Internet Commercialization and the Politics of Global Computer Networks

Paper presented at MiT7 Unstable Platforms: The Promise and Peril of Transition, May 13-15, 2011, MIT.

[Extracted from Master's Thesis: The World in the Network: The Interop Trade Show, Carl Malamud's Internet 1996 Exposition, and the Politics of Internet Commercialization]

By most estimates, networked communications is at a critical juncture. In the U.S., debates focus on the need the shore up lagging broadband infrastructure and on the need to ensure that the so-called last mile of connectivity into homes and businesses. Globally, the situation appears more dramatic as countries and commercially operated platforms prove willing to "switch off" the internet or severely limit its availability. One way to better understand these struggles is to return to an earlier chapter of Internet connectivity struggles. This study will examine the largely overlooked history of the "Interop" computer-networking trade show, and argue that it would prove critical to the Internet's global physical expansion and commercial success. Assembled by a core group of former Arpanet researchers, Interop suggests that the success of the Internet as a global communications medium was not only a technical achievement, as is commonly framed, but also the result of organizational accomplishments. These activities helped the emerging network accommodate powerful commercial interests as well as the larger economic and technological forces sweeping the industrialized world. This study will also examine an affiliated "global" trade show, the Internet 1996 World Exposition. Through that event, technologist Carl Malamud drew on the rhetoric of turn-of-the-century world's fairs to demonstrate the value of faster networks as well as argue for a conception of "the commons" that could ideally be served by the rapidly privatizing Internet. In the absence of a comprehensive history of the commercial expansion of the Internet, analysis of these practices provides a pioneering analytic narrative of a crucial moment of transition. By highlighting these hitherto neglected practices, this examination deepens our understanding of the forces that proved critical to the Internet's commercial success.

In 1992, David Clark, former chief protocol architect of the Internet, pronounced, "We reject: kings, presidents, and voting. We believe in: rough consensus and running code." This early Internet formulation would come to define the Internet's image as a transformative technology that was giving individuals an unprecedented ability to create, publish, and exchange information. This formulation would also provoke law professor Lawrence Lessig (1999) to predict that the phrase would become "a manifesto that will define our generation."

Internet standardization has been seen primarily as a technical achievement, and the groups tasked with overseeing this standard-setting and architectural design processes – namely, the Internet Activities Board (IAB) and the Internet Engineering Task Force (IETF) – as exemplars of the collaborative and technical practices that emerged as part of the Internet. According to conventional wisdom, these technical practices gave the fledging network a leg up over numerous competitors in the 1980s and 1990s. The IETF and the IAB were not political structures in the traditional sense – they operated without legal mandate or any enforcement mechanism to promote their standards – but they did offer mechanisms for controlling the network's development and a venue for arranging contributions from a growing user base.

These organizations certainly were important, yet they alone cannot account for the Internet's rapid transformation into a commercially viable infrastructure. Nor can they adequately explain how the Internet community addressed the considerable social and logistical challenges of managing an increasingly diverse range of users and networks.

This study suggests that one answer might lie in a widely overlooked force in the expansion of the Internet: the network of people involved with the "Interop" computer-networking trade show. Interop founder Dan Lynch assembled a core group of Silicon Valley network engineers, vendors, and entrepreneurs associated with the military-industrial research world. Beginning in 1987, and for nearly a decade, these engineers engaged with a network of people and interests from the commercial and user communities, addressing the considerable technical and organizational challenges of creating interoperable hardware. Lynch brought these different communities together in a manner that since has been described by scholars as "network forums" (Turner 2006), from which emerged shared understandings of the viability of the Internet community's TCP/IP core networking protocol, as well as how the interconnection of distinct networks might be accomplished. The Interop trade show became a sensation, becoming one of the few places that actually demonstrated functioning inter-networks: distinct networks that connected to one another but also linked outward to the Internet, as well as products that functioned across the networks themselves. It provided a site for representatives from industry, academe, and government to share an understanding of themselves as architects of the emerging networked society, freely integrating economic, technical, and social frames as they envisioned a global system of interconnected computer networks crisscrossing the globe, and what the society that supported it might be like. With each "translation" across another domain, the vision of the Internet attracted more allies. Together, they would not only create the first prototypes of the global Internet but also establish the collaborative processes that proved critical for the mutual accommodation and adaptation required for the Internet's commercial success.

This study of the Interop network builds on analytical frameworks that examine how people and things can be translated into forces that shape society and technologies (Pinch and Bijker 1987; Turner 2006; Abbate 1999; Callon 1987), and focuses in particular on the social processes through which a diverse set of interests can be recruited and brought into alignment. By doing so, this analysis shifts away from an emphasis on protocols and standards as purely technical, and instead considers the expansion of technologies across domains as a complex process of "translation" that is as much social and organizational as technical. Drawing on Janet Abbate's definitive history of the Internet, this study demonstrates how the "kinds of social dynamics that we associate with the use of networks also came into play during their creation" (1999, 4). In particular, this study traces the practices and processes, which include demonstrations and trade show exhibits, that reveal the visions that bound various actors working to scale technologies (Marx 1964; Nye 1994; Flichy 2007; Kelty 2008), and also the organizational achievements that helped coordinate new

methods of management that established processes of coordination between different actors (Callon 1986; Thrift 2005; Yates 1993).

Unlike standards-setting organizations like IETF, the Interop trade show and its publications never took an explicit position on competing standards; Interop had no formal authority within the marketplace, anyway. Instead, Interop created systems for managing flows of information, including conveying Internet practices of bootstrapping between standards and rapid implementation as well as the coordinated processes and procedures required of larger infrastructures. This occurred at a time when the established practices of managing technical standards of the Internet were becoming increasingly difficult to maintain.

Interop founder Dan Lynch was a former ARPAnet researcher and a member and industry representative at the Internet Architecture Board (or IAB – it was originally called the Internet Activities Board), the core architectural leadership organization that guided the development of the Internet. As these primarily research-oriented practices became increasingly difficult to implement in the complex commercial and highly litigious standards environment, Lynch and the other engineers affiliated with Interop reoriented Internet standards-setting by applying these practices to the practical imperative of assembling functional links between networks. By doing so, they fashioned a hybrid model of network standardization that exposed the broader commercial community to the Internet engineers' manner of condensing the "process of standardization and validation into implementation" (Kelty 2008, 173) and offered useful knowledge related to the practicalities of linking networks. Such instruction also "routinized" Internet practices: that is, Internet leadership imposed a kind of "system" for linking computer networks and developing products that would run on such networks that allowed them to achieve better control of implementation and expansion processes (Yates 1993, xvii). In turn, this system of organizational solutions functioned as a tool of standardization, a "gateway" that made it possible to transfer technical as well as social, and cultural practices across otherwise incompatible domains (Edwards 1998; Jackson et al 2007). In these ways, Interop functioned as a critical intervention for an information technology industry in flux.

The networking industry, as well as many companies, wanted to use the standards they themselves had chosen, which were often proprietary, rather than accept the interoperable standards that made interconnected networks and even open markets possible (DeNardis 2009, 38; Kelty 2008, 144). Convincing them to set aside their commercial rivalries and build functioning, testable products that were also compatible with one another (as opposed to creating competing, proprietary systems to "lock" customers into specific products and associated support resources) was both a political *and* a technical feat. Yet Interop's approach proved persuasive because, in order to participate in the trade show, Interop required vendors otherwise uninterested in the success of Internet per se to connect their products to the show network. Lynch and the other researchers leveraged their considerable influence to encourage commercial networking companies to work together to address substantial inter-networking challenges in an experimental research setting. For vendors the hybrid setting afforded them the privacy to take risks and make mistakes away from

the competitive pressures of the marketplace. In short, the Interop network operated as a site where competing commercial networking interests were persuaded to cooperate enough to abandon proprietary standards and instead construct interoperable technologies.

This paper also explores a project affiliated with Interop, Carl Malamud's Internet 1996 World Exposition. A showman-intellectual in the spirit of Marshall McLuhan, Malamud developed his exhibition in the spirit of a "world's fair," a metaphor that reflected his preoccupation with the development of earlier technological systems, especially railroad transportation, that promoted a particular vision regarding the latent tension between privately managed communications systems, public access, and the "politics of the commons." The 1996 exposition launched just as the most influential engineers and entrepreneurs in the Interop network began to drift away. Although computer networks were still an "unfinished" technology – they "broke down" with some frequency, were as yet unable to accommodate real-time audio and video streams, and had yet to extend much beyond industrialized nations – the affiliates of the Interop network had helped to create the social and technical conditions necessary to fulfill a vision of the Internet as a global, commercially viable communications medium. Paradoxically, although some people do not consider the exposition to have been a success, commercially or otherwise, it can still be looked to as an alternative vision of how the networks that comprised the Internet might have continued to develop and as a critical record of the models and discourses that existed around Internet infrastructures.

This study of the Interop network attends to an aspect of Internet expansion and commercialization that has been largely overlooked in historical accounts to date. It considers the challenges of translating utopian visions into commercially viable technologies and infrastructures, and in the process, interrogates a widespread assertion that the Internet was largely developed in the academic world that existed apart from larger economic forces. This research suggests that the global success of the Internet should be attributed to the reemergence of the collaborative work styles and systems rhetoric of the military-industrial research culture into the commercial sphere. It focuses on the degree to which technological systems must be consciously created in order to be successful at scale, and considers the organizational strategies and alliances that computer engineers and entrepreneurs building computer networks employed to help ensure the Internet's place in the global landscape. It also considers how Interop trade show functioned as an important site of negotiation for the developers who worked to shape critical discourses around testability and connectivity, and how this ensured the commercial success of the Internet.

Internet Explorers and Digital Worlds

Silicon Valley comprises sprawling suburbs dominated by corporate landscapes that seamlessly fade into one another. In the past four decades, this region has been best known as a locus of innovation, entrepreneurship, and extraordinary economic growth. Its success can be attributed to the numerous forums that brought together individuals from different companies and organizations, from the public and private sectors, and

from academic and educational institutions. These encounters encouraged allies and competitors alike to discuss common problems and consider solutions that often helped the interests of numerous independent firms. These forums also encouraged individuals to form flexible, innovative partnerships serving a shared recognition of the need to assure the Internet's global success. This study explores a series of Silicon Valley-based forums affiliated with the Interop trade show network, an enterprise with direct ties to the highly collaborative and entrepreneurial Cold War-era military research world, and that network's role in the commercialization of the Internet.

Over the course of several months, beginning in April 2009, I visited the Silicon Valley and San Francisco Bay area to conduct a series of interviews with individuals, almost all engineers, affiliated with the Interop trade show at the height of its influence. In our conversations, I focused in particular on the artifacts – trade show publications and research collaborations – that typified the Interop network at the height of its influence. I also focused on the particular visions that have mobilized programmers and engineers.

The system builders involved in the conceptual and physical construction of the Internet devoted a lot of time to telling stories and writing about the impact that new technologies might have on society. These narratives were often a combination of fact and fiction that helped make sense of the present and order the future in which the relationship between time, space, and progress would change. These stories also allowed individuals to legitimize their visions for the emerging utopian society by making themselves into credible representatives of the communities that they were helping to build. Turner suggests that members of the Whole Earth network, including Kevin Kelly and Stewart Brand, did this by using their conversations to turn "digital media into emblems of network members' own, shared ways of living, and evidence of their individual credibility" (2006, 7). In her research on computer engineers, Janet Abbate argues that engineers working to expand and popularize the Internet employed technical standards and documentation practices that had support within a large segment of the computer science community (Abbate 1999, 178). Chris Kelty has described the kinds of stories that computer programmers and engineers tell as "usable pasts" (Kelty 2008, 64-94) that reflect their ideas about the relationships between "operating systems and social systems" (2008, 43). Kelty has argued that, for technical actors, these stories are an important process of "meaning-making" because they occupy a world "finely controlled by corporate organizations, mass media, marketing departments, and lobbyists" even as they "share a profound distrust of government regulation" (2008, 72). He writes about the technical actors affiliated with Free Software, and the particular ways they have maintained a space for the "critique and moral evaluation of contemporary capitalism and competition" (2008, 76).

In contrast, network developers in the early 1990s possessed a "double aspect." Like Kelty's "geeks," the network engineers affiliated with Interop often employed "usable pasts" that helped them understand their practices in relation to the technical and political economy of the early 1990s. Yet these visions also focused primarily on the practicalities of expanding the Internet through the privatization of the

physical networks (and later the establishment of private services), integrating the Internet into the emerging networked economy. Network engineers held romantic notions of themselves as explorers crafting the prototype of a future ideal society. At the same time they worked as system-builders (Hughes 1983), adopting a "managerial ideology" (Flichy 2007, 6) as they operated across multiple (technical, economic, political, and social) registers to assemble a global information infrastructure. These resources included not only massive investments in labor and capital but also a diverse range of interests. The assembly of diverse networks into a singular infrastructure was a social and organizational feat as much as a technical one. In their struggle to "work out" *their* relationship to governance, the global capitalist economy, and personal liberties, Interop's network engineers actively sought to place themselves in intellectual connection with the actors of previous technological systems. They often focused on stories about infrastructures and standardization, integrating their visions into larger questions about governance and larger global economic flows.

