THE RISE AND FALL OF NETVILLE: THE SAGA OF A CYBERSPACE CONSTRUCTION BOOMTOWN IN THE GREAT DIVIDE [1]

BY JOHN LESLIE KING, REBECCA E. GRINTER, AND JEANNE M. PICKERING, UNIVERSITY OF CALIFORNIA*

INTRODUCTION

The challenge of building new technologies has often been described as the problem of bridging the divide among technical and social expertise. Sometimes this divide is bridged when the innovators of a new technology are sheltered from the outside world. Eventually though these innovations must be offered to the broader social world – in order to become truly great – and as a consequence the development community becomes exposed to powerful social forces that can potentially destroy it.

This article describes one community who exploited the shelter provided to them and built a truly new technology. ARPA and research traditions provided a shelter that protected a community we call Netville. The shelter helped Netville to establish and maintain the values of intellectual curiosity, informal meritocratic reward structure, and egalitarian presumptions that allowed them to overcome their geographic distribution and develop an entirely new technology [2]. Together the people of Netville built the Internet.

As with all truly great inventions, eventually they are discovered by the outside world. One consequence of this find was the slow erosion of the very shelter that had protected Netville and nurtured this development. This paper also describes the inevitable downfall of Netville as the Internet started changing from a research to a commercial venture.

THE RISE OF NETVILLE

It is hard to say precisely when the Internet was first developed; however, by the late 1960's a small community of researchers had begun to develop ways of getting computers to communicate with each other. The desire to have inter-computer communication came from two sources, the electronic mail systems of timeshared computers and the push by the Advanced Research Projects Agency (ARPA) to create a network.

A single timeshared computer allowed a number of individual users to use the computer, either sequentially or at the same time. Electronic mail was developed for these machines as a way of allowing the users of the machines to talk with each other. However, e-mail was limited to the machine itself, and messages could only pass among users of that machine. A number of these timeshared machines existed in research environments and researchers using and supporting more than one of these machines at their site had started to experiment with ways of getting the machines to talk with each other, so that all local users could share e-mail.

At the same time ARPA was interested in building a network for two reasons. First, as a Department of Defense (DOD) research agency they were engaged in the mission of protecting the United States from technological surprise. The network ARPA wanted would be a robust command and control network that would be capable of surviving a nuclear attack (Newlin, 1995). Second, ARPA owned computers that were spread among a number of research organizations across the country. It also wanted a network to link these computers together so that researchers working on ARPA funded projects could share and access resources.

John Leslie King, Rebecca E. Grinter, and Jeanne M. Pickering ({king, beki, pickerin}@ics.uci.edu) are researchers at the Center for Research on Information Technology and Organizations and Department of Information and Computer Science at the University of California in Irvine.

ARPA and research institutes had a tradition of working together, so it was not completely novel that they might form such a coalition and protect and nurture Netville. ARPA had two ways of working with research institutes. First, they had procedures for contracting out research work, and they used these to provide funds and equipment for the network development. Second, they focused on results and left the researchers free to pursue any innovative directions that they chose.

ARPA's support gave Netville the resources and the opportunities to work together to build the network, but they did not help the research-developers to find their commonality. That was provided by the research institutes that the members of Netville belonged to. Netville was and remains a highly disaggregated community, geographically and technically, but they found common social bonds through their association with research institutes.

Netville members came from research institutes across the United States, and subsequently across continents. However, typical members of Netville were socially bound together by their ties to these research institutes as undergraduates, graduates students, systems administrators, and faculty or to the military or commercial firms that were working on the network. Other members of Netville, high school students, former graduates, and colleagues managed to pursue systems administrators in these institutes to give them access to resources. Netville members also had access to a wide variety of hardware and software. The common bonds that tied the community together also made them recognize this heterogeneity and support it rather than shut it out and force people to conform to certain hardware and software standards.

Netville straddled the divide through its shared values of: intellectual curiosity, informal meritocratic rewards structure and what we call an egalitarian presumption. Intellectual curiosity meant that finding a new or improved solution to a problem was its own reward. Status within the community was assigned to members because of their contributions to the network development, as opposed to be given formally through managerial channels. People who developed solutions, and often maintained their code for years subsequently, became "gurus" within Netville [3]. The egalitarian presumption was simply that anyone who had the skills to understand the problems faced by Netville, and help develop solutions was allowed to participate in network development. These shared values united Netville, and were encouraged and supported by the research institutes involved in the project and ARPA.

EMBLEMATIC DEVELOPMENTS IN THE RISE OF NETVILLE: E-MAIL AND TCP/IP

Netville's interest in exploring the technological possibilities stands in sharp contrast to the classical model of most development efforts. The classical model of software engineering development works towards an artifact by following a life cycle. The development of the Internet also had development cycles, but they were characterized by socio-technical solutions to new problems that emerged in the existing technological infrastructure. They were also characterized by high degrees of collaboration among the members of the community made possible by ARPA protecting them from the pressures of competition. The development of electronic mail and the underlying communications infrastructure the Transmission Control Protocol and the Internet Protocol (TCP/IP) along with the Domain Name Service (DNS) illustrate the unusual development life cycle, as well as the influence of the institutional shelter on the work of Netville.

FOOTNOTES

[1]
This article is based on (King, Grinter, and Pickering, forthcoming).

[2]
Netville is the name that we have given this community.

[3]
In computer science a guru is someone known for their expertise with a certain machine or system. Often gurus make their status known, by mentioning in their signature files, or plan files, or more recently their WWW pages that they have "guru" capabilities. Guru was a natural word for the participants of Netville to adopt and use.

[4]
A RFC begins life as a request for comments made by some members of the community regarding a change that they believe should be made to the network. The RFC is then discussed by the community at large. When agreement is reached these documents are kept as the standard documents that inform all of Netville about the change. Everyone is expected to observe the change. The informality of RFC's is well captured by Vinton Cerf: "In April 1969, Steve issued the very first Request for Comment. He observed that we were just graduate students at the time and so had no authority. So we had to find a way to document what we were doing without acting like we were imposing anything on anyone. He came up with the RFC methodology to say, Please comment on this, and tell us what you think." (Cerf, 1993).

Electronic mail was not in ARPA's original plan for the network. ARPA was much more interested in building a robust network capable of withstanding massive attacks. It also wanted a network that would allow researchers at different sites to share data through file transmission and remote login (which became ftp and rlogin respectively). However, members of Netville had seen electronic mail on their timeshared machines and had already started trying to share the messages among the different machines at their site. Collectively the members of Netville had the experience of networking their machines, and by sharing and combining their expertise they collectively developed electronic mail across the Internet. As a small group they used informal agreements to make sure that everybody could read and send mail to everyone else.

As these innovations took off more researchers were attracted to the network and so the amount of machines hooked up grew. The original network, the ARPANET, was subsequently split into two parts, MILNET – the military network – and the ARPANET for research. The two became known as the Internet: a network of networks. Netville realized that as the user base grew these informal agreements would break down. Using the network as the venue for discussion Netville developed an electronic mail standard (RFC 822) which became a standard for the messages on the network.[4]

By standardizing on the lowest common denominator – the message itself – Netville preserved the rights to explore the numerous possibilities for mail handling systems. They also made it possible for people using different computers to build systems that worked well for their local circumstances. Subsequently, a number of mail handlers, MH, Berkeley Mail, and R-Mail were developed and electronic mail was able to pass between these systems easily.

TCP/IP and DNS complemented electronic mail by providing the transportation mechanisms between the different nodes on the network and giving the addressing capability. TCP/IP and DNS made it possible for anyone on the Internet to communicate with anyone else. TCP/IP originated as the protocol for passing packets of information between the different computers on the network. It's adoption by the community at large was significantly helped when it was packaged with a release of Berkeley Software Distribution's (BSD) UNIX 4.2. It was estimated that the release alone resulted in the conversion of 90% of the academic computer science departments to TCP/IP (Comer, 1991).

Once TCP/IP was a widely used standard and easily available the number of computers hooked to the Internet increased and so the demand for IP addresses grew. IP addresses define each machine on the Internet uniquely, so that packets can be routed to that machine. When Netville was small the addresses could be handed out to individuals as they joined the community and everyone could maintain their own lists of these addresses, necessary so that they could send information to those machines. However as more institutions joined the network Netville could not organize this assignment effectively. At this point ARPA stepped in and created the Network Information Center (NIC) who had the duty of assigning addresses.

However, assigning IP addresses was not the only problem. As more machines joined the network the addresses became increasingly difficult to remember. This was a problem for two reasons. First, people wanted to remember addresses of machines so that they send information to those systems. IP addresses look like this: 128.0.4.56 which is not very memorable. Second, the machines needed to know about the other addresses so that they could check that they existed and were able to receive that information. Address tables were maintained manually by Netville members, and eventually it became enough of a challenge to maintain them that they decided to do something about it. DNS was Netville's solution.

REFERENCES

Cerf, V. (1993). "How The Internet Came To Be" As told to Bernard Aboba. Internaut Magazine. Available at URL: http://tars5.elte.hu/internt/current.html.

Comer, Douglas, E. (1991). "Internetworking with TCP/IP Volume 1 Principles, Protocols, and Architecture" Prentice Hall: Englewood Cliffs, NJ.

King, J. L., R. E. Grinter and J. M. Pickering (forthcoming). "The Rise and Fall of Netville: Institution and Infrastructure in the Great Divide" In: Kiesler, S. (ed.) Research Milestones on the Information Highway Lawrence Erlbaum Press: Mahweh, NJ.

Moreau, R. (1984). "The Computer Comes of Age: The People, the Hardware, and the Software" MIT Press: Cambridge, MA.

Newlin, D. Burton, Jr. (1995). "Standards and Organizations Involved in the Constructing the Information Superhighway" In Kahin, Brian and Janet Abbate (eds.) Standards Policy for Information Infrastructure MIT Press: Cambridge MA.

Zuckerman, Laurence (1996) "Browser Moves By Microsoft Make Even Netscape Blink" New York Times. Wednesday October 9, 1996. C1-C2.

DNS was a technical solution, a translation between the numbers and a more memorable name like machine.department.institute.domain/country. It also embodied some social solutions that categorized the Internet. Individual sites wanted the right to choose their own machine names and institute names. DNS supported that by allowing any name as long as it had not already been taken by another organization. At the highest level, the Internet classified different organizations by their country or enterprise type. This standardization of Internet addresses allowed individual institutions to create their own names but at the same time ensured that the addressing schemes were consistent and recognizable to others.

Electronic Mail, TCP/IP and DNS did not follow a classical development life cycle. Rather these technologies and their accompanying strategies solved the technical and social problems that Netville faced in designing, building, and maintaining the Internet community. Together they designed patches for each others' software, discussed solutions to problems, and shared visions of the future directions for the network. What makes Netville particularly fascinating is that it was sui generis: a computer supported cooperative work project that got its start as an effort to build the computer support network through which the collaboration would take place. But behind these collaborations was the shelter, the institutional factors, that enabled and arguably encouraged these innovations.

THE FALL OF NETVILLE

In the late 1980's two events changed the future of the Internet. First, new and powerful institutional forces that had not previously known about or not found it useful started to see potential in the technologies. At the same time ARPA signaled its intention to withdraw their financial support. The age of the Internet had arrived and it began a slow transition from a research network to a commercial one. This is a process that we call patron swapping.

Patron swapping does not happen overnight, and the Internet is still changing from its roots in research to its new life as a commercial enterprise. This can be seen currently in the development of the World Wide Web (WWW). The WWW began life in much the same way as most other technologies, a small project, shared among members of Netville who worked collaboratively to provided browsers, and the technology to support the WWW servers. At the same time they also developed a set of standards for HTML the protocol language of the WWW using traditional Netville mechanisms, RFC's and on-line discussions.

However WWW development also highlights the presence of the newer institutional forces. Two companies have emerged in a competition for the market of people wanting to purchase browsers, Netscape and Microsoft. The founders of Netscape left Netville, where they had designed a WWW browser called Mosaic to found the company and build a commercial browser. Microsoft was always a commercial vendor, and later on, when the WWW had truly taken off it joined the rush of companies to build browsers. Even as we write this, the two companies are competing intensely for the WWW market (Zuckerman, 1996).

Although we cannot offer empirical proof of the outcome of this transition we can assess the ongoing changes in light of the effects that they will have on the values of Netville. Presumably as these values change, so will Netville. In this section we focus on three phenomena that will change Netville: proprietary fame, the loss of novelty, and the rise of path dependency.

Proprietary fame gives developers financial success for the development of technologies, and it was not a reward for Netville developers. The development of innovative technologies was rewarded within the community by the status of becoming a guru or known for that development. Netscape is perhaps the most well-known example of this. While Netscape was a technical step forward in comparison with older browsers, the fame the developers sought did not come exclusively from their achievements but also from financial returns.

Proprietary fame has two ramifications for Netville. It makes sharing technologies difficult, because the developers do not want to lose their market share. It also makes the generation of common standards much harder, because it's in everyone's best interest to have the market standardize around their product exclusively.

Netville were the pioneers of electronic communications and internetworking, and they were ildly successful. While the Internet still provides room for innovations, such as the WWW, many of the research questions that attracted Netville members have been mined out. The new questions have a different character. A good example of this is the shift from being concerned about how to make the network work to how to deploy the network on a large scale. Questions of how to make computers communicate excited the members of Netville. It is unclear whether they find as much satisfaction in answering questions about the character of telecommunications reform, and the application, maintainability and social impact of the network.

Path dependency is a term coined by Paul David to describe the interesting phenomenon of early technologies becoming so established in use that they cannot be displaced by newer and clearly better technologies. Earlier we described the development of TCP/IP and DNS as two solutions to the problems of working in a heterogeneous environment. Today Netville lives with those solutions, and innovations in Internet technologies must conform to those standards. Recently domain naming and TCP/IP have started to reach their limits. Yet Netville cannot reinvent new solutions because too many other players have far too much invested in these standards.

CONCLUSION

In a sheltered world the citizens of Netville built a truly innovative technology, one that continues to grow and remains an outstanding achievement. Once the network had been established these institutional patrons that had protected Netville began to withdraw their support. New patrons emerged with their own visions about the role of the Internet. The process of patron swapping signaled a change for Netville, and its role in the development of the network. Proprietary fame, the loss of novelty, and path dependency present fundamental challenges to Netville, and their future will be greatly influenced by their ability to alter their own culture.

ACKNOWLEDGMENTS

We would like to thank Roy Fielding, David Harnick-Shapiro, Sam Horrocks, Tim Morgan and John Romine for the valuable information that they contributed to this study and for their contribution to maintaining our departments' commitment to the network. Dave Crocker, John Vittal, Einar Stefferud, and Marshall Rose helped us find information not available elsewhere, and shared their insights with us. Finally, we must thank Lisa Covi, David O'Leary, Ignace Snellen and Sara Kiesler, for their insightful comments.