WORKSHOP ON NETWORK DESIGN AND SOCIETAL VALUES

September 24-25 2008
Arlington, Virginia

INTRODUCTION

Digital electronic networks have emerged as one of the most powerful and exciting technologies of the late 20th and early 21st centuries, embodying and promoting wide-ranging societal and individual aspirations to create, produce, communicate, buy, sell, organize, connect, associate, educate, learn, entertain, campaign, and collaborate on a local, community, national, and global scale.

One mark of a great technology is its capacity to transform and be transformed. This we have witnessed in the relatively short lifespan of digital electronic networks, as societies have reacted to them and, in turn, shaped and reshaped them in multiple iterative cycles of mutual transformation. For scientists and engineers, the challenges are legion. In this document, however, we report on some of the complex interactions between network science and technology and societal values, focusing on moral, political, and sometimes also cultural values.

BACKGROUND

The broad community of network scientists and engineers, in collaboration with the NSF Network Science and Engineering (NetSE) program, poses this challenge: to develop the fundamental principles and methodical knowledge that will help us understand large, complex networks, and help us better design such networks in the future. The scope of NetSE ranges from design and development of network technologies, to "network science" and to the relationships between and among both of these and with people and societies. As a step toward this ambition, scholars and researchers, both inside and beyond traditional science and engineering, have been invited by NSF and the NetSE Council (an external community organization helping to refine the NetSE objective) to participate in a series of workshops to think about key issues and approaches.

In this context, on September 24-25, 2008, the workshop on Network Design and Societal Values assembled a group of scholars and researchers in the humanities, social sciences, law and policy as well as scientists and engineers to identify promising research in the humanities, social sciences, law and policy, past and potential, that connects the study of moral and political values with computer and information system design, development, and deployment.[1] Although the focus of the workshop was specifically on networks, the workshop sought to bring to bear the wealth of expertise and past work on the complex, mutual interplay between design of technology and political and social life.

But identifying promising research in relevant non-technical fields was not the only goal. At least as important was to identify past and potential research that could speak beyond the communities of its authors' academic origins to network scientists and engineers as well – results, questions, approaches, literatures, cases, and issues that might be

[1] See Appendix I for a list of participants.

meaningful to scientists and engineers, that might even influence the design of computer and information networks (e.g., hardware and software). What might these be? How might decisions in network design usefully and systematically take them into consideration? And, by the same token, what hard problems in network science and engineering might successfully migrate onto the agenda of the humanistic, social, and political study of technology? How might these problems stir and energize these areas?

THE REPORT

The report is inspired by ideas emerging from brief presentations by Workshop participants and from the discussion following these presentations, where several salient themes gelled.[2] Going into the workshop, participants were asked to prepare remarks not only about their own work but reflecting a line of research or scholarship in which they conceived their work to fit. This placement did not need to track traditional disciplinary boundaries (e.g., the names of their home departments) but could be associated with a set of questions, a particular method, an object, or objects of study, a set of issues, an annual conference, etc. Participants were asked to reflect on how this line of work contributed to a landscape of study of networks and societal values, for scientists and engineers as well as the members of their communities. Participants from technical fields were asked to reflect on instances in which they had encountered problems that they understood to be socio-technical in nature, and prior collaborative experiences to address such issues.

Individual presentations and group discussion suggested that workshop findings would be more easily presented as a research landscape, characterized by several key dimensions, each defined by an open ended set of questions, rather than a research agenda, defined by a single list of questions. The dimensions that seemed best to capture relevant past research and exciting and valuable future research were: Methods and Approaches, Issues, Themes, and Integrated Case Studies. We also include a bibliography of additional readings.

It bears repeating that the workshop's horizon was not on all interesting and worthwhile research on network technology through the lens of humanities and social sciences but on research in both fields that offered exciting potential for mutual influence.

DIMENSIONS OF THE LANDSCAPE

RESEARCH METHODS AND APPROACHES.

Issues, questions, themes, methods, and cases raised at the workshop build upon a significant body of past and ongoing research across the disciplines. Workshop participants were asked to describe their own work, and to give some insights into their research methods.

Noshir Contractor, with a background in behavioral science, investigates factors that lead to the formation, maintenance, and dissolution of dynamically linked social and knowledge networks in communities. The goal of this research is to develop theories

[2] See Appendix II for the workshop agenda.

(network science) of network formation at this level, and to translate this theory into design principles that lead to more effective and useful networks among groups such as health care professionals, first responders, and other sorts of professional groups, as well as social contexts such as virtual worlds.

For this sort of work, the emergence of the Internet and the higher-level networks that form on top of it provide a source of observable data that can be used to test theories and designs. Networks that are embedded in technology are perhaps easier to study and analyze than networks that only manifest as social behavior and off-line records. But this fact hints at the possibility that with better instrumentation of today's networks, we may be able to extract data, apply theory, and help improve the operation of those networks.

As an example, peer-to-peer networks (P2P) are not designed and engineered by network operators. They just "happen", as individuals choose to have their machines join the network. The research in behavioral science and the factors that lead to the formation of human networks are similar to the factors that govern the formation of P2P networks. So perhaps a better understanding of network science at the human level can help us design P2P networks at the technical level that are more resilient, efficient and useful.

Yochai Benkler brings his background in law to the study of human collaboration, and in particular to the phenomenon he calls peer production. The efficiency and utility of networks such as the Internet make practical what was before perhaps too cumbersome to undertake: the creation of knowledge and content by the unmanaged cooperative contributions of many people. Wikipedia is perhaps the most recognized example of the peer creation of knowledge, but there are many other examples. Benkler believes that we, as a society, should place great value on this sort of collective endeavors, and studied the factors that make it practical and constructive. As an agenda for research, we must move from the rich, empirical observations we have of these systems to more abstract structures that can be studied and modeled. We need more knowledge of human behavior and the foundations of cooperation if we can make the design of peer systems a methodical process.

He made the point that the idea of peer production does not only apply to the production of knowledge, but to the production of physical networks as well. P2P networks, mentioned above, are one example, and another is the creation of multi-hop (mesh) wireless networks out of devices contributed by the collective users. Such a network can only come into existence if the users choose to participate

Jinyang Li, an experimental computer scientist, echoed some of the above comments as she talked about the construction of distributed systems such as P2P systems. In decentralized systems with open membership, it is hard to create a stable system through technical constraints alone. Mechanisms that allow the maintenance of trust, such as identity systems and trust networks, seem to be important social building blocks of workable distributed systems. In balancing centralized and decentralized systems, technologists have observed that while centralized systems can be designed to be *technically* robust and resilient, they are prone to disruption at a higher level, for example legal. The balance should not just be seen in a space of technical tradeoffs, but in a larger space of social and legal considerations.

Judith Olson described her work in understanding successful and unsuccessful human collaboration from the perspective of psychology. Her work is empirical—extensive case studies of actual collaboration, and lab experiments involving humans tasked to solve real problems, has led to models of behavior that predict the outcome of collaboration. Her work provides a checklist of issues that will influence the success of collaboration: whether the intellectual structure of a field encourages competition or cooperation ("are you trying for a Nobel prize"), disjoint vocabularies, unnecessary heterogeneity in the technical tools of collaboration, physical distance, inherent modularity of the problem, and so on.

Her comment about the pragmatic barriers caused by the heterogeneity in the tools for collaboration should be a hint to the computer science community—we have not yet build network applications that can cover up the diversity in our systems and user interfaces. Tools for tele-collaboration are still awkward to use, prone to failure and disruption. We should step up and resolve these issues.

She, like several of our other speakers, used the example of collaborative activity, facilitated by the network, as an important goal. There are different words for the same essential idea: peer production, micro-contributions, distributed human computation, and so on.

Beki Grinter, with a background in computer science, described her research interest as interactive computing: the intersection of computing and humanity. Her research methods are anthropological and sociological. One thesis of her work is that human interaction is deeply local, the Internet is global, and the consequence is that society has now redefined "local". As an example of this phenomenon, she has studied the nature of online religion: the use of the Internet to allow participation at a distance in church services and the social fabric of the church. She has observed that large churches are now importing their services into the U.S. from abroad over the Internet, and these churches are an important part of the social linkage for new immigrants to this country. We both import and export religion over the Internet. Her work, like the work of others in this description, helps to shed light on those factors, both technical and cultural, that make the online social constructs effective and viable. She also observed that one must not be Internet-centric in this sort of analysis; mobile phones are an important part of the technology base that facilitates the creation and maintenance of these "local" groups.

Wendy Chun brings to the discussion the research method of critical theory, which has its roots in literary criticism but more generally invites us to think critically (and methodically) about both the process of interacting with the Internet and the content that is on it, but also to think critically about the framing of the Internet and its social implications. Critical theory reminds us that the act of "reading" is not just a one-way process where the reader is the recipient of the words of the writer. The reader, too, brings to the process a rich context, which participates in the construction of the meaning of that which is read. The reader is an active participant, as much as the writer. Critical theory reminds us, both as readers and writers, to think in a rigorous way about the context we bring to the process. Critical theory also reminds the reader to look "through" the presented media to the context, assumptions and motivations of the creator and the ways in which technology frames our language and actions.

In the context of a technology-rich environment like the Internet, critical theory would ask us to consider what aspects of technology shape our perception of media. Are the two

disconnected, or does the nature of Internet technology shape or limit our reaction to or perception of media? More generally, beyond the study of “media”, come questions about the modes of use of an artifact like the Internet, and the understanding of the local contexts of use, such as the example of online religion mentioned above. Critical theory raises questions regarding the relationship between technology, politics and society more generally.

We should also think critically when we consider language *about* the Internet. The Internet has been represented as a platform that fosters personal freedom and anonymous action, and also as the foundation of a global network of surveillance. We should consider the interplay between technological features and the context we each bring to the conversation in trying to understand such dichotomies.

The tools and discipline of critical theory will be particularly valuable as we try to *design* a different future, and must find ways to describe this future in terms that are both comprehensible from the varied contexts of the readers, and which invite a serious conversation about the values embedded in that future design. Words like “security”, “identity”, or “accountability” must be used with care, as they are rich in context and unshared assumptions.

Jon Kleinberg described the use of tools from graph theory and network algorithms to understand the structure of networks at all levels, from social to ``link and router''. The emergence of the Web as a vast mesh of linked objects triggered a change in his research discipline, since this large corpus allowed empirical study of the networks that have emerged. Certain aspects of these networks, such as their ``small-world'' structures, are well recognized at this point. But such observations point to deeper questions about why networks have this structure (especially networks that are not engineered but which just ``happen''). Does our understanding of these networks, and the nature of the forces that shape them, tell us anything about the formation of emergent networks at lower layers?

Another important topic is the study of online search. Search (and its results) are based on a ranking of sources, and there can be no general and neutral form of ranking. All ranking implies a value structure, which can be implicit or explicit, static or evolving. More generally, the nature of search offers a window into the collective minds of the searchers, and thus the mood of the time. Search, like reading, brings a great deal of user-specific context to the experience.

The emergence of large online social networks is another major shift in the landscape. Social networks, like other sorts of networks, can be analyzed and modeled to see what general properties they possess. One can also ask further questions about online social networks: for example do they provide a new platform for certain sorts of efficient search? Should we be trying to design networks that are optimized for search?

Helen Nissenbaum discussed research rooted in philosophy and ethics. She described an integrated approach formulated specifically for the task of analyzing design for values and approaches to guiding design practice taking values into consideration. The fundamental argument behind these efforts is that values are embodied, embedded, expressed, and reflected in design. Technology is not value-neutral: artifacts have politics, code is law, and technology has agency.

This approach includes “Values in Design” (VID), which generally refers to the study of fine-grain design characteristics for values embodied in them or promoted or afforded by them. Values-at-Play, Value-Sensitive-Design, and Reflective Design include heuristics for taking values into consideration during the design process, that is, for taking values into consideration in the design practice.

Larry Peterson is a computer scientist with interests in systems and networks. Recently he has spearheaded the development of a global platform for experimentation on distributed systems called PlanetLab. His discussion focused on a number of social and legal questions that have arisen as various researchers have built and deployed experiments on PlanetLab. Many experiments involve new applications that directly engage people, which raises the question of whether the deployment of a new application over the Internet constitutes performing an experiment involving human subjects. Some experiments do gather personally identifying information, which means that experimenters must be aware of and sensitive to issues of privacy and dignity. Many computer science experiments are now being reviewed by university internal review boards to confirm that they provide suitable safeguards for the people who might be involved in them. On the other hand, commercial players in the Internet deploy similar systems freely. This begs the question of what limits should be placed on academic researchers, relative to other actors who seek to understand and evolve the Internet.

Deirdre Mulligan, by training a lawyer, discussed both pragmatic and more fundamental issues. With respect to research (as discussed by Larry Peterson), she noted that in some fields such as health care, the research community protected itself legally by having language added to relevant legislation to add protections and exemptions to those doing research. The CS community, only recently coming to understand the deep ways in which their research intersects with social and legal issues, has not in the past sought out these protections. She raised the issue of more active and direct involvement with lawmaking in order to protect our ability to do research.

Paul Ohm provided some additional perspectives on the interplay of law and technology. First, he pointed out that the law (like some other non-technical fields) tends to look at technology as a static thing, but technology evolves rapidly. But noting that fact does not tell us how to model the future trajectory of something like the Internet. His practical experience at the Department of Justice, where he prosecuted criminal behavior, illustrates the range of stakeholders that bring pressure on technology to evolve. Their interests include surveillance and the gathering of forensic evidence. He noted with respect to surveillance, (e.g. observing what is sent over the network), law enforcement, academic researchers and network operators operate under three, very different sets of rules.

ISSUES

The workshop identified numerous issues. We acknowledge that those listed below are diverse in generality, size (of existing body of work), and scope, including some overlap. It is also important to note that disciplines vary in the ways they apply the identical label. Below are a sample of the issues that generated greatest interest and sometimes disagreement among workshop participants.

Security: We can study security from multiple perspectives. What does security mean to network researchers in computer science and engineering? For example, is it the perfection of private communication, or the inspection of communication by third parties to detect attacks? Is it possible to have both outcomes? What does security mean to political scientists, philosophers, or sociologists? What does it mean to the end-user, who must make sense of the rich network context and make decisions about safe and unsafe circumstances? How can we translate these definitions of security across fields? What happens, for instance, when different fields try to analyze an issue using the framework of security, or to justify a position by appealing to the goal of security? What are the tradeoffs between security and other values (e.g., free speech)? Among all the actors (or agents) on the network, including individuals, institutions, and governments, is everyone's security of equal value? And how does the value of security differ among users, institutions, and national governments themselves?

Identifiers and identities: The current Internet perhaps pays too little attention to how actors can and should be identified. For reasons of security (in its many guises, as discussed above), a future network may be designed to provide better tools for identifying users, services and other network components. But this objective in turn raises many important questions with rich social implications. Is there one or many approaches to defining identity? What's at stake in different (technical) choices? Why is identity often posed as a panacea? Can we test this proposition? How should identity online mesh with identity and identities in relation to other spheres of interaction, particularly in the relation of the individual to governments, financial institutions, and other corporate entities, such as merchants and service providers? Can we embed application layer solutions (e.g., eBay reputation systems, or social network identities) in a more general network architecture or design? Are there alternative approaches up and down the layers, and can these approaches successfully migrate? What sorts of collaboration would be effective in exploring this space and posing preferable approaches?

Openness: This is a term that has been used with various meanings in relation to networks (specifically, the Internet). One of the most important meanings, with technical and societal implications, is the capacity for everyone to *join* the network. In the case of the Internet, this means, at least in theory, that anyone is free to implement on their machine the protocols (e.g. TCP and IP) that will let that machine connect to the Internet. This contrasts with a scenario in which the protocols themselves are not open, in which case one would need the permission of a controlling or licensing authority to implement the protocols and/or connect to the network. Another important form of openness is that the users of the Internet are permitted to use any application that they choose: in principle neither the low-level protocols nor the Internet Service Providers limit what the user can choose to do. Important questions follow from this observation. What values are at stake? What does openness mean? What are the trade-offs in open and closed networks or protocols? Open networks may promote organic growth, but also suffer, in the case of malicious actors, from a lack of vetting or barring mechanisms. Open systems therefore often bring up issues of trust and individual accountability and thus identity online (as discussed earlier). Open systems can only invite users to participate. What are the mechanisms and conditions that encourage participation in open systems? Must the design of open networks take into account incentive structures? Systems that are open in the sense that anyone can use them, but closed in the sense that users cannot study the internal design, may force participation at a technical level in ways that the user did not expect. For example, a user of Skype may

be surprised to discover that they are relaying calls. Should such a system be called open?

Trust: A system that limits the opportunity for users to do harm to one another is not the same as one that achieves the same result based on trust. This is the difference between trustworthy technical artifacts (so-called trusted systems, as in secure banking) and technology that enables people to trust one another. How can we incorporate social values in the design of networks that actually promotes and sustains sociality? Do social networks, based on voluntary associations among users, point toward a model for trust networks more generally? Is the trust that pervades such networks durable over time and across platforms and between layers?

Mechanisms of regulation, control, or enforcement: Workshop participants agreed that behavioral constraints and affordances could be embedded in a network environment at various different junctures and layers. For example, they can be built into the technology, expressed in law and policy, through social norms, through incentives structures. The picture is even more complicated than this because even within these different junctures (or modes) there are various possibilities, and network design choices may produce unintended points of control. For example, technical constraints can be imposed at different layers (e.g., physical versus application) or following different strategies (e.g., through post-hoc auditing or front-end vetting). Reputation systems are an example of a socio-technical system that controls behavior, and yet disreputable people game these systems by putting in false scores or starting a new identity once the reputation is bad. Choosing mechanisms and points of control is a technical matter but ethical and political implications should be carefully considered. This issue covers a potentially huge terrain and offers great possibilities for collaboration among different approaches. It can be tackled thematically and also through detailed case studies.

Local and global: The Internet is touted as a global network but its value and meaning is often local (culturally, geographically). This requires study of networks embedded in a variety of contexts. Research might therefore address who appropriates a network for what purposes, and how different economic, social, political, and cultural contexts make such action possible. This research may draw from human-computer interaction, but may also adopt a more anthropological or sociological lens in examining the everyday and local uses of a network. Such insights may inform network design, particularly those attempts to develop a network that is sensitive to local variations in use and deployment. Can network design also build upon the general geographic distribution that tends to characterize social network membership? Can we develop networks that are optimized according to the spatial and social distribution of our likely network associates? Might we adjust our approach to network search, for example, given network information about geographic hotspots for certain query strings? How can or should scientists and engineers take local political contexts into consideration when designing the features of networks and network services?

Privacy: The issue of online privacy covers a universe of questions and issues. Do we agree on the meaning of the term; do we understand what other values it protects and what other values it clashes with? Can we identify technical mechanisms that might mitigate these conflicts? Do we understand how much do we want or need privacy, under any of its several definitions? What opportunities for monitoring and measurement do network design decisions create? Are privacy concerns inherent in the architecture of the network, or do secondary technologies (such a mass storage for data retention) play

a more important role? Whom do network architectures empower to monitor user behavior and information? The current architecture of the Internet, for instances, puts Internet Service Providers in a uniquely powerful position to monitor all the activity of its subscribers. What are the minimal features of a network that commercial service providers require (e.g., location-based IP)? How can we break apart information that we would find desirable for the network to reveal from that which it must necessarily produce?

Conditions of participation (related to several other issues above): This rather obscure title refers to a set of questions about expectations network users may reasonably have about the powers they have when they join a network and, conversely, what users may experience as part of normal participation in a network. To what kinds of activities are users legitimately expected to submit as a condition of participation? Specifically, researchers may wish to study whether traditional notions of real property have analogs in virtual worlds like Second Life. Do users have a right to object to unsolicited email as long as they have signed up for email, or to having their systems used as "zombies," or having search "bots" visit their websites? Could we imagine a network in which only consensual associates could exchange packets? To what degree do the conditions of participation of social networks already follow this model?

Motivations for participation: Why do people join and participate in a network? Noshir Contractor's work on the creation, maintenance, dissolution, and reconstitution of networks focused precisely on this role of motivations. Can we design networks that take into account the various motivations of their users? What defines a successful network from this perspective? Should networks adjust to users' motivations, and if so, how might networks determine or allow users to specify their respective motivations? What other criteria figure in the success of a network? Judith Olson's work on remote scientific collaborations, for instance, delineates the myriad factors that may obtain in pursuits supported by the network. On the other hand, what are the motivations for voluntary, collaborative online activities? What, for instance, are the social motivations of commons-based production on the Internet? If the degree to which certain network structures enable production of this sort has become clearer, there still remains much to explore about the micro-foundations of cooperation and collaborative production in general. For instance, can we develop networks that promote cooperation through solidarity rather than by reward or punishment? Can network design decisions (e.g. the nature and degree of revelation about identity) help cultivate voluntary participation and behavior that conforms to the norms of the community without recourse to punitive mechanisms or technical restrictions?

THEMES

Certain ideas seemed to crop up across discussion of several of the issues and case studies. They seemed more appropriately to be understood as themes, rather than as issues.

Visibility and transparency: The concepts of visibility and transparency are salient in two respects. The first we might describe as individual exposure and self-presentation on a network—that is the degree to which users can or must reveal information about themselves at different layers of a network (MAC address, IP address, application account, etc.). Trust, for instance, often requires some degree of exposure, as in reputation systems or social networking sites. Visibility in this sense may also refer to

the ability to communicate or reveal one's motivation for participation or collaboration (as discussed above). But these concepts have another meaning in a related context: the ability (or not) to examine the inner workings of a network design, protocol, or application. Take, for example, the design decision to allow Web users to view page sources, contrasted with the usually invisible algorithms that establish rank order for search results. Or technologies or software that are open, (in the terminology of the above discussion), and thus leave users free to tinker. Transparency of this sort has emerged as a political value among certain technologists and stakeholders, who argue that open access to software is an ethical virtue on the same level as the sharing of intellectual concepts.

Incentives: Understanding the structure of incentives can shed light on relationships between architecture or design, on the one hand, and behavior or outcomes, on the other. An integrated study of existing incentives through empirical, ethnographic, historical, etc. methods is an important way of understanding what is already in place. One may also wish to disrupt, shape, or take advantage of naturally occurring incentive structures in order to achieve certain ends, for example, security or privacy, in the context of networks or network transactions. How might we determine the generalizability of an incentive structure of a specific network or application? Are incentive structures from one network or application appropriate, legitimate, or effective in another?

Networks as Experimental Environments: The Internet and Web have emerged as hugely important environments for studying individual and social behavior. There is plenty of scope for thinking about the needs and requirements of research online. Network engineers are also engaged in experimentation in such activities as PlanetLab and potentially GENI inspired systems. What is the relationship between those who intentionally and inadvertently use these systems and the designers and developers of these systems? Must networks users consent to participation? Is there something importantly different in the responsibilities designers and engineers have to users when the systems they put out for use are "experimental?" To what ethical code should academic network researchers hold themselves, and how might such a code compare to the one, if any, that obtains in commercial research? How can network engineers best communicate the value of their research to those who are likely to be involved in the experiment or later affected? Or, alternatively, if large-scale experimentation is simply not possible with consensual parties, should we set a grand challenge for network engineers and designers which asks that they determine how to do research on networks that itself solves the problem of network monitoring?

INTEGRATED CASE STUDIES

There is an important place for integrated case studies. In general, these would be rich multidisciplinary studies of events, mechanisms, applications, architectures, etc. relating to networks.

Web search: One example discussed at the workshop was search, search in networks (social search, web search), including, for example, algorithm design and privacy. Why do we take for granted the current model? Are they the best we can manage? Must search algorithms tuned through machine learning be opaque to policy analysis? Is this a problem for values in design?

Technology adoption by government agencies: Under what circumstances do agencies view technology (e.g. RFID tags in passports) as a procurement or policy question? What determines the perspective different agencies take, and what are the effects of this decision on the primacy of values in the adoption process? Which procedures open up the most productive spaces for discussion of values?

Standards setting: Standard setting is an important site for determining socially relevant design features. There is often little reward for outsiders to participate in standard settings meetings. Why is this so and what about these meetings dissuades outside participation? How can outside stakeholder enter into or contribute to the debate? What are the social, bureaucratic, and epistemological conditions of participation?

*Self-organizing wireless network*s: We can imagine a study of the deployment of a wireless network in a municipality based on multi-hop or mesh technology that would call upon engineers, social scientists, and policymakers to shape the landscape of successful deployment. Researchers would consider the significance of local context and specific cultural, political, and motivational triggers.

Engineers' response to assertions about values: How do engineers articulate the values at play in their selection of and approach to a technical problem? How do they respond to the assertion that values figure in their work? Do they resist this idea? Under what conditions do engineers reflect on values in design, and how might these reflections lead to different design choices?

FOR FURTHER READING: METHODS OR THEORETICAL FRAMEWORK

This sample of books and papers written or recommended by workshop attendees will provide a deeper and broader window into the range of research methods and topics discussed here.

Books:

Behavioral Science

Monge, P, and N. Contractor, Theories of Communication Networks, Oxford University Press, 2003

Analytic, but also ethnographic:

Miller, D. and Slater, D., *The Internet: An Ethnographic Approach*. Berg, Oxford, England, 2000.

Legal:

Benkler, Y., The Wealth of Networks: How Social Production Transforms Markets and Freedom Yale University Press, 2007

Economics

Jackson, M. Social and Economic Networks. Princeton University Press, 2008.

Critical theory:

Chun, W.H.K., Control and Freedom: Power and Paranoia in the Age of Fiber Optics, MIT Press 2007

Historical approaches: not about the network per se, but about thinking about the relationship between infrastructure and society.)

Hughes, T., Human-built World: How to Think about Technology and Culture, University of Chicago Press, 2004

Nye, D., *Technology Matters: Questions to Live With*. MIT Press, Cambridge MA, 2007.

Nye, D.E., *Electrifying America: Social Meanings of a New Technology*. MIT Press, Cambridge, MA, 1990.

Rosenberg, N., *Inside the black box: technology and economics*. Cambridge University Press, Cambridge, UK, 1982.

Papers and other publications:

Analytic:

M. Flanagan, D. Howe, and H. Nissenbaum, "Values in Design: Theory and Practice" In Information Technology and Moral Philosophy Jeroen van den Hoven and John Weckert (eds.) Cambridge: Cambridge University Press, 2008

A. Barth, A. Datta, J. Mitchell, and H. Nissenbaum, "Privacy and Contextual Integrity: Framework and Applications," Proceedings of the IEEE Symposium on Security and Privacy, May 2006 (Showcased in "The Logic of Privacy," The Economist, January 4, 2007)

H. Nissenbaum, "Where Computer Security Meets National Security," Ethics and Information Technology, Vol. 7, No. 2, June 2005, 61-73 (Also, In Cybercrime, Eds Jack Balkin, James Grimmelmann, Eddan Katz, Nimrod Kozlovski, Shlomit Wagman and Tal Zarsky, New York, NYU Press, 2007

H. Nissenbaum, "Will Security Enhance Trust Online, or Supplant it?" In R. Kramer and K. Cook (eds.) Trust and Distrust Within Organizations: Emerging Perspectives, Enduring Questions, Russell Sage Publications (2004): 155-188

L. Introna and H. Nissenbaum, "Shaping the Web: Why the Politics of Search Engines Matters" The Information Society, 16(3):1-17, 2000

Law:

Schwartz, A.. Mulligan, D., Monda, I., Storing Our Lives Online: Expanded Email Storage Raises Complex Policy Issues, *I/S: A Journal of Law and Policy for the Information Society*

Mulligan, D., Reasonable Expectations in Electronic Communications: A Critical Perspective on the Electronic Communications Privacy Act," 72 *Geo. Wash. L. Rev.* 1557 (2004).

Economics:

Lian Jian and Jeffrey K. MacKie-Mason (2008), "Why Share in Peer-to-Peer Networks?", International Conference on Electronic Commerce (ICEC'08), Innsbruck, Austria, 19-22 August 20 Lian Jian and Jeffrey K. MacKie-Mason (2008), "Why Share in Peer-to-Peer Networks?", International Conference on Electronic Commerce (ICEC'08), Innsbruck, Austria, 19-22 August 20

Social Theory:

Olson, J. S., Hofer, E., Bos, N., Zimmerman, A., Olson, G. M., Cooney, D., and Faniel, I. (2008). A theory of remote scientific collaboration. in G. M. Olson, A. Zimmerman, and N. Bos (Eds.) *Scientific Collaboration on the Internet.* Cambridge, MA: MIT Press.

Empirical:

Qualitative:

Olson, J. S., Ellisman, M., James, M., Grethe, J. S., Puetz, M. (2008) Biomedical Informatics Research Network (BIRN) in G. M. Olson, A. Zimmerman, and N. Bos (Eds.) *Scientific Collaboration on the Internet.* Cambridge, MA: MIT Press.

Quantitative:

Bos, N., Shami, N. S., Olson, J. S., Cheshin, A., & Nan, N. (2004) In-group/out-group effects in distributed teams: An experimental simulation. *Proceedings of Conference on Computer Supported Cooperative Work.* 429-436.

Nan, N., Johnston, E. and Olson, J. S., Unintended consequences of collocation: using agent-based modeling to untangle effects of communication delay and in-group favor. *Computational & Mathematical Organization Theory*. Volume 14, Number 2 / June, 2008

Systems building:

Grinter, R.E., Edwