorsement of the US National Science Foundation who, in 1986, adopted TCP/IP as the standard for the National Science Foundation network (NSFNet). Even so, it was not until Tim Berners-Lee's work at CERN had delivered the HTTP protocol and the first iteration of the HTML mark-up language, that all the necessary pieces fell into place.

Berners-Lee's work laid the foundations for the web as we know it and for every modern browser that would follow. At the time, there were a number of competing systems that already allowed users to access and publish networked resources, the most popular being anonymous FTP servers, but also Gopher and WAIS. Crucially, none of these provided any method whereby one could link from one piece of information within one document to another piece of information in another (Hardin and Schatz, 1994: 896). Berners-Lee's work on WWW aimed to do just this. In 1991, he described their experiments thus: "We have a prototype hypertext editor... a browser for line mode terminals which runs on almost anything... can access files either locally, NFS mounted, or via anonymous FTP. They can also go out using a simple protocol (HTTP) to a server which interprets some other data and returns equivalent hypertext files" (Berners-Lee, 1991). Initially, this "World Wide Web" browser only ran atop the expensive NeXT system, and the entirety of the web amounted to, well, "...primarily the CERN phone book."

It was Berners-Lee's determination to effectively 'open source' the codebase which created the space for others to take the WWW browser concept and run with it. And run with it they did. In the next couple of years, a huge number of similar browsers emerged on different platforms, each bringing with them a number of extensions to Berners-Lee's original. While some chose to also support other networking protocols (gopher, FTP, NFS etc.), all aligned themselves to the emerging World Wide Web and HTTP/HTML.[i] The Erwise browser, developed at the Helsinki University of Technology, followed in April 1992 and was the first to include clickable hyperlinks and the loading of multiple documents (Holwerda, 2009) Despite such innovations, Erwise's fate was determined by the Finnish recession and a lack of investment support: "...the next step, to commercialize it, did not happen" (Tikka, 2009). From the University of California at Berkeley's Experimental Computing Facility came the ViolaWWW browser, which brought support for scripting and 'applets' but ultimately failed because it was only available on UNIX platforms. The Stanford Midas browser introduced the 'plugin' concept by allowing an external handler programme to read and display Postscript files inside the browser. The Samba browser was

Robert Cailliau and Nicola Pellow's effort to bring the original CERN WWW browser to the Mac, but it struggled in terms of stability. This growing enthusiasm of developers for the HTTP/HTML was matched by an expansion in available content and the total number of servers online. This growth was in no small part due to the efforts of Tim Berners-Lee and those at CERN in working the academic conference circuit in '90-'92 and evangelising about WWW. By the end of '92 there were an estimated fifty servers to access, most based in academic institutions (Gillies and Cailliau, 2000: 233). When the development team at Helsinki demoed Erwise for the first time, they estimated that the web had consisted of twelve sites and no more (Tikka, 2009).

Developed at the National Centre for Supercomputing Applications (NCSA) at the University of Illinois, Mosaic was launched in February 1993 and quickly eclipsed its contemporaries. The NCSA was one of four national supercomputing centres established and funded by the US National Science Foundation, and which together formed NSFNet. NCSA's Jospeh Hardin and Dave Thompson introduced some colleagues to the ViolaWWW browser and the content then currently available on the web, following a trip they had taken to CERN towards the end of 1992. Among them was Marc Andreessen who, having drafted in colleague Eric Bina to help, had by 23rd January '93 developed the 0.5 alpha version of Mosaic. Andreessen and Bina had built it over their Christmas holidays. Its impact was near immediate. Commenting in '94, Andreessen recounted how Mosaic had "...started with 12 users in early '93 for [the] initial alpha release, by mid '93 when things... started coming to people's attention we were in the hundreds of thousands of users" (in Systemseminartv.com 1994).

While Andreessen might have claimed that with Mosaic they were not trying to invent anything new,[ii] it brought a number of new features previously unseen in a browser. It was the first to add support for inline graphics, sound, and video; the inclusion of which gave rise to the phrase "hypermedia," (Hardin and Schatz, 1994: 895) and so began the journey from a text only web to the rich multimedia platform it so quickly became. Mosaic also introduced bookmarking to aid user navigation, and provided a history feature by which users could retrace their steps. In addition it synthesised many of the innovations of those browsers that directly preceded it; about which, Andreessen was fairly brazen: "...we happily borrowed — *stole* — protocols, formats, code and so on from all kindsa different places" (in Systemseminartv.com, 1994). The *inheritances* from WWWbrowser, Erwise, Viola et al. were all clearly evident in the look, feel and behaviour of Mosaic.

The NCSA had a long held commitment to cross-platform releases for software they developed, and so held off on an official release until November that year. The availability of Mosaic on Unix, Windows, and Mac systems was a key factor in its success, giving it a far larger potential audience than previous single platform browsers, while also demonstrating the potential of HTTP and the web for facilitating information and communication between competing computer systems. It also had the major advantage of being the first browser that could be easily installed; Tim Berners-Lee commented of the initial alpha release, "...it installs very easily, as the binary is completely self-sufficient" (Berners-Lee, 1993). That the application dispensed with any convoluted resource packages, but was instead a single executable file made it far less intimidating for your average computer user. It was, "...simple to use, [and] insulated the user from unnecessary technical detail" (Thompson, 1994).

Understanding the appeal of the early web is perfectly distilled in Gary Wolf's Wired article of late '94, "*Why I Dig Mosaic*", wherein he details just how compulsive and immersive this new world of information could be, and why Mosaic proved to be such a compelling conduit. In it, he describes how Mosaic "...brought me in contact with information that I didn't know I wanted to know" (Wolfe, 1994) His journey begins with an attempt to verify some information on the CERN website, but he is quickly diverted via a poetry archive to a researcher's family homepage: "it was a type of voyeurism, yes, but it was less like peeking into a person's window and more like dropping in on a small seminar with a cloak of invisibility" (Wolfe, 1994). While it's not clear exactly how many copies of Mosaic were downloaded, the figure is thought to be around a million (Gillies and Cailliau, 2000: 241). The number of servers online at the point at which the alpha version was released had been fifty, but by October of '94 this had increased tenfold, and by June the following year there were around 1500 (Wolfe, 1994) Within two years of Mosaic's alpha release the web went from 1.5% to 23.9% of all traffic on NSFNet. (Gray, 1996) The response was phenomenal: "...it took off like a rocket... nerds and neophytes alike were riveted to their computer screens" (Gillies and Cailliau, 2000: 236). Suddenly a whole other world had descended upon the previously cloistered academic networks.

Such rapid growth created a "...a combustible mixture of attention, power, money and politics" (Post, 2009: 150). Mosaic had been released to the web under generous licensing terms that played a major role in the pace and scale of its adoption. It was free for personal and academic use, with licenses only needing to be sought for use by commercial bodies. When Andreessen and Bina left NCSA in late 1993 to start up Mosaic Communications with SGI founder Jim Clark they retained this model for the release of Netscape Navigator. Marc Andressen describes the model:

> "It's fairly straightforward, the only twist is that we're giving the client away, but that's under restricted conditions... free for basically personal, educational, single end-user use... deploying it within a corporate setting or redistributing it requires you to pay us." (in Systemseminartv.com, 1994)[iii]

Similar, free-at-point-of-use models have propelled some of the largest and most successful businesses on the web. Virtually every major search engine, every social network, every cloud-based collaboration and storage platform has achieved critical mass by — either initially, or in many cases perpetually — allowing free access to services; everyone from Facebook to Dropbox. Free is now the expectation, and this is a huge problem. Not for businesses though, many who have responded to the advent of 'free' very successfully. Many have adopted ad-supported models or, alternatively, offer very limited free services such as low-capped storage or just the shell of a mobile application, in order to later upsell to paid services or content (Chen, 2012). Many of the struggles that we now contend with in terms of user privacy and data abuses undoubtedly stem from the ease with which we subscribe to — what appear to be — free services. To understand the true costs we are paying for these services is clearly difficult for users to divine. The implications of the complex skein of exchanges around access to services are forever up ahead of us and out of reach, while whatever signposts to them may reside in the present, are buried in lengthy contracts of legalese, and constructed in such a way that they are almost certain to remain unread by the people that need to understand them most. While these issues are discussed at greater length elsewhere, with respect to Google, it is clear that Mosaic

has a part to play in this story, and that it was a defining moment in the establishment of user expectations about the web, and what it would cost them.

> *"...we had no sense that it was going to take off and simply monetize so quickly."*
> ***Joseph Hardin*** (Severance, 2009)

NCSA also licensed the technologies in Mosaic to a number of companies and insodoing sparked the commercialisation of browser software that would give rise to the browser wars of the late '90s (News.bbc.co.uk, 1997) and which still continues today (Coldewey, 2011). Some licensees, like Spry, bundled up versions of Mosaic with other utilities, selling consumer focussed products that allowed people to quickly and easily connect to the web. Spyglass — NCSA's designated "master licenser" (Karpinski, 1995) — would themselves enter into a licensing agreement with Microsoft, who in turn would make use of Mosaic code in their Internet Explorer browser, which would carry a credit to Mosaic as far as version 6, released in 2001.

Mosaic shipped with no security features whatsoever. The addition of a secure transfer protocol was absolutely essential for the development of commerce across the web, and this began to be explored both by engineers at EIT and Marc Andreesen's Netscape. EIT developed the S-HTTP protocol and bundled this with a supporting version of Mosaic (*Secure Mosaic*) as part of their CommerceNet consulting services, while Netscape produced the competing SSL protocol, which eventually emerged as the standard. This represents the first instances of commercial ventures supplementing recognised standards as published by IETF, W3C, ECMA, ISO, IEC et al, and the first encounter in the continuing struggle to reconcile the drive to innovate for commercial and competitive advantage while maintaining the integrity and evolution of an open web.

Chris Wilson — one of the original NCSA development team and later of Spry — remarked at the time (in Karpinski, 1995): "What essentially started out as a research project is turning into a commercial venture that a lot of people are jumping in on." Perhaps most of all though, Mosaic brought users to the Internet in sufficient numbers that businesses and advertisers began imagining it as a new and viable medium through which they could connect with customers. The first Internet marketing conference took place in November 1994. Ken McCarthy anticipated the future of the Internet thus: "when [it] really matures, the people that are gonna be on it the most — for better or worse — are people from Madison Avenue." (in Systemseminartv.com, 1994) Advertising embraced the Internet wholeheartedly, to the detriment of traditional media advertising, such as TV and print.

Mosaic also prompted the first real crisis of Internet governance. It is not a huge exaggeration to say that, for many years, the Internet was in the hands of one man: Jon Postel. He personally maintained the original hosts.txt file — the index for where servers were on the network — first at UCLA and then University of Southern California's Information Sciences Institute. For years it was the case that if you wanted your site/server to be accessible on the network, you had to email Postel to request that it be added to the database; he would make the addition and send out an updated file (Post, 2009: 143). Postel was one of those behind the DNS standard, proposed in 1983. DNS allowed for increasingly complex and numerate domain names by introducing the nesting of names within domains (i.e. docs.google.com, where both 'docs' and 'google' are nested second-level domains within the '.com' top level domain), and proposed that the databases associating names and IPs be distributed across the network, rather than with a

single host. In 1984 he founded the Internal Assigned Numbers Authority (IANA) that would allocate IP addresses and manage domain name allocations for the DNS. This work continued until 1992, when the National Science Foundation (NSF) made the decision to reallocate responsibility to a commercial firm, Washington DC based, Network Solutions Incorporated (ICANN, 1993).

The NSF-NSI contract started in January 1993, the same time as the alpha release of Mosaic v0.5. DNS applications rose from ~200 per month in January 1993 to "...over 30,000 per month by late 1995, to more than 200,000 per month when the NSF-NSI contract expired in January 1998." (Post, 2009:150). Domain names quickly began to be traded as commodities, and in 1995 the NSF issued an extension of powers to the NSI, that allowed them to charge USD100 for two years for a second level domain registration. The U.S. government had just created an effective monopoly by appointing a single U.S. based contractor as the sole issuing body for domain names worldwide. In 1997, NSI would be valued at just over a quarter of a billion dollars on the basis of its role in domain name registrations. This was just the first in a succession of controversies regarding U.S. influence over Internet governance, that would continue through their mandating of ICANN — the non-profit that assumed responsibility for the DNS from NSI in 1998 — right up to the present day.

With its origins in two U.S. funded initiatives — ARPANET and NSFNet — it is perhaps no surprise that the U.S. government sought to retain a key position of influence over Internet governance in the early years, but that that influence should be allowed to persist until well into the 2000s, as was the case, is perhaps more surprising. However, with the announcement of a new 'Affirmation of Commitments' in 2009 (ICANN, 2009), the U.S. DoC relationship with ICANN did finally change fundamentally, and a number of new boards with international oversight were established. The legacy of U.S. influence is still very apparent today, not just in the sheer volume of English language content on the web, but evidenced also by the fact that it was not until May 2010 that top-level domains existed in anything other than the Latin alphabet.[iv]

In its near-perfect aggregation and synthesis of features from existing browser efforts, cross-platform availability and easy installation, Mosaic brought users to the web in their hundreds of thousands, and in so doing, changed the entire landscape of the Internet. No longer just the preserve of university professors and their students, the web began to be explored by an eager public, excited commercial interests, and a U.S. government that took the first steps in defining Internet governance.

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[i] For a fuller account, Matthew Lasar's article, "Forgotten Web Browsers of the Early '90's" http://goo.gl/M3DwZ

[ii] http://www.systemseminartv.com/page/97.html, Andreessen presentation starts ~30mins.

[iii] http://www.systemseminartv.com/page/97.html 56m30s