Exploring Global Connectivity

I met Carl Malamud[1] at the 2009 Tech Policy Summit, an event focused on issues around regulation, spectrum policy, and America's lagging broadband infrastructures. Malamud was in attendance to speak about the need for the greater accessibility of information such as government data and public archives.[2]

Malamud has been an open access advocate for more than twenty years. In that time, he has taken on not only the Securities and Exchange Commission (SEC)[3] but the Smithsonian Institution,[4] the Government Printing Office (GPO),[5] and, most recently, the U.S. federal judiciary. In early 2002, Malamud made unsuccessful bids to run the Internet Corporation for Assigned Names and Numbers, or ICANN, which handles the most crucial functions of the Internet, pushing to run it as a public trust.[6] For many years,

[1] Malamud (born, 1959) had nearly completed a PhD in economics at Indiana University—where, incidentally, he focused on the deregulation of AT&T—when he left to build computer networks in the late-1980s. The son of a Fermi National Accelerator Laboratory physicist, Malamud became acquainted with the world of high-energy physics, mainframe computers and other computing technologies, and international scientific research [Lausanne/CERN] at an early age.

[2] Malamud, Carl. 2009. Tech's role in promoting greater government transparency and accountability. Appearance on panel at the Tech Policy Summit, May 11-13, in San Mateo, CA. http://www.techpolicycentral.com/media-vault/2009/06/2009-tech-policy-summit-podcas.php.

[3] In the early 1990s, Malamud took the SEC's corporate filings, which were public documents but difficult to find, and made them freely accessible and searchable on the Internet. When Malamud later threatened to close the site, public demand forced the SEC to set up its own site.

[4] In 2006, Smithsonian Business Ventures, which is affiliated with the Smithsonian Institution, sought to partner with Showtime to create "Smithsonian on Demand." Malamud protested and later testified before the Senate on the matter. The testimony is available here: http://public.resource.org/smithsonian.html.

[5] In 2009, Malamud began an online campaign (YesWeScan.org) to oversee the office that publishes documents and other publications generated by the three branches of government, in part to draw attention to the need for the government to make public domain information more broadly accessible online.

[6] ICANN has overseen this function since the late 1990s. For news about the contract, see

Malamud was also an author of technical resource manuals who also wrote for industry journals and Interop trade show publications, explaining complicated networking technologies to a technical audience. Malamud's projects have almost always been provocations – equal parts public spectacle and demonstration – that highlight larger technical or social issues and then offer "work-arounds" to address them. These projects are prototypes that mobilize actors to imagine themselves at the forefront of an emerging ideal society and offer tools to manage that change (interview 2009; a list of all interviewees appears in Appendix A).

In the early 1990s, Malamud published a global survey of the emerging Internet, entitled *Exploring the Internet: A Technical Travelogue*.[7] Dan Lynch and the Interop Company had funded Malamud's travels, and his published account was distributed to attendees at the Interop93 conferences. In his travelogue, Malamud provides an account of the various sites around the world that were gradually linking themselves to the global Internet. Casting himself as "one of the free-spirited aboriginal technologists on the new frontier" (Fischer 1995, 271), Malamud recounted his travels around the world, crisscrossing the United States from Silicon Valley to Washington, D.C. to Chicago, Europe from Prague to Geneva to Amsterdam, the Pacific from Honolulu to Tokyo to Hong Kong to Kuala Lumpur, Singapore, Canberra, Seoul and various other cities. In each of these places, Malamud discovered the heterogeneity of the actual hardware, wiring, design, and organizations of various components of a global computer network infrastructure**:** from CERN's global Internet hub; a Czech university's reverse-engineered network, made from old IBM mainframes; and Torben Nielsen's local area network (LAN) made from salvaged military aircraft material in Hawaii.

Malamud's *Technical Travelogue* was emblematic, making manifest the global connectivity that numerous network developers envisioned through the construction of a fully-operational show network at the Interop trade show – and, likewise, the "correctness" of their project, and their own role in the physical assembly of these far-reaching architectures. Malamud celebrates their technical skills and showmanship. He writes that in the hours before the Interop91 event, a team of network engineers installed more than thirty-five miles of cable—enough "to wire a 20-story high-tech skyscraper"—as well as fifty subnets, a microwave link, two different backbones, and a connection to the NSFNET[8] so that 300 vendors could

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http://www.zdnet.co.uk/news/it-strategy/2003/02/10/flak-flies-over-icann-contract-renewal-2130201/. For a copy of Malamud's bid, see http://trusted.resource.org/org-proposal.htm.

[7] Malamud's *Technical Travelogue* was also edited by Lynch, Ole Jacobsen, and Dave Brandin (vice president of Programs at Interop). Malamud appeared as a speaker at Interop93 to discuss his book.

[8] In 1990, the U.S. Department of Defense's Advanced Research Projects Agency (ARPA) transferred to the National Science Foundation (NSF) control of the Internet backbone, which was subsequently known as the NSFNET. The NSF was actively involved in the expansion and privatization of the network in this period. In April 1995, NSF gave up control of the Internet. Fred Turner has referenced this transfer as a moment that facilitated "the interlinking of commercial, alternative, and government-sponsored networks and the mixing of for-profit and not-for-profit uses across the system" (2008, 213).

demonstrate the interoperability of their products[9] in Interop-themed groups known as "Solutions Showcases" (Malamud 1993, 29-33). In the book's foreword, Lynch celebrates these achievements, proclaiming that "this book demonstrates what many of us have long felt: the worldwide network is here. Interoperability is not some imaginary goal at vendor briefings but a concrete part of networks all over the world" (in Malamud 1993a, vii). Like the Interop show network, which was known as the INTEROPnet or the "ShowNet," the *Technical Travelogue* mobilized developers (both the network engineers and the users) themselves. In this regard, Malamud's *Technical Travelogue* functioned as a spectacle, less an account of the various states of the distinct networks that would comprise a global Internet than a celebration of technological forces that network developers had unleashed.

Innovation depends on actors who invent technologies as well as construct the problems that these technologies address (Carlson 1992). In the early 1990s, network developers worked to solve the complex routing problems of linking networks while they simultaneously interwove technical protocols and strategies into the massive social and economic restructuring already underway. Such pronounced shifts required individuals and organizations to conform to their new protocols and strategies, regardless of their proximity to these changes. In this way, Malamud's multiple trips around the globe not only captured a snapshot of the Internet under construction (as it existed in 1991) but also revealed the resistances to, and efforts to limit or control, connectivity. By doing so, he also created the rhetorical space for network engineers to act as global problem-solvers.

In Taipei, for example, Malamud writes that he found Taiwan's networks, such as SEEDNET, unable to adequately connect to other regional networks or to U.S.-based NSFNET without dropping packets, or information, or cutting off communication altogether.

> The SEEDNET problem was certainly just a temporary one, but it showed the strains that were beginning to appear on the routing infrastructure of the Internet. … Cutting *off* people who probably wouldn't talk to you is certainly a rational response to the problem of saturating the Internet. The problem, however, was that this didn't solve the long-term problem of scaling the Internet. The Internet was doubling every 7 to 10 months and there … was obviously a need for many types of networks: the day of "the" network had long passed. Yet, this diversity meant that the network was starting to fragment and splinter into subsets of connectivity. (Malamud 1993a, 335-336)

As Malamud suggests, these experiences led him to conclude that an "integrated global Internet" would be difficult without greater attention to interoperability. One solution he offered was the engineers themselves, even suggesting that they functioned alongside protocols and hardware as a critical layer in the technical infrastructure: "Technology alone doesn't make a network, though. The next layer is the people layer where technology is applied, deployed, and networks start being used" (Malamud 2006, 364). In this way, Malamud explicitly intertwined technical and social solutions, infusing the physical construction of computer networks

[9] These products included Frame Relay, SMDS, X.400, and SNMP.

with a moral-technical framing (Kelty 2008) that equated openness with liberal democratic ideals. Put another way, for Malamud, there was a "correct" way to build networks.

> Is your routing protocol complex? You've raised the cost of entry. Do you have an acceptable use policy? You've limited your population. Have you invented an anonymous FTP mechanism and an RFC series? You've encouraged the spread of the network. ... Infrastructure ... reflects how we apply ... fundamental human values. Privacy, for example, can be protected or destroyed by a network. (1993a, 364-365)

Malamud conceptualized the creation of an "ideal market infrastructure that would allow open systems to flourish" (Kelty 2008, 14) and support "fundamental human values." For Malamud, the articulation of these values would include practices such as organizing people and machines across locales and time zones. It would also include sharing documentation of core operating standards, which in this case was a global communications infrastructure, the technical standards of the International Telecommunications Union (ITU).

One underlying narrative of Malamud's account was the ongoing conflict between the OSI and the TCP/IP standards, a struggle that has become so heated over the years that it has come to be known as a religious battle, although the conflict could be better described as the "struggle between the Corporation and the State" (Kelty 2008, 67). Kelty has described this conflict as one that focuses on the relationship between information technology (IT) as a reorientation around the ownership of ideas and IT as an economic driver. The battle between Apple and Microsoft is the most famous, illustrating the degree to which this struggle, and the deep ambivalence it provokes, has become a central component of the network cultures that have around arisen around the Internet. Malamud's articulation of this dispute was his 1991 effort to "liberate" the technical standards from the ITU. The "Blue Book,"[10] as it was known, comprised international specifications that were normally only available in paper form for purchase. Malamud had come to believe that the inaccessibility of international standards was endangering the future of the Internet by "hindering technical progress" (1993a, 3) and the development of new products. With the help of key figures in the Interop network, Malamud persuaded the ITU to publish their complete standards (totaling more than 19,000 pages) on the Internet at no charge.[11] In his account, Malamud suggested that "once the data was digital, we could all start using advanced services, write better code and … enter a state of standards equilibrium, a nirvana of documentation" (1993a, 9). This "experiment," as it was called in the trade show press release, was announced over "live video link" at the Interop91 Fall trade show. Malamud would coordinate the

[10] According to an Interop press release in advance of Interop 91 Fall, these international specifications regulated "high speed modems (V series), X.25 packet-switched networks, ISDN and Broadband ISDN, X.400 message handling systems, fax, telex, teletex, and the X.500 global directory." http://www.scribd.com/doc/2571592/INTEROP-91-Fall-to-Feature-Major-Announcement.

[11] He did do by enlisting the support of Tony Rutkowski, Counsellor to the Secretary-General at the ITU, as well as Vint Cerf, Chairman of the IAB. Richard desJardins, one of the leading authorities on the Government OSI Profile (GOSIP) and an architect of the Open Systems Interconnection (OSI) standards, was also involved.

conversion of the standards into accessible data files and the publication of the data onto the Internet.[12] That was the plan.

Malamud's argument was that the rapid commercial growth of computer networks necessitated a radical change in the ITU's policies to adapt to the competitive economic pressures of open markets and open standards that had shaped the information technology industries since the 1980s. In this case, the drive toward "openness" became an attempt to make telecommunications standards more widely accessible by posting them online. In the end, however, the "experiment" had mixed results: the ITU gave Malamud half of its standards (the other half had been lost in the organization's outmoded filing system), which he converted and posted on an FTP server, before the ITU abruptly canceled the project months later.[13]

Malamud had initially "hacked" the ITU under the rubric of "The Documentation Liberation Front" (Malamud, 1991). By the time Malamud published his "technical travelogue" two years later, however, he had further developed the narrative around his provocation with the moniker "Project Bruno," thus adopting a "usable past" involving philosopher Giordano Bruno, who was killed for revealing secret knowledge to the rest of the world.[14] In this sense, his project demonstrates the gulf that existed between the two models of standardization—Open Systems Interconnection (or OSI) and the Internet community's TCP/IP—and the degree to which these differences mobilized network engineers like Malamud to work to build a commercially viable network infrastructure. Each model represented different avenues of legitimacy. TCP/IP had been developed to allow for the linking of diverse networks, an imperative that was reflected by its emphasis on implementation, and its availability to anyone via the network. By contrast, OSI[15] seemed likely to define global network architecture (Abbate 1999, 172-179; Russell 2006, 48-49). Endorsed by governments around the world (as well as the U.S. Department of Commerce), these standards were based on a model of comprehensiveness and consensus that had grown out of more than a century of coordination and standardization of international telecommunications. OSI allowed businesses to create proprietary standards for products; the standards body would function as the validating body that would determine that various standards could interoperate with one another (Kelty 2009, 167-168). Developed by the same organizations

[12] This was handled through an anonymous FTP (or File Transfer Protocol) file-sharing site.

[13] The letter canceling the project can be found here: http://www.scribd.com/doc/2571598/Dear-Mr-Malamud. As an aside, the ITU didn't revisit the question of posting their standards online and free of charge until 2007. In the press release announcing the decision, Malcolm Johnson, Director of ITU's Telecommunication Standardization Bureau (TSB), suggested that posting the standards online would help "bridge the 'standardization gap' between countries with resources to pursue standardization issues and those without." Retrieved from: http://www.itu.int/newsroom/press_releases/2007/21.html.

[14] Giordano Bruno was a 16th century philosopher and mathematician burned at the stake for heresy. Although he is remembered as martyred for his beliefs, it is unclear why he was declared a heretic.

[15] The battle between TCP/IP and OSI has been analyzed in depth elsewhere. For an internal history, see Hafner and Lyon's *Where Wizards Stay Up Late* (1996). For a technical history, see Abbate's *Inventing the Internet* (1999) as well as Kahin and Janet Abbate's (eds.). *Standards Policy for Information Infrastructure* (1995). For a discussion of TCP/IP debates in the context of the history of open source, see Kelty, *Two Bits* (2008).

that had coordinated and standardized international telecommunications for more than a century, its proponents assumed that once OSI standards were fully implemented, competing internetworking protocols, including TCP/IP, would be phased out completely.

Malamud's project also reveals another tension around standardization: that it implies consensus. Within the Interop network, the need for consensus likely related to the practicalities of establishing partnerships to ensure the commercial success of the Internet. Yet even within the confines of the Interop network, standardization was a complicated experiment that tacked between cooperation and competition, with various social groups jockeying for the ability to translate their practices across domains, often employing tactics to limit the capacities of other groups. This occurred most dramatically between proponents of competing models of standardization and, as we have seen, with the Internet leadership as they sought to retain control over a commercializing network, but it also occurred within factions.

In his 1993 recounting of the project, Malamud concluded that the strategies of the "Bruno" project were not sustainable on a larger scale. "Bruno was a stopgap, and even if a few people working on their own could come up with a new stopgap, what we need is a real solution" (1993a, 366). Malamud considered getting countries, perhaps Korea, to set up standards havens with the professed hope of forcing organizations such as the ITU to widely distribute the material so that it would be available to citizens and developing countries alike. Janet Abbate notes that "efforts to create formal standards bring system builders' private technical decisions into the public realm; in this way, standards battles can bring to light unspoken assumptions and conflicts of interests" (1999, 179). For Malamud, by beginning to identify a particular course of action around the documentation of technical standards, he expressed "openness" in a manner that might have appealed to the sensibility of many Interop affiliates. However, given the pressing demands of privatizing and commercializing the network, Malamud's projects were often seen, at least by people like Dan Lynch, as troublesome provocations that drew attention away from the most critical tasks at hand (interview 2009: see Appendix A). Malamud was equally interested in commercializing the Internet, although, as we shall see in later chapters, his impulse to promote a "people layer" in infrastructures would later lead him to very different conclusions about what commerce might look like online. He would come to believe that a "coherent business environment" required parks and schools and museums that would attract "visitors" (1996).[16] He would see himself as the right man for the job.

[16] Byczkowski, John. 1996. World of Fun. *Norwich Bulletin.* January 28. http://www.scribd.com/doc/2576777/World-of-Fun.

I Know It Works, I Saw It At Interop

We join the Interop[17] in the early 1990s, at the height of the trade show's influence. The semi-annual event had become one of the most respected and popular trade events in the industry.[18] The events were based in the U.S, usually in San Jose, San Francisco, and Las Vegas, although by 1992, the trade show had expanded to international venues such as Sydney, Paris, and Tokyo. "Interop was like a rocket ship," former Interop Vice President of Programs David Brandin recalled in a recent interview. "For years it was the only place where you could see the stuff work" (Appendix A). "Seeing the stuff work" at Interop entailed the spectacle of a real-time "demonstration" of the emerging communications infrastructure and a "process" for assembling those networks. Interop offered lectures and in-depth tutorials by leading researchers[19] as well as "Bird-of-a-Feather" informal meetings. The event showcased vendors' latest computer networking hardware, including routers, access points, storage arrays, and security appliances through a functioning show network, or "INTEROPnet" that demonstrated these technologies in practice. "Most trade shows are satisfied to leave individual networks to vendor booths, or to put a simple Ethernet cable into place on the show floor. Interop manages to put in one of the more complex networks in the world in the space of just two days," Malamud wrote about the Interop91 San Jose event in *Communications Week* (1991). "A real network means vendors can prove new technologies work. There is nothing like an interoperability demonstration featuring dozens of competing vendors to convince users that a new technology is real. The vendors get to help build new markets. The engineers get to test their products in a real environment. And dozens of talented computer engineers get to stay up all night and pull off a technical tour de force."

Pulling this off required Interop founder Dan Lynch to bring together individuals from different firms and research groups in a series of encounters that occurred around the Silicon Valley-based trade show that (re)-infused the hybrid production strategies of the region with the military-industrial practices of collaboration and implementation from which computer networking technologies had first emerged. He assembled the somewhat overlapping worlds of military-industrial research, enterprise networking firms, and user communities. Forming flexible partnerships, representatives of multiple groups came together, driven by

[17] The present-day gathering is one of the oldest and largest information technology trade shows, billed as "the event where the global IT community comes together to see all the latest technologies in action" (2009), which includes the latest in security, networking, storage, and software products. Interop has replaced COMDEX, or Computer Dealer's Exhibition, which dominated the technology industry for decades with shows that offering computer hardware, software and associated components to all levels of manufacturers and developers. Despite its success, the present-day trade show shares little in common with Interop as it existed from its founding in the mid-1980s until 1995. In this earlier iteration, Interop was a smaller, specialty conference and series of publications, more narrowly focused on enterprise computer networking and on integrating the efforts of the engineers and vendors working to connect various networks together.
[18] According to the ConneXions publications, attendance at the event averaged 30,000 attendees.
[19] MIT's Dave Clark and Purdue University's Doug Comer taught the most popular of these tutorials.

a shared vision of a grand scheme of inter-networks and the recognition of the practical need to ensure the global success of the Internet.

These groups assembled as part of a broader struggle to standardize and expand the Internet technology. In the 1980s and early 1990s, the network system's place in global or national information infrastructures was uncertain. For the embattled Internet leadership, Interop gave them a venue to retain their authority over a rapidly changing information infrastructure. For the network engineers, Interop allowed them to build the prestige and entrepreneurial networks vital in the emerging freelance patterns of employment. Through Interop, these engineers and researchers also worked to ensure that the Internet did not simply become a global infrastructure in name only but retained the collaborative practices within which the technology developed. For networking firms, Interop presented an opportunity to respond to the massive global reorganization of the information technology industries that had ushered in "open systems," and with it the demand for open markets and open-standard processes for high-tech networked hardware and software. Interop afforded them a space to not only learn *how* to link networks but, more critically, to field-test "interoperable" products before releasing them on the open market. By tacking between the commercial demands of global markets and the moral-technical visions (Kelty 2008) of engineers, Interop translated the cybernetic dream of boundless connectivity (or seamless integration) through a global inter-linking of computer networks. However, the popularity of the trade show only tells part of the story. In the 1980s networked computing was expanding exponentially, although the Internet faced a raft of competitive corporate and government forces that left its long-term success uncertain (Abbate 1999, 147-179). It was in this moment of ambiguity that Interop emerged.

Struggles Over "Open Systems"

On a sunny June afternoon in 2009, I met Dan Lynch at his home in Napa Valley, Northern California's wine country. I had come there to learn more about the Interop trade show that the former ARPAnet researcher and computer manager at Stanford Research Institute (SRI) had founded more than two decades earlier. In many ways, his story parallels the critical role that the military-industrial research world had in the standardization and commercial success of the Internet. In our conversation, Lynch recalled that contests around standardization, and the campaigns toward commercialization that subsequently became possible, were at the heart of the Interop trade show.

In 1986, Lynch received a request from the Defense Communication Agency (DCA), which was charged with centralizing communications throughout the military as an attempt to bring operations under central Department of Defense control (Abbate 1999, 20),[20] to help further develop applications and products

[20] The DCA was founded in 1960 as the combat support agency of the U.S. Department of Defense (DoD) focused on providing real-time information technology. DCA is now known as the Defense Information

for the core networking TCP/IP protocols. In response, Lynch organized an invitation-only meeting to brainstorm about the future of the Internet protocols. A few hundred current and former ARPAnet researchers – computer scientists and engineers from industry, government, and academia that had been instrumental in the development of the Internet – were in attendance.[21] Those first interoperability meetings functioned as collaborative workshops between vendors and researchers that focused on existing and emerging issues with the Internet protocol, both within the ARPA research community and among the vendors in the field.[22] They were intended to promote solidarity between vendors and researchers at a critical stage in the Internet's development and, within a larger climate of anxiety around U.S. global technological and economic leadership.[23] Within a year, in 1987, Lynch restructured the meetings into a commercial conference and trade show and shortened the name to "Interop." The relationships that these early meetings fostered would last for more than a decade, ensuring the construction of an increasing number of projects built according to TCP/IP protocols and later the Internet's long-term success in the battles over a global network standard. These relationships would also work to a more immediate effect: Lynch wanted to build a permanent display of TCP/IP's capabilities, an exhibit he called the "Connectivity Showcase." In an email thread posted August 28, 1987, Dan Lynch relayed a plan that would involve dozens of vendors "demonstrating TCP/IP interoperability to the public. It will be open daily … and will be paid for by the vendors who want to clearly demonstrate that their products run harmoniously together. Users will be able to

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Systems Agency (DISA), which is responsible for planning, developing, fielding, operating, and supporting command, control, communications, and information systems for the DoD.

[21] The attendee list at these first meetings read as a who's who of the military-industrial research culture that had developed and implemented key elements of Internet functionality. It included MIT professor David Clark, Purdue University professor Douglas Comer, Dave Crocker, Vint Cerf (co-inventor of TCP/IP protocols), and Jon Postel (editor of the RFC documents and administrator of the Internet's names and numbers process). [Interop Company. 2nd TCP/IP Interoperability Conference, December 1-4 1987 Attendee List, SRI Network Information Center Records, Lot X3578.2006, Interoperability Materials, Computer History Museum, Mountain View, California.]

[22] In 1991, the five key areas identified were**:** Routing and Addressing, Multi-Protocol Architecture, Security Architecture, Traffic Control and State – to accommodate real-time applications – and Advanced Applications, among them the "increased need for innovation and standardization in building new kinds of applications." Source: David Clark et al. 1991. "Towards the Future Internet Architecture," RFC 1287: 3. Presumably these goals had remained the same, or nearly the same, since 1986.

[23] Although it is outside the scope of this thesis, efforts to build global infrastructures amenable to U.S national and corporate interests should be read against the larger geo-political struggles over long-term technological and economic competitiveness. President Ronald Reagan's mid-1980s foreign policy was defined by a return of Cold War era closed world politics. In his 1985 State of the Union address, Reagan defined the U.S. mission one "to nourish and defend freedom and democracy, and to communicate these ideals everywhere we can." As former Interop international vice-president David Brandin suggested to me in a phone interview in August, 2009, the emergence of Interop was directly related to the considerable anxiety over America's ability to retain global technological and economic control. Japan presented a particular threat because it had launched a joint government-industry-university research effort focused on artificial intelligence, parallel processing, and microprocessor technologies (Brandin 1987; Edwards 1996, 298-299). For a period account, see Brandin, David R., and Michael A. Harrison. 1987. *The Technology War: A Case of Competitiveness*. New York: John Wiley & Sons.

come in and run demos between any machines they wish to find out about."[24] Lynch later altered his plan to have a year-around exhibition. The following year, Interop launched the first trade show network, a "fairly ambitious demonstration of TCP/IP interoperability" that included an *intranet* (a private computer network within an organization) that linked 49 different vendors to one another and to as many different pieces of hardware as possible[25] in order to illustrate that although the Internet TCP/IP protocol suite was developed to link distinct networks, it was "not tied to any particular physical medium" (Almquist 1989, 2) and thus able to run on intranets as well. The show network also provided two connections out to the Internet.

In many ways, Lynch was an ideal candidate to spearhead the Internet's transition into a commercially viable communications medium. He already had extensive experience with the assembly of the Internet itself. In the early 1980s, he[26] had managed the painful "cutover" that many consider the birth of the Internet. That massive, multi-year effort transitioned two hundred or so U.S. government contractors and research teams from Network Control Program (NCP) and their own proprietary networks to the more flexible and powerful TCP/IP protocol suite that made interconnected networks possible.[27] The magnitude of this change was as much cultural as it was technical. From the 1960s until 1980, networks were relatively closed systems managed by a single entity – whether by a government agency, company, or utility. Components were made by a handful of companies who had built them to their specifications. Many had built their own networks with proprietary hardware, software, and architectures (Abbate 1999, 148-151; Kelty 2008, 145;). The transition had proven so unpopular with vendors that Vint Cerf, then DARPA research manager, had twice shut down the ARPAnet in order to convince the companies that they would be forced to comply with the changeover (interview, 2009).[28] In fact, failure to adopt these new protocols would have meant getting cut off from the network itself. In a 1991 interview Lynch recalled, "Dozens of us systems managers found ourselves on a New Year's Eve trying to pull off this massive cutover. We had been working on it for over a year. There were hundreds of programs at hundreds of sites that had to be developed

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[24] Lynch, Dan. 1987. Message to Re: Sun routers. http://www-mice.cs.ucl.ac.uk/multimedia/misc/tcp_ip/8706.mm.www/0067.html.

[25] According to the February, 1989 *ConneXions – The Interoperability Report*, the media included several versions of Ethernet, IBM/802.5 Token Ring, and amateur packet radio. The original article can be accessed here: http://www.cbi.umn.edu/hostedpublications/Connexions/ ConneXions03_1989/ConneXions3-02_Feb1989.pdf.

[26] As Director of the Information Processing Division at the Information Sciences Institute (ISI-USC)

[27] Cerf, Vint. 1987. Message to [ih] NCP to TCP/IP Transition. http://www.postel.org/pipermail/ internet-history/2009-April/000796.html.
One of the best accounts of this time period is Abbate's *Inventing the Internet* (1999). An insider account of the time period can be found in Hafner and Lyon's *Where Wizards Stay Up Late: The Origins of the Internet* (2000).

[28] Kahn, R.E. 1994. The Role of the Government in the Evolution of the Internet. Communications of the ACM, 37(8): 16. Kahn, who co-invented TCP/IP with Cerf, was director of ARPA's Information Processing Techniques Office from August 1979 until September 1985. In addition, Cerf left ARPA in October 1982 and Barry Leiner did not replace him until August 1983, Kahn personally managed the transition to TCP/IP. [R.E. Kahn, oral history interview, OH 192, CBI.]

and debugged." Once the changeover was complete, Lynch commemorated the occasion by making buttons that read, "I Survived the TCP Transition."[29]

Within three years, by the mid-1980s, Lynch and the other ARPAnet veterans once again found themselves working to convince an unwilling user base to conform to the TCP/IP Internet protocols. This time, they needed to convince a rapidly expanding vendor and user community to adopt these protocols *without* the authority to compel them to employ them, and in the midst of an increasingly acrimonious contest over "open systems." At the time, there was a proliferation of proprietary hardware, software, protocols, and systems (Kelty 2008, 147). Chris Kelty suggests that although the concept of "openness" held many different agendas – variously articulated as open source code, self-publishing, specifications available to certain third parties, or standards set by governments and professional societies – all carried an antagonism toward "proprietary" systems (2008, 147).

For the developers and consumers (users) alike, struggles over open systems and "interoperability" took on the guise of a "cultural imperative" that integrated the ideals of the free market and of the free exchange of knowledge (Kelty 2008, 148). As Carl Malamud's attempt to provoke the ITU into releasing their "Blue Book" of international standards suggests, the struggle between the TCP/IP and the OSI core inter-networking standards had become emblematic of the split between a bureaucratic, monopolistic telecommunications industry and a flexible, networked computing industry.

The Internet TCP/IP protocol suite's eventual success over the international standard have been commonly described as a triumph of the Internet model—that is, of a culture of "openness"—over proprietary industries. This success has been framed primarily as a technical achievement, and the groups tasked with overseeing this standard-setting and architectural design processes – the Internet Activities Board (IAB) and the Internet Engineering Task Force (IETF) – as exemplars of the collaborative and technical practices that emerged as part of the Internet. The IETF and the IAB, were not political structures in the traditional sense – they operated without legal mandate or any enforcement mechanism to promote their standards – yet they functioned as the primary mechanism for governing the Internet. It occurred primarily through a set of technical documents, known as "Request(s) for Comments," or RFCs, that oversaw the development and implementation of the specific technical protocol standards that comprise the Internet. RFCs had initially emerged while the network was a military research project as a consensus-style process through which a technical document became an Internet standard only after it had been placed in the "standards track," significantly developed, and then reviewed by a number of parties. The IAB (as well as the Internet Engineering Steering Group, which oversaw the IETF) had control over which documents entered the process (Galloway 2004, 134). The RFC process had emerged to promote informal communication in the "absence of technical certainty or recognized authority" (Abbate 1999, 74); the process also helped ensure

[29] Lynch, Dan. 1991. Message to comp.protocols.tcp-ip, 23 June. McKenzie box 2, Bolt Beranek, and Newman library, quoted in Abbate 1999, 140-141.

that the scattered collaborators who were involved in these conversations were able to easily communicate with one another. On the 30th anniversary of the RFC, in 1999, Vint Cerf described the RFC process as a conversation:

> When RFCs were first produced, they had an almost 19th century character to them - letters exchanged in public debating the merits of various design choices for protocols in the ARPANET. As email and bulletin boards emerged from the fertile fabric of the network, the far-flung participants in this historic dialog began to make increasing use of the online medium to carry out the discussion.[30]

According to conventional wisdom, these innovative technical practices gave the fledging network a leg up over numerous competitors, most notably OSI standards.

Although the RFC process has become part of the mythology of the Internet, it does not address how standards are able to move across other domains, or how a version of the RFC process survived in the commercial environment. As the Internet's user base rapidly expanded, the leadership of technical organizations like the IAB and the IETF had become increasingly unable to manage the network architecture and standards (Abbate 1999, 207-208).[31] Perhaps more revealing, RFCs effectively documented the processes of interoperability, yet, according to Lynch, they were too obscure to be implemented as published. "If you tried to build a network just using RFCs, you'd run into a lot of problems that had already been worked out in the field. This was a major issue with corporate engineers who weren't part of the RFC process" (interview 2009). Put another way, the RFC process would have been of limited use in the expansion of the Internet. Herein lies the Interop network's great contribution to the standardization of the network: it provided a mechanism for the practicalities of physically implementing RFC standards in a chaotic market climate that largely was not interested in the Internet per se, but rather only in creating networks. It provided, as Janet Abbate suggests, a site that "internalized the competitive forces of the market together" (1999, 145). Once there, out of a mixture of practical need and technical desire, these parties would forge partnerships that would rapidly address some of the thorniest issues around interoperating networks.

A close look at the corporate practices in Silicon Valley in the 1980s and 1990s reveals that Interop and its role in the expansion and commercialization of the Internet might best be understood within the industrial community that helped drive the regional critical capacity in the global economy. In contrast to the Internet's technical organizations, which attempted to define their authority over the Internet's protocols, architecture, and practices, the Interop trade show network functioned as a hybrid implementation and

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[30] Cerf, Vint. 1999. RFC 2555 – 30 Years of RFCs. http://www.faqs.org/rfcs/rfc2555.html.

[31] Abbate argues that these organizations lacked accountability and international representation as well as faced increasing legal challenges and a host of other challenges that compromised their ability to manage the rapidly growing network. This crisis was such that, in 1991, senior Internet leadership, specifically the Internet Activities Board (which included Dan Lynch, Vint Cerf, and David Clark) called a series of meetings about the future of the Internet. For a compelling account of this crisis in Internet governance, and the related conflicts around Internet addresses, see Laura DeNardis' *Protocol Politics: The Globalization of Internet Governance* MIT Press. 2009.

production environment. Individuals from different companies and organizations, often fierce competitors, came together to discuss common problems and consider solutions, and the process encouraged them to form flexible, innovative partnerships driven by a shared recognition to keep the Internet advancing globally. At Interop, standards were negotiated informally, and competitive standards like OSI were actively incorporated into the conference talks as well as the INTEROPnet. Put another way, the trade show translated the IETF's standardization formulation of "rough consensus and running code" into a commercial environment, and did so at a time when the growing user base and complexity of the network connections meant that testability had become increasingly difficult. The trade show also promoted the TCP/IP standards by constantly demonstrating the protocol suite's capacities, and by driving the implementation of products based on TCP/IP. Although it is impossible to determine how much impact Interop ultimately had, there is evidence to suggest that these tactics must have contributed to the Internet's later success. By the late-1980s, as increasing numbers of products based on TCP/IP began to show up, OSI standards no longer wore the guise of an apparent global standard. Computer scientist Carl Sunshine (1989) put it this way, "It is ironic that while a consensus has developed that OSI is indeed inevitable, the TCP/IP protocol suite has achieved widespread deployment, and now serves as a de facto interoperability standard" (Sunshine 1989, 5, quoted in Kelty 2008, 175).

After managing the transition to the Internet, Lynch had gone on to open several businesses of his own. All failed, but the experiences had drawn him into the industrial economy of Silicon Valley, a global competitive environment infused with the collaborative and deeply entrepreneurial working style as well as the systems thinking of the military-industrial world. In this way, Silicon Valley also functioned as a location where the military industrial research world re-inserted itself into the commercial environment. One of the most influential groups in the region was Douglas Engelbart's Augmentation Research Center (ARC) at the Stanford Research Institute (SRI) (and later at Xerox's Palo Alto Research Center). Himself a veteran of SRI and a friend of Engelbart's, Lynch was likely deeply influenced by Engelbart's philosophy of "bootstrapping" which attempted to leverage man's collective capacity to address the world's complex, urgent problems. Fred Turner has suggested that Engelbart "worked to create an environment in which individual engineers might see themselves both as elements and emblems of a collaborative system designed to amplify their individual skills" (2006, 108). That idea can be understood as an organizational strategy to retain the flexibility of small research groups as they grew in size. These concepts helped shape Lynch's thinking as he considered how to implement technical advances in an environment that demanded that the Internet leadership convey procedures and coordinated processes to a user base that was only somewhat willing to go along. That Lynch and the other network engineers accomplished this "routinization" of the RFC processes helped determine the success of Interop, and also of the Internet more generally.

Depicting Technological Change: The INTEROPnet as Prototype

Numerous theories of technological change have posited the form and function of technologies as determined by the cultural values, interests, and interpretations of social groups (Bijker, Hughes, and Pinch 1987; Bijker 1995). Among the concepts introduced are closure and stabilization, processes where a social group involved in designing a technology decides that a problem has been solved, which in turn defines (and limits) how the technology is understood and used in society (Pinch and Bijker, 1989). The most visible element of the trade show was the INTEROPnet. This demonstration simultaneously illustrated "connectivity" and "openness" in practice and outlined the capacities of the TCP/IP protocol.

> In order to show off this diversity of media, we suspended the cabling from the ceiling, where it was in plain view. Unfortunately, the diversity wasn't as apparent as we would have liked, since most of the kinds of media use cables that are thin and black … A number of people complained to me that the transceivers, which were hung on loops in the cable about a dozen feet above the floor, looked "messy." (Almquist 1989, 2)

From these uncertain beginnings, the show network would mature into a spectacle illustrating the technical prowess of its engineers and their practices of bootstrapping between standard and implementation that had emerged with the development of computing technologies in America. The focus on interoperability and connectivity would help drive the binding visions that unified engineers. Engineers associated with the Interop network, like Karl Auerbach, used the show network to illustrate their vision that interoperable networks would allow the seamless flow of information:

> The whole idea here, you've got to make your equipment talk to one another. Because consider a telephone. What value would be the fanciest telephone in the world if it couldn't talk to another telephone on the other side of the country? (1993)[32]

As a prototype, the INTEROPnet provided a mechanism to illustrate both the technical viability of the Internet protocols, but also to promote those technical standards' ability to "interoperate" with a number of competing protocols. Such flexibility underlined the importance of integrating innovation and implementation, a technique that resembled the IETF aesthetic of "rough consensus and running code." The network design of the show network at Inteorp93, for example, was altered more than a dozen times in the weeks leading up to the event. Interop Manager of International Engineering and Design Bo Pitsker echoed this sentiment:

> Networks should be implemented very quickly. Because if the deployment of the network is stretched out over a period of years, which frequently happens in the corporate setting, the requirements change. By the time that networks built, it's already obsolete. We design the network and implement it in a period of less than six months. And then we tear it down. We re-design it, and re-deploy it in less than six months again. (1993) (see Figure 6)[33]

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[32] Auerbach, Karl. 1993. Interop93. Interop93. San Jose, CA: Interop Company promotional material. Video. http://www.lazy-booklet.org/~latzko/interop93full.mp4.

[33] Pitsker, Bo. 1993. Interop93. Interop93. San Jose, CA: Interop Company promotional material. Video. http://www.lazy-booklet.org/~latzko/interop93full.mp4.

These tactics also helped the Internet leadership retain and extend their influence over the network system as it extended into the commercial domain, at a time when more explicit efforts to exert oversight over network standards had proven inadequate.

Coordinating Collaboration Through the Interop Trade Show INTEROPnet

The Interop trade show network functioned as a kind of hybrid production network research lab that, if it had been privately funded, might have cost millions of dollars (see Figure 7). Interop's show network was built on participation from academic researchers as well as their counterparts in networks and enterprise information technology. A number of companies, like Cisco Systems and Sun Microsystems, donated technical expertise and hardware. The trade show fostered collaborative research in an environment where competitors (entrepreneurs and companies alike) could work out challenging interoperability issues more efficiently and with relatively less risk than they would have faced on the open market.

Figure 6: Screen grab of the construction of the Interop trade show's INTEROPnet (or ShowNet). The routing and bridging equipment used to construct the show network was estimated to have been as much as a major corporation would use to supply offices in fifteen or twenty cities.[34]

[34] Interop93. San Jose, CA: Interop Company promotional material. Video. http://www.lazy-booklet.org/~latzko/interop93full.mp4.

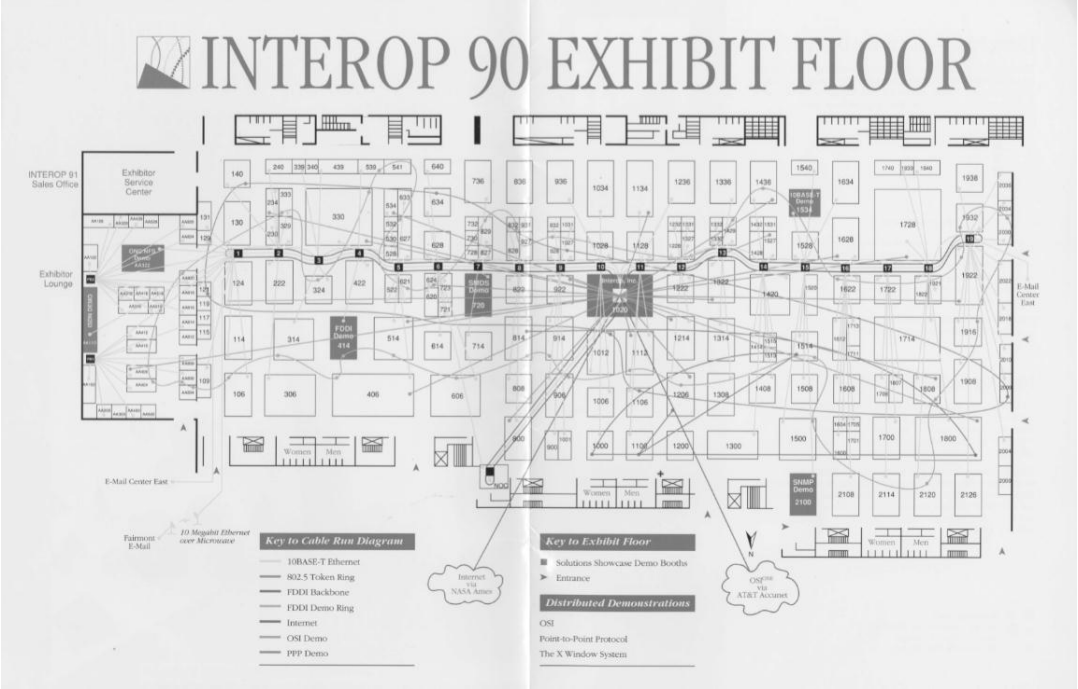

Figure 7: Diagram of the Interop90 exhibition INTEROPnet (or ShowNet). Note connections to the Internet via NASA Ames and to the OSI-supported networks via AT&T Accunet. Courtesy of the Computer History Museum.

In his account of the Interop show network, Malamud wrote:

> I spoke to one engineer who says he gets more bugs worked out in one week at INTEROP than he can in six months in the lab. By testing his implementations with those of other vendors, we can quickly hone in on ambiguities in the standards and figure out what to do to make the standard an interoperable reality. (1993a, 33)

In their analysis of network development in a British aerospace project, John Law and Michel Callon (1992) have argued that what is required to successfully join distinct networks is a "negotiation space" that affords project builders the autonomy and privacy to make mistakes, experiment, and arrive at solutions (1992, 21-52). They have also written that the negotiation space needs to be able to "impose itself as an obligatory point of passage" (46). Thus, even as "interoperability [became] increasingly difficult to achieve," the nature of the INTEROPnet and the Interop leadership itself forced engineers and firms to address difficult internetworking issues caused by competing standards and test new products to ensure that they neither failed to work with competitors' products nor "broke the Internet" (Pitsker 1993, 3). Interop's focus on bootstrapping between consensus around standards and rapid implementation helped drive the construction of products according to TCP/IP protocol specifications by entrepreneurs as well as by more established computer companies**.** This was helped by the practicalities as much as by loyalty to Internet practices. Thus, although the OSI model was far more comprehensive, it was generally still not yet built, making rapid implementation difficult. In a matter of years, the Internet protocol had become one of the most widely

employed standards. By the mid-1990s, the ISO model, which had once seemed untouchable, had been officially retired.

Depicting the Global Network

Who was in this world that network developers created? To the extent that it is possible to assemble a partial image of the Internet as it was imagined by one group of engineers affiliated with Interop, it would be largely American, white, likely affiliated with a university, entrepreneurial, and overwhelmingly male. In this way, it resembles many other histories of the Internet. As Turner has noted in his account of the Whole Earth network, "it would turn away from questions of gender, race, and class, and toward a rhetoric of individual and small-group empowerment" (2006, 97).

The spectacle of the INTEROPnet had unleashed visions of boundless connectivity, ideas so compelling that, as Ole Jacobsen wrote in an issue of the trade show journal *ConneXions – The Interoperability Report,* attendees had considered aloud whether they might soon be connected to outer space: "On Thursday morning, September 29, the space shuttle Discovery lifted off, and I heard a few attendees wondering if they'll be able to contact the shuttle from next years show floor. I can just see it now: %pingdiscovery.shuttle.nasa.gov" (1988, 7). Yet for all of the attention paid to connectivity and markets, there was almost no attention paid to regions of the world that were not already industrialized. For the Interop engineers, theirs was a world in which they were the rightful heirs to the global networked computing infrastructure that they had assembled into a unified entity. They were the ones tasked with ensuring that users behaved in the proper way. This claim recalls a story Karl Auerbach told me. During one early Interop event, a hacker based in Italy kept breaking the Interop show network. He and Carl Malamud responded by "turning off" the Internet in Italy (interview 2009).

By the mid-1990s, Interop's grand era of influence came to a close. Lynch had sold Interop to Ziff-Davis for 160 million dollars in late 1990, but had continued to run the business until late 1994.[35] By this time, many engineers felt that the largest computer-networking issues had been resolved. Lynch recalled that he left when the trade show started to become what he called "overrun with marketers" (interview 2009). Interop continues to operate to this day – and is in fact one of the largest enterprise networking trade shows in the world. Still, Lynch's point is well taken, for the energies that had invigorated the production of physical networks had largely given way to excitement over the World Wide Web. Although the core membership of the Interop network seemed to be fraying, the visions around the network forum remained intact for a time. Interop affiliate Carl Malamud was still focused on the global need for connectivity. His *Technical Travelogue* had offered a detailed representation of a disorganized and heterogeneous emerging

[35] After Ziff-Davis acquired another information technologies trade show, *Networld*, Interop was renamed *Interop+Networld* trade show. Despite these institutional changes, however, this study will retain the term "Interop" throughout to describe the trade show.

Internet, a half-formed vision populated by a range of individuals with distinct problems and goals that differed from the carefully manicured heterogeneity of Interop. In short, Malamud's publication presented a different aspect of the difficulties of scaling a technology. He had just begun to scheme how to pull off his most far-reaching endeavor yet – an international exposition organized *on* the Internet – but also *for* the Internet.

In Truth, All the World was There: The Internet 1996 Exposition[36]

By the mid-1990s, dramatic increases in public computer networking as well as the expansion and privatization of computer networks had helped facilitate the growth of a series of commercial and alternative networks. For Carl Malamud, faster networks brought with them the promise of new services and products, and with that, the possibility of additional consumers. Malamud had authored numerous technical resource manuals but by 1993, he began to actively explore the communications applications in the online space. He started a non-profit organization, Internet Multicasting Service (or IMS).[37] Malamud's choice of the term "multicast" (sometimes called Multicast Backbone, or "Mbone") referred to an experimental method for sending audio and video over existing Internet infrastructure that would cut down on the expense of sending large data files that also tended to overload existing bandwidth.[38] It also revealed his intention to become a "desktop broadcaster" (Malamud, 1993b).

Through IMS, Malamud developed projects that explored the possibilities he envisioned for the new medium, including a 1993 effort to integrate fax and e-mail. This initiative, which Malamud developed with Interop affiliate Marshall Rose and debuted at Interop, was conceived as a kind of "community library" that would service the public "over a portion of the telephone address space."[39] Malamud also launched one of the first Internet radio stations, an initiative he called "Internet Talk Radio."[40] His online-only service, which

[36] Frederick Ward Putnam (Chief of Department of Ethnology, World's Columbian Exposition) 1891, quoted in Griffiths 2002, 46.

[37] Christophe Diot et al, 1997. "Multipoint Communication: A Survey of Protocols, Functions, and Mechanisms." IEEE JSAC.
Brown, Ian, Jon Crowcroft, Mark Handley, and Brad Cain. 2002. "Internet Multicast Tomorrow." The Internet Protocol Journal. http://www.isoc.org/pubs/int/cisco-1-6.html.

[38] I find Andy Lippman's example of the video streams available on airplanes to be a handy way of thinking about multicasting, versus broadcasting, which assumes similarly assumes a one-to-many model but is considerably less accommodating to the notion of temporal consumer demand.

[39] In my interview with him in 2009, Malamud suggested that this "hack" upset several of the *Interop* inner circle, who feared that Malamud had strayed too far into established telecommunications territory. Drawing the attention of the FCC, the Interop organizers believed was trouble they were anxious to avoid. Malamud recalled that he had been asked to cancel the fax project at Interop. He went ahead with his plan, apparently with few ill effects. RFC 1529 is associated with this project: http://www.faqs.org/ftp/rfc/pdf/rfc1529.txt.pdf.

[40] In addition, Malamud launched of one of the first live streaming "cyberstations" at Interop94.

offered recordings of National Press Club luncheons as well as a "Geek of the Week" program featuring recorded interviews with Internet pioneers, had an estimated 100,000 listeners in about 30 countries.[41]

For Malamud, digital publishing offered an opportunity to develop the Internet in a manner analogous to the development of networks. That is, he saw the creation of online information spaces as well as the growth of a "variety of ways of interacting" online, through electronic mail as well as "real-time video connection," to be a project undertaken by a group of experts who would guide the development of quality material online. A 1993 interview suggested that Malamud took his role as a "desktop broadcaster" seriously, basing his IMS company in the National Press Building among traditional media representatives.

> It is the global village, and we need people producing real information... We want to see professional production on the Internet. We want to show NPR, and CNN, and these other groups, here's how you, who produce information, after all … here's a new medium you can send your information out onto … We are next to the Kansas Star Gazette and the Arkansas Gazette. And on this door down a long hall, you'll see Internet Multicasting Service. …A room that's kind of half-radio station, half-TV studio. And a whole bunch of computers. We have the fastest link in Washington DC to the Internet. … [W] hat we're ready to do there is pump large amounts of data into the network … It is the global village, and we need people producing real information. (Malamud 1993b)

Malamud's statement also reveals the intimate connection he saw between connectivity, which in this case meant a faster network, and, in turn, new services and new consumers.

By 1994, this conviction would help drive Malamud's decision to undertake one of the most ambitious Internet projects of its time. Nearly a decade after Dan Lynch had first assembled the former ARPAnet researchers to brainstorm about the future of the Internet, Malamud employed a version of the Interop trade show as a model for the Internet 1996 Exposition, a year-long international trade fair and exhibition that set out to drive greater connectivity. It comprised a website that employed flashy graphics and midi audio files,[42] a series of online exhibits, and geographically located events permitting face-to-face meetings, as well as network structures such as a global network "backbone" and multiple computer "libraries." In its membership and implementation strategies, the initiative resembled the networks that had first formed around Interop trade shows. For the Internet Expo, Malamud brought together network developers and computer-networking firms as well as international university researchers—some of the same groups that were already working in partnership through Interop forums—and employing similar frames, to assemble a prototype of a global Internet, albeit this time on a worldwide scale and in real time. The exhibition diverged from Interop in other significant ways, both in the management structure and the

[41] This audio was originally made available through FTP. These recordings are still available today, now through the World Wide Web. The "Geek of the Week" program is available here: http://town.hall.org/radio/Geek/ and 1993-1995 recordings of National Press Club luncheons are available here: http://town.hall.org/radio/Club/.

[42] The visual style of the Internet Expo website looks quite similar to O'Reilly's *Global Network Navigator.*

project's framing of the solution. The next few pages provide an overview of the Internet 1996 Exposition and its components, which the remainder of the chapter will examine more closely.

The Internet Expo got its start when Carl Malamud approached Vint Cerf – Internet pioneer and MCI senior vice president as well as board member of Malamud's non-profit Internet Multicasting Service (IMS) – with the notion of putting on a world's fair. Malamud was looking for a way to continue funding his company, and he believed that the world's fair metaphor presented an ideal opportunity. He had been working for several years to build a communications business on the Internet. For Malamud, communications on the Internet was still in its infancy and many metaphors seemed appropriate: "We can easily call ourselves a global schoolhouse, a telephone company, or a radio station." Malamud had chosen the radio metaphor, framing the collection of projects that IMS comprised—the free international fax program, the collection of online audio recordings of people building the Internet, and the online databases of telecommunications and SEC standards—as "Internet Talk Radio." When the radio metaphor hadn't yielded sufficient funding for his efforts, Malamud thought about what might prove more appealing to corporate interests, considering a "global schoolhouse" and a "telephone company" before settling on a "world's fair" (1997, xv-xvi), a framing that has long proven evocative for technologists. This metaphor evoked the spectacular displays that emerged in Industrial Era expositions—from the Crystal Palace in London, to the spectacular lighting displays of the World's Columbian Exposition in Chicago, to wireless telegraphy displays at the Louisiana Purchase Exposition, to the vernacular architectures of the 1939 New York World's Fair—that captured the public's imagination and faith in a idealized technological future.

In less than a year, Malamud assembled an array of supporters. Putting on an international exposition for the Internet allowed him to mix Interop's hybrid production strategies and cybernetic ideals with the countercultural idealism of the MIT Media Lab and the status seeking jockeying for position and status of global trade shows. Interop provided early institutional support for the exposition, and the fair became a keynote of the Interop trade show gatherings throughout 1996. Jun Murai from Keio University in Japan, and Dr. Rob Blokzijl, a physicist with the National Institute for Nuclear and High Energy Physics (or NIKHEF)[43] in the Netherlands were collaborators. Other supporters included network developers affiliated with Interop, including Simon Hackett, Joichi Ito, Paul Vixie, and Mike Millikin. In addition, publisher Tim O'Reilly of O'Reilly & Associates and a number of MIT Media Lab professors and students helped, including then-student Deb Roy and Glorianna Davenport's Interactive Cinema Group. Corporate support totaled more than $100 million in resources and included support from U.S.-based companies like Sun Microsystems, MCI, IBM, Bay Networks, and UUNET Communication Services as well as from the Dutch Ministry of Economic

[43] *Nationaal Instituut voor Kernfysica en Hoge-Energiefysica, or* National Institute for Nuclear and High Energy Physics has since changed its name to *Nationaal instituut voor subatomaire fysica*, or National Institute for Subatatomic Physics). It is one of seven locations of the Amsterdam Internet Exchange, an Internet exchange point, that began in 1994 as a collection of Internet service providers

Affairs, Deutsche Telekom AG, Korea Telecom, Samsung, AT&T Jens Corporation, IBM Korea, NEC Corporation, Sony Corporation, and Keio University. As we see, the international sponsors were concentrated in Korea and Japan but also included representatives from the Netherlands and Germany. More than 80 "regions" of the world created online pavilions, including Japan, Tibet, Singapore, Egypt, and the Netherlands. U.S. government presence in the lead-up to the fair was minimal, although President Clinton sent a letter of support; after the project launched, there would be a number of exhibits sponsored by the United States.

The initiative had a number of core design elements that defined the scope and look of the Internet Expo. As we shall see, the fair metaphor – in its reliance on the vernacular and its sense of the spectacular – deeply shaped the event. Instead of merely trying to attract the attention of traditional media (as he had with earlier projects), Malamud would use the exhibition to illustrate the most ambitious aspects of the networked society he envisioned. These included "pavilions," (online websites that would be open for anybody to develop),[44] online "events," and geographic places where the public could interface with the fair. Two final technical components of the fair, which Malamud dubbed the "Internet Railroad" and "Central Park," were envisioned as its infrastructural legacy. Malamud also hoped that they would help mobilize corporate (and even national) interests to improve the expensive yet sluggish connections that were "holding up" the development of the Internet and keeping it from functioning as it could.

> The international links were so overloaded that many were losing 70 percent of all packets by trying to put the equivalent of a grand piano through a mail chute. Using the world's fair as an excuse, we set about trying to beg and wheedle bandwidth out of carriers. (1997, 144)

This additional bandwidth would be required in order to make the audio, video, and real-time streams "flow" around the world as rapidly as had been envisioned. To achieve this, Malamud needed telecommunications carriers to partner with one another for the duration of the event and allocate additional bandwidth or assemble faster connections between countries and regions. The project received its earliest, and most substantial, support from the telecommunications firm MCI,[45] which donated backbone resources for a year. Other carriers and exchange sites would also support the project. Malamud hoped that the Internet Expo would demonstrate what he saw as a critical need for a global network "backbone." A final aspect of the event would consist of large computers staged at "key Internet exchange points" that would mirror data, and thus provide a measure of redundancy and alternative routes through which Expo pavilions could be accessed, avoiding "traffic jams" and expensive international connections (Malamud, 1995). These technical components (the "Internet Railroad" and "Central Park," respectively) will be examined in more depth later in this study.

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[44] These pavilions were almost exclusively sponsored by national governments or corporations. There were a few exceptions, including "Randyland," which was designed by an individual.

[45] MCI, like AT&T, was part of the international construction boom in the 1990s.

The fair launched on January 1, 1996. Over the months, the exhibition enlisted the support of additional sponsors, and affiliated with additional projects and offline events. As this occurred, additional pavilions were added to the fair website. Online, the Internet Expo functioned as a web directory that aimed to be encyclopedic—in the words of co-organizer Rob Blokzijl, —to "take all aspects of world and society and make it visible to the world" (1995).[46] These various initiatives were organized on the Expo website in several ways: by location (regions and continents), themes (such as "Cities and Districts," "Food and Markets," and sub-themes such as "World Art Treasures" and "Mimi's Cyber Kitchen"). These included initiatives created explicitly for the Internet Expo, and included country-specific projects. At launch, Japan committed twenty-two corporate projects, including the multimedia "Sensorium" – more than any other country. Additional exhibits included the Netherlands' simulated cow pavilion, art and technology exhibits, and an IBM-sponsored Mongolian road race. Some of these events were created specifically for the exhibition, but many more, including Malamud's "Congressional Memory Project,"[47] Ted Machover's "Brain Opera,"[48] the "CyberFair96,"[49] and the chess match between world champion Garry Kasparov and IBM's "Deep Blue" computer,[50] were events that the exposition "linked to" from elsewhere on the Internet.

[46] Blokzijl, Rob. 1995. A world's fair. Presentation at the semi-annual Networld + Interop, July 21, in Tokyo, Japan. http://www.scribd.com/doc/2576764/A-Worlds-Fair.

[47] This was largely a repackaging of Malamud's work through the Internet Multicasting Service. In it, he recorded nearly ten months of U.S Congressional feeds to a database, where the audio was searchable by member of Congress, date range, location, or political party affiliation.

[48] MIT's Ted Machover debuted his Brain Opera at the MIT Media Lab, where it was recorded for the Internet Expo website (and streamed to a convention center in Japan), as well as at New York's Lincoln Center Festival. The performance was based on Marvin Minsky's book, *The Society of Mind*, included a set of "hyperinstruments" designed by Machover and his Media Lab students.

[49] The Cisco/MCI Global Schoolhouse CyberFair96 was an initiative to help schools get online. More than 350 schools signed up, posting information about their school as well as various photos and designs from students.

[50] To celebrate the fiftieth anniversary of the electronic computer, IBM and the Association for Computing Machinery (ACM) sponsored a chess match between Kasparov and the corporation's "Deep Blue" computer. The speculation about "thinking" machines and the ways in which the game of chess explored the bounds of machine "intelligence" is a rich topic, which has been explored at The Computer History Museum in Mountain View, California. More information is available here: http://www.computerhistory.org/chess/.

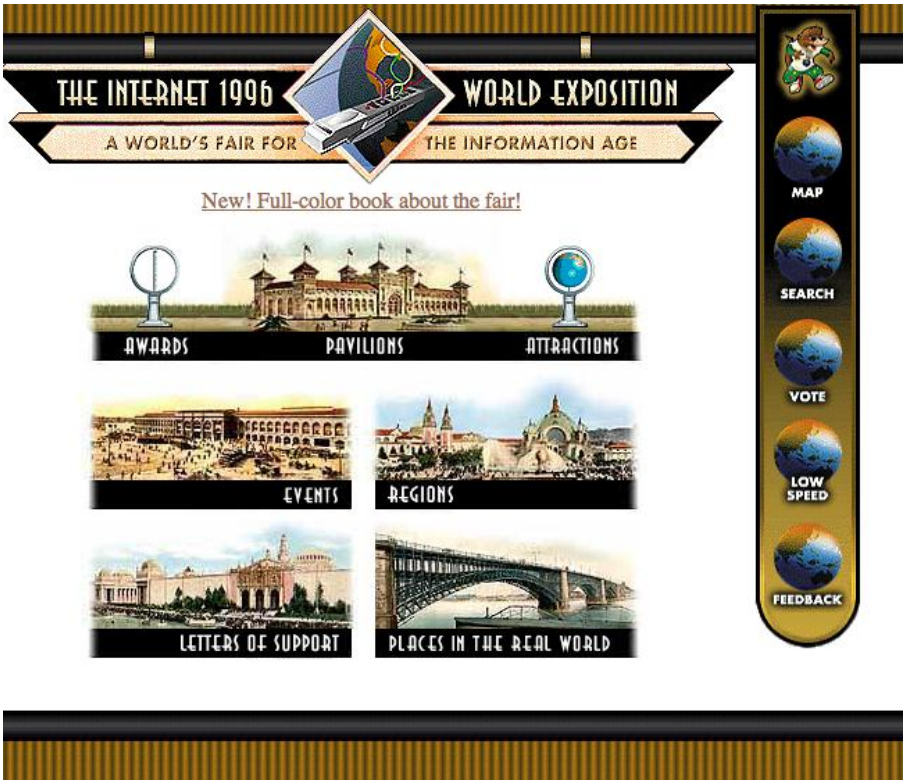

Figure 8: Screen shot of the Internet 1996 Expo website, www.park.org.

At the end of 1996, the Internet Expo event officially came to a close, celebrated with a closing ceremony in Kobe, Japan, that included blessing an exhibition "time capsule" – a digital videodisc of the main portion of "Central Park" that had grown to over 10 gigabytes – that would be stored in the City of Kobe Museum. The exhibition website had received some fifty million "hits," with an estimated five million unique "visitors" (Malamud 1997, 172-173).[51] In the months following the fair's closure, Malamud set about transforming the website "fairgrounds" into a "public park." He added an online map to the exposition website, depicting the event as an enclosed outpost of pavilions connected by rail in an otherwise unpopulated frontier. Also in 1997, Malamud published a coffee table book detailing the planning and execution of the event. The website (www.park.org) remains online, an archive of the Internet 1996 Expo but also as a record of the Internet as it appeared in 1996, and intended to be a "pristine structure that will remain forever present" (1997, 253) (see Figure 8).[52]

[51] The term "hit" refers to the number of times a file is sent to a browser by a web server. Since a website is comprised of many different files, a single request to view a single webpage can generate numerous hits. In contrast, a "visitor," suggests an individual accessing a website, although one visitor can make multiple visits to a site. By comparison, according to a May 1995 article in *Interactive Age*, Netscape.com reported 30 million hits and 3 million users daily and HotWired.com, a online spin-off of *Wired* magazine, reported 3 million hits and more than 400,000 users daily. http://www.cs.columbia.edu/~hgs/internet/notes.html.

[52] Malamud envisioned that he would maintain an archival "snapshot" of the project. The notion that the Internet might function as a "library" was a common metaphor in the 1990s. Today, many sites and events

Today, however, the many links on the site itself are no longer working, an artifact of the early Internet, and a time when many believed that the Internet might store permanent records of knowledge and events. Let us turn now to the closer examination previously promised.

Reviving the Spectacles of the Industrial Age

By the mid-1990s, the dramatic increase in public computer networking as well as expansion and privatization of computer networks had facilitated the growth of a series of commercial and alternative networks that had sprung up, promising to usher in the digitized meritocratic marketplace communications medium. Interop founder Dan Lynch had accomplished much that he had set out to do with the trade show. He had helped ensure the success of the Internet protocol. He had also been a critical force in the assembly of heterogeneous networks into a global Internet that had become intertwined with the global economy.

For Carl Malamud, in contrast, the physical expansion of computer networks as well as the growing commercialization of the Internet had led him to conclude that network infrastructures had advanced sufficiently for him to articulate his own visions of connectivity. On one hand, the Internet Expo modulated Interop's collaborative practices, persuading partners to work together to assemble a functioning exhibition network that would simultaneously demonstrate connectivity while also offering a near-future experience of what the Internet could become, and of the role that corporations would play in this future. At the same time, the Internet Expo diverged from the Interop trade show in a number of ways. Whereas Interop emphasized the critical importance of successfully inter-linking heterogeneous networks to one another, the Internet Expo emphasized the speed and bandwidth of the connection. Both stages, of course, are critical to the "seamless integration" of computer networking technologies, yet they operate at different stages in the expansion of a technology. Malamud believed that a critical next step in bringing the Internet to scale would require a global public demonstration that would include governments as users. He also believed that it would require an additional driver: consumers, who, presumably, would bring with them the promise of the commercial viability of products and services.

In order to accomplish his goals, Malamud enlisted the support of a range of interests. In July 1995, Malamud stood before a crowded conference audience at the Interop trade show in Tokyo and formally

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affiliated with the Internet Expo have since been moved or taken offline. The website remains an archive of the web capabilities at a particular point in history. Unlike a site that is constantly updated, it can seem incongruous today, prompting a blogger who recently came across www.park.org to complain that "instead of leaving a recyclable graveyard of architectural oddities, what is left is frighteningly static … Clicking through to view the exhibits leads either to shell sites, diversions to vast telecom conglomerate promotions sites, or the familiar old 404 not found tombstones … despite over 100 million US dollars from diverse governments and corporations funnelled [sic] into it." *Everything2* blog, http://everything2.com/title/Internet%25201996% 2520World%2520Exposition. More files are available on the CD-ROM that accompanied the book publication, although some require "vintage" plugins to run properly.

unveiled the *Internet 1996 Exposition: A World's Fair for the Information Age*. As he had previously, Malamud relied on a usable past, imagining himself in intellectual connection with the actors of previous technological systems, and actively sought to make this very connection to his international audience.

> It is tempting to say that we are living in unique times, but if we look at history – if we learn from history – we will see many parallels between our information age of this century and the industrial age of the past. (1995)

The past that most interested Malamud was the succession of global public expositions that ushered in the industrial age, spectacles that simultaneously astonished and subdued audiences – from the mechanization of factories (1876) to the standardizing influence of the railroad (1893) to the managerial efficiency of assembly lines (1915) to the commoditized futures of the "World of Tomorrow" (1939) – events that integrated the technological processes and the corporation ever more completely into society**.** Recalling these expositions allowed Malamud to frame the introduction of the commercial Internet through the lens of inventions that were both technological and territorial.

As he had in the *Technical Travelogue*, Malamud depicted standardization as a critical battle in which progress and a better future were at stake. An exposition, Malamud offered to his audience, functioned as a critical site in the success of a technology. To prove his point, Malamud relied on the usable past of George Westinghouse and his struggles with Thomas Edison over the future of electricity. The battle, Malamud suggested, was resolved at the 1893 World's Columbian Exposition in Chicago.

> This was 1893 ... This was the birth of electricity and there was a big fight going on. A guy you may have heard of, Thomas Edison, had got into the power business. He was championing a power distribution technology called direct current, DC. … but DC had problems. Most of the power got lost in the distribution network.
>
> A bunch of young Turks had come up with a radical new technology called Alternating Current, AC. They claimed AC would allow efficient power distribution over long distances, but Edison … waged a bitter public campaign, telling people how AC would harm their health, how the technology was unstable, was untested, that AC was nonstandard and we couldn't allow every group to come up with their own standard.
>
> One of the leaders of the young Turks was an engineer named George Westinghouse. He got the contract to build the show network for the 1893 Chicago Columbian Exposition. He put in 22,000 horsepower of generating capacity. Chicago was a great success. Soon after, George Westinghouse received a contract to place his equipment at Niagara and the modern power industry was born. (1995, 11)

In his recounting of the story, Malamud promoted a version that emphasized the conflict as a "battle of the currents," the version of the struggle between two competing technological systems that was popularized in the press at the time. This downplayed the degree to which the controversy played out on technical, economic, and political levels, and the degree to which it was resolved on these levels (Hughes 1983, 106-140). The specifics of electricity aside, Malamud's message was clear: he was celebrating the work of scaling a technological system and transforming society, emphasizing it over the invention of the technology

itself. By describing the wiring of the Chicago Exposition as a "show network" (and later, the control of this show network as a "network operating center"), Malamud expressed this past success in terms familiar to his Interop audience (1995, 8, 10-11). In the process, he suggested that the exhibitions functioned as critical sites of technological change. In other words, Malamud enticed his audience to become part of the reorganization of society and the economy by supporting his proposed Internet exhibition.

Malamud's story likely operated on another level as well. In my interview with him, Malamud suggested that a new generation had driven the Internet's expansion. Although this study argues that original ARPAnet researchers were, in fact, deeply involved in the expansion and commercialization of the Internet, Malamud's statement implies something about the multiple stages of standardization that a technological system undergoes. In the 1980s and early 1990s, Interop trade shows defined their user base largely as businesses and consumers. However, by the mid-1990s, the increasing availability of personal computers and the advent of the World Wide Web had greatly increased the number of users – and hence not only their perceived commercial importance but also their "claim" in the network. At the same time, the Internet was still far from a developed technology. The network risked fracturing into multiple competing models. Significant gaps in the networking infrastructures remained. As Internet traffic grew exponentially, outages proliferated. In a 1995 *InfoWorld* column,[53] network engineer Bob Metcalfe predicted that the Internet would collapse by the end of 1996. Malamud had come to believe that what was needed was to drive development that would result in greater connectivity and faster networks.

In a manner reminiscent of the Interop tactics, the Internet Expo offered a prototype for how collaborative partnership could drive improved connectivity. In a 1995 promotional video, Vint Cerf suggested that an Internet railroad would link "various cities together, and expose the various populations to the wonders of the Internet" without "any freeway congestion." Their efforts, Cerf suggested, would be accomplished through the traditional Internet leadership, which included Cerf, and the telecommunication corporation that employed him.

> We'll be able to "deliver the goods" just as we did with the railroads of the 1800s. So please join with The Internet Society and with MCI to help build the Internet railroad for the 1990s. (1995)[54]

Malamud gambled that this tactic of driving collaborative partnerships that had worked so successfully for Interop would help to generate the political and corporate will to assemble fast enough networks so that the kinds of services that would attract consumers would be easily accessible. As with electricity's rapid integration into society, Malamud imagined that the seamless integration of computer networks into daily life was critical if the technology were going to become "useful" for the larger public.

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[53] Metcalfe, Bob. 1995. "Wireless computing will flop – permanently." *Infoworld* 15(33): 48.
[54] Cerf, Vint. 1995. World's fair promo tape. *Internet Multicasting Service* presentation at the semi-annual Networld + Interop, July 21, in Tokyo, Japan. http://www.archive.org/details/ org.park.expo_promo.

> The computer must disappear, becoming part of the facilities instead of a showcase on stage. In the early days of electricity, there were no electrical outlets. Wires ran all over the place and homeowners became adept at stringing new appliances directly into the mains. Over time, we learned how to make the infrastructure disappear, to become a natural part of buildings. (1997, 31)

Just as world's fairs had left "lasting impressions on the landscape ... and on the minds of their visitors" (1997, 27), Malamud imagined that the Internet Expo would help address what he saw as a critical danger for the commercially operated Internet. Worrying that financial interests would leave little "public space" for citizens, Malamud would create two "architectural legacies": the "Internet railroad" to drive connectivity, and the "Central Park" as a series of global repositories of data. Malamud suggested, in a manner reminiscent of Disney's *Spaceship Earth,* "We are trying to get consumers to move to the global village, to bring this technology into their homes and businesses, to bring this technology into their daily lives. … This Internet's worlds fair is about public parks, but it is also about building the infrastructure that will allow our information economy to succeed" (1996, 25-27). Malamud had helped build numerous Interop show networks. For Malamud, the Internet 1996 Expo would be the ultimate ShowNet.

Exploring the "Global Village"

The 1990s were driven by market populism and an enthusiasm for the "new economy" that celebrated private investment, entrepreneurs, and deregulation. Many pundits also rejected any role that the government might play in the development of the Internet. Yet the Internet Expo not only relied heavily on corporate sponsors, it also engaged numerous government and other bureaucratic organizations.

The Internet 1996 Expo officially went online in January 1, 1996. In actuality, the pavilions and the infrastructures designed for the exhibition came online gradually throughout the year. The exhibition was produced around the same time as two other projects that explored the affordances of the Internet as a global communications medium. All had some connection to the MIT Media Lab, though all but Malamud's Internet Expo were generally conceived as online artistic exhibitions. The first, a book/web project produced to celebrate the research group's 10th anniversary, was *A Day in the Life of Cyberspace*.[55] For ten days in October in 1995, the site's organizers pulled in stories and other materials covering a number of themes, including Privacy, Place, Expression, Wealth, and Environment. In her thesis on the project, co-designer Judith Donath suggested that the virtual event was intended to offer a "Portrait of the Net, 1995" that would "encourage people to think about how cyberspace is developing and its impact on their own lives and to send in writings and pictures about their experience with this new world" (1996).

[55] Donath, Judith. 1996. *A Day in the Life of Cyberspace.* Cambridge, MA: MIT Media Lab. Multimedia project. http://www.media.mit.edu/events/1010/1010_intro.html.

A similar hybrid book/web project, photographer Rich Smolan's *24 Hours in Cyberspace: Painting on the Walls of the Digital Cave*,[56] was timed to launch on the same day as the grand opening of the Internet Expo. Smolan's project pulled together a team of 150 photojournalists who, on February 8, 1996, "fanned out across the world to document how the Internet and online communication are changing people's lives." For twenty-four hours, a team of computer programmers and editors worked in real time to download the photographs sent from the field and to put the best ones online**.** The site contained about 200,000 images and allowed users to add their own pictures and stories. An estimated four million people visited the site over the 24 hours the site was active. The project was later released as part of an exhibit at the Smithsonian Institution and published as a book and CD-ROM. By far the most ambitious, both in scope and scale, was the Internet 1996 World Expo, which, unlike the other exhibits, was explicitly focused on the infrastructures of the Internet, and therefore, on technical barriers to connectivity.

Although the fair was produced, in part, while Malamud was at the MIT Media Lab, the visual style of the fair had the most in common with O'Reilly & Associates' *Global Network Navigator (or GNN),*[57] which had been the first commercial website (and the first online advertising) on the World Wide Web.[58] In a similar manner, the Internet Expo site employed digital interfaces that drew on elements employed on the GNN site. This included a Whole Earth countercultural vernacular that drew on visual elements like balloons. Like the GNN, the Expo highlighted sponsors and other commercial elements on the site. However, the critical aspects of the Expo were not its visual style, but rather its treatment of infrastructures.

Prototypes and Corporate Infrastructures

Malamud used the metaphor of the world's fair in one final way to draw attention to the most critical aspects of his project: the construction of large public infrastructures. These two main elements consisted of the "Central Park," comprising a dozen donated servers located at key Internet exchange points around the world and an Internet Railroad (originally conceived as a "globe-girdling" T3 line) that would "supercharge" Central Park (1995). Both were intended to improve connectivity as well as the quality of content online, and would be funded largely through corporate support.

The linked machines of "Central Park" functioned as storehouses of web sites, multimedia, and other data that was amassed and systematically distributed to other key machines around the world. They helped

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[56] Smolan, Rich. 1996. *24 Hours in Cyberspace.* Cambridge, MA. http://undertow.arch.gatech.edu/homepages/virtualopera/cyber24/SITE/htm3/toc.htm?new.

[57] O'Reilly and Associates, Inc. launched GNN after an early prototype of the site was first demonstrated at the Interop 92 trade show. At this point, the Internet was overseen by the NSF, which had rules against commercial activity online. O'Reilly obtained a special dispensation to put online advertisements on his site. The GNN home page as it looked when it launched in 1993 can be found here: http://oreilly.com/gnn/.

[58] Also in 1993, the graphical browser, Mosaic, was made available to the public for the first time, quickly becoming popular enough to drive growth in the World Wide Web itself. This growth was followed by the commercialization of services on the Web.

compensate for the technical difficulties and expense of sending large multimedia files over long distances. They also reflected the degree to which Malamud conceived of his project as a web directory that was not only assembling but also recording all of the content available online. Curiously, once data had been collected, Malamud noted that a provider would be free to take this information and "sell it or give it to their users."

Despite the contemporary popularity of the "information highway" metaphor, for the second technical element of the Internet Expo, Malamud instead chose the metaphor of an "Internet Railroad." Alluding to the railroad as a mass (and not individualized) transit mode that helped to industrialize the U.S., Malamud noted:

> The backbones are carefully managed infrastructures that aggregate traffic from thousands of simultaneous users. These key transit links are intensely monitored and planned. The term *information highway* implies a wide-open space that people wander about in. A transit backbone is more like a train, where packets arrive at a router, queue up until a slot becomes available, and are injected into the long-distance links. If the current Internet is a set of unpaved country roads that may someday lead to the information highway, our backbones are truly the narrow-gauge rails of the beginning of the nineteenth century. (1997, 143)

In this way, the prototype served the larger political goal of trying to elicit the proper support that would serve as "the first step toward a real global infrastructure" (Malamud 1995). Even in countries with Internet access, links between countries were limited (1997, 144). The numerous links between the U.S. and Europe were very slow, but four times faster than Japan's connectivity to the rest of the world. In part because Asia had the least developed infrastructure, the Internet Railroad had the largest impact there. In Japan, NTT donated fourteen T3 lines to connect all of the regions together. JCSAT committed two full transponders off two satellites, bringing connectivity to Japan as well as to the entire Pacific Rim. This line would also connect various locations, providing data exchange and real-time audio/video streams. On a larger structural level, the emphasis on physical infrastructure and technology transfer as well as connectivity extends the railroad metaphor to include its deep connections to the imperial age and colonialism.

At the end, however, the Internet Railroad was temporary. Almost all of these infrastructures were donated only for the duration of the Expo, and at the end of the trade show, many of the links were returned to their original purposes. However, by pulling off such an ambitious infrastructural prototype, Malamud had hoped to encourage providers to build more robust networks.

> We weren't network operators and we didn't see any point in competing with the commercial providers. The whole point of the world's fair was to go one step ahead and provide a spur to accelerate the development of the Internet. (1997, 154-155)

To do so, he had assembled these infrastructures (and the whole exhibition in fact) using strategies employed at Interop. In an account of the event, Malamud noted:

> The bottom line for us was that we were able to build the infrastructure for our world's fair, just as the engineers in 1893 installed lights and trains and the other networks that they used for theirs… For one year, the Internet Railroad was an international service provider with

> operations in half-dozen countries, 24-hour network operating centers, and a host of users at universities, special event sites, and Central Park sites. The railroad provided an ideal customer story for the contributing companies because everything we did was out in the open … [M]ore importantly, the regional backbones, national backbones, and special event sites provided ideal training for the engineers participating. (1997, 155)

Malamud had once envisioned himself as an explorer. With the Internet Expo he functioned as a salesman exporting technology and the technological practices of Interop. The exhibition had drawn sufficient attention through the year that it was active, and even achieved some success in encouraging Japan to improve its internal national networks as well as its connectivity to external networks. Yet once the fair closed, it was largely forgotten. The Internet Expo was never as successful as Interop. It was never able to foster the kinds of long-term partnerships that occurred through the Interop trade show, nor did the exhibition model truly offer the right environment to foster collaborations between fierce competitors. Perhaps most critically, by venturing into collaborations with national governments and a wider array of commercial sponsors, the Internet Expo ventured squarely into territory that Interop organizers had always adroitly avoided: namely, the degree to which the Internet not only challenged the traditional territories of telecommunications industries, but also of numerous national governments that had historically seen telecommunications as the realm of the state. The model of a world's fair might have had the right mix of corporate and national competitive qualities to convince numerous entities to participate, yet it was unlikely that such an exhibition would ever have led to the kind of collaborations and flexible partnerships that emerged through the military-industrial research world. Notwithstanding, at the same time, the success of Malamud's project was less critical because the exhibition represented an early vision for how a truly global network infrastructure might have emerged.

Conclusion

Infrastructures are visible when they are under construction, as they were in Silicon Valley in the 1980s and 1990s. These networks, conceptually and physically half-formed, revealed the visions of the engineers themselves, which have been the focus of this study. As evidenced by their willingness to "disconnect" users from the Internet for various infractions, these engineers understood that the global information technology system they were constructing required widespread adherence to be effective. In this way, the half-formed nature of these networks also directly confronts *how* the technology – an invention first developed to address the U.S. military's need to promote a flexible, heterogeneous system able to string together a diverse range of command and control systems (Abbate 1999, 144) – was "normalized" in order to become a commercially viable communications medium. These infrastructures, or at least traces of their presence, are discernible across Disney's simulated landscapes of the emergence of the networked age.

Aspects of this question have been approached by a number of scholars. Fred Turner, for example, suggests that cybernetic discourse and the collaborative, interdisciplinary work styles of the military-

industrial research world intertwined with the American counterculture to help fuel what would become a widespread utopian vision that computer networks would usher in an ideal society. By the 1990s, descendants of this research world – organizations like the Stanford Research Institute (SRI), the MIT Media Lab, and the Santa Fe Institute – became "models of a collaborative world … in which technologies were rendering information systems visible, material production processes irrelevant, and bureaucracy obsolete" (Turner 2006, 178). These models, and the relationships they supported, helped blend countercultural and cybernetic rhetoric and practice in ways that helped corporate executives model and manage their work in the post-industrial networked economy. Yet this analysis offers less insight into the physical construction of networks.

The role of the military-industrial world in the commercialization of the Internet has also been addressed on the technical side. Some analyses have focused on the groups tasked with overseeing the standard-setting and architectural design processes – the Internet Activities Board (IAB) and the Internet Engineering Task Force (IETF). Yet these organizations were less suited to respond to the practicalities of implementing these standards, particularly at scale. As Janet Abbate suggests, "perhaps the key to the Internet's later commercial success was that the project internalized the competitive forces of the market by bringing representatives of diverse interest groups together and allowing them to argue through design issues" (1999, 144), a collaborative tactic formed in the military-industrial research labs. The present study contributes to this existing body of research by suggesting that the Interop trade show network, as a series of forums where former ARPAnet researchers partnered with commercial interests, functioned as one of the systems that Abbate describes.

The present study has focused on the network of individuals and activities around the Interop trade show, suggesting that, unlike other mechanisms of standardization, the show network not only offered a manner of ensuring partnerships among a set of diverse and often competing interests, but also offered a mechanism for testing standards in a technically complicated and commercially competitive environment. This suggests that Interop functioned in tandem with the established RFC documentation process (and the organizational logics comprised),[59] addressing the practicalities of implementing these standards across domains. Such strategies ensured that the Internet's core organizational logics would be adaptable enough to transform into a private commercialized infrastructure and survive the resulting fragmentation of authority.

The figures most closely associated with Interop were actively involved in securing the Internet's future and explicitly integrating the Internet into the emerging global economy. For most of the network engineers affiliated with Interop, this expansion was driven by an attention to interoperability, a goal that envisioned interconnecting machines that were, at least ideally, interchangeable, openly sharing and processing information. This imperative drove toward "open systems" that, according to Chris Kelty,

[59] In his work on protocols, Alexander Galloway has referred to these logics as the "governmentality" of information systems (2004, xviii).

amounted to "openness through privatization," a formulation that equated the marketplace with the free exchange of knowledge and fought against the proprietary solutions that threatened monopoly control by corporations over products.

In particular, then, Interop was driven by the practical need to ensure that the flexible TCP/IP standards, first built to satisfy military conditions, thrived in the global open market, and thus become the de facto standard for global networked computing. To leverage the widespread support that Internet protocols and practices had in the computer science community at large, Interop organized the expansion of the Internet through universities around the world. By doing so, they avoided engaging with national governments. They also avoided the attendant flood of difficulties that included competing protocol standards that already had the support of many governments as well as competing claims of ownership from nationalized telecom industries.

Although Carl Malamud was deeply immersed in Interop's goal to transform the Internet into a vehicle of global enterprise, he also tended to advocate for an articulation of the commons, expressing ambivalence about what a wholly commercial turn would mean for more civic-minded activities on the Internet. These efforts revealed a crucial difference between Malamud and many Interop engineers with deep ties to the military-industrial research world. Individuals like conference founder Dan Lynch as well as Vint Cerf and David Clark belonged to a close-knit group of former ARPAnet researchers working to retain substantial authority over the Internet, most explicitly as representatives of the IAB. In contrast, Malamud was not only a generation younger than these Internet pioneers, but he came from a different "user community" that shared more in common with early commercial publishers like Tim O'Reilly of O'Reilly and Associates and other technical groups. These distinctions would become even more apparent as the most substantial challenges of routing information between computer networks were solved and the Internet moved into a new phase of standardization and expansion. In other words, spectacles like the Internet Expo focused on technical aspects of networks, and on the need for greater connectivity, in order to allow the *affordances* of built networks to flourish.

Perhaps the greatest point of departure in this regard was Malamud's Internet 1996 Exposition. Employing many of the same strategies and figures involved with Interop, Malamud produced an event that not only successfully demonstrated the viability of faster networks, but also explicitly highlighted the role of governments and other state actors that, until this point, had largely been excluded from Interop-style network expansions. To further appeal to them, he even touted the potential consumer appeal of a massive spectacle that traded on the nostalgia and excitement of a world's fair. These tactics likely annoyed the Internet leadership that studiously worked to define the Internet for its technical attributes, not for its communities; and had fought even more powerfully to work outside of the regulatory and political boundaries of international law and of national governments and commercial enterprises. Malamud, in

contrast, invited these parties to the table. His interest in this next stage of standardization reflected the degree to which earlier battles over TCP/IP had, for the moment at least, been settled.

Lest this study appear to be merely an historical account of the relationship between mobilizing utopias and the managerial demands of commercialization, Carl Malamud's own career suggests that much of the same operational logic that drove Internet commercialization in the early 1990s – the work of reconstituting society to conform to the logics of network protocols – has not simply been a chapter in the history of the early Internet but rather a utopian effort that is constantly underway. In 2009, Malamud discussed how he and a small group of dedicated open-government activists "liberated" the U.S. federal courts' record database from the privately-managed paywalls,[60] making it what he believed it should be – free and widely accessible – by publishing millions of pages of the cases on the Internet. Malamud also shared his principles of open data—that includes data that is widely accessible, "machine processable," and available in a primary and non-proprietary format (Malamud 2007).[61] These changes, Malamud suggested, were leading to the next "wave" of governance.

> We are now witnessing a third wave of change—an Internet wave—where the underpinnings and machinery of government are used not only by bureaucrats and civil servants, but by the people. (2009, 18)

This transformation, Malamud has suggested, results in "government as platform" (O'Reilly, 2009), a term that conceives of government systems as the basis for private enterprise as well as for the traditional tasks of governance. Malamud has further argued that, in this view, the traditional tools of government become critical elements of the architecture of the network itself.

> Government information—patents, corporate filings, agriculture research, maps, weather, medical research—is the raw material of innovation, creating a wealth of business opportunities that drive our economy forward. Government information is a form of infrastructure, no less important to our modern life than our roads, electrical grid, or water systems. (2009, 21-22)[62]

By proposing new expectations about the accessibility of government data, a subject that has preoccupied him for nearly his entire career, Malamud promotes new channels of connectivity between citizens and the state while at the same time advocating for the "reformation" of traditional government structures to conform to the managerial logics of protocols. More precisely, for Malamud the "mobilizing visions" that so engaged his imagination in the 1990s continue to critically inform his work today. Governance and the control of the production and distribution of knowledge, as it relates to the Internet, have changed considerably in the intervening decades. Malamud's attention has turned away from the construction of "big networks." Instead,

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[60] This database is known as PACER, the government-run Public Access to Court Electronic Records. It is only accessible for a charge, is not searchable, and not user-friendly for the general public.

[61] In 2007, Carl Malamud and Tim O'Reilly of O'Reilly Media held an invitation-only "Open Government Working Group" to generate principles for open government data. The 8 principles are available here: http://resource.org/8_principles.html.

[62] Here, Malamud cites Alfred Chandler's *Strategy and Structure* (1962) as the defining work on "the intertwined nature of government, infrastructure, and industry."

his focus has turned toward the far more intimate project of incorporating the logics of networks into individuals themselves. He seeks to cultivate individuals who possess the capacity to self-govern, distributing the responsibilities once assumed by modern states to citizens themselves. In this way, Malamud is an example of the enduring impact of the Interop trade show and the politics of Internet commercialization on individuals.

Appendix A: List of Interviewees

Auerbach, Karl (former ARPAnet engineer and key member of the Interop trade show INTEROPnet team. 2009. Interview with author in San Jose, California, June 30**.**

Brandin, David K. (former vice president and director of SRI International and vice president of programs at Interop). 2009. Phone interview with author, July 28.

Clark, David (senior research scientist at MIT Computer Science and Artificial Intelligence Laboratory as well as chief protocol architect from 1981-1989 and chair of IAB). 2009. Phone interview with author, June 25.

Crocker, David (former ARPAnet engineer who contributed to the development of internetworking capabilities in the research and commercial sectors). 2009. Interview with the author in Palo Alto, CA, June 25 and June 29.

Davenport, Glorianna (founding member of the MIT Media Lab and former director of the Interactive Cinema group). 2009. Interview with the author in Cambridge, Massachusetts, March-April.

Jacobsen, Ole (editor and publisher of *The Internet Protocol Journal* and long-time editor and publisher of Interop Company's *ConneXions—The Interoperability Report*). 2009. Interview with the author in San Francisco, July 2.

Lucas, Marty (directed audio and web production for the *Internet 1996 Expo*). 2009. Phone interview with author, July 7**.**

Lynch, Daniel (former computing manager at SRI, long-time member of the IAB [1983-1993], and founder of Interop Company). 2009. Interview with author, June 24.

Malamud, Carl (former document resource author, founder of the Internet Multicasting Service and Public.Resource.Org). 2009. Interview with the author, May 13.

Rheingold, Howard (member of the Whole Earth network as well as author of *Virtual Community: Homesteading on the Electronic Frontier* and former executive editor of *HotWired,* one of the first commercial content web sites). 2009. Interview with the author, June 23**.**

Rose, Marshall (network protocol and software engineer who contributed to the development of network management and distributed systems management and founded Dover Beach Consulting). 2009. Phone interview with author, June 27.

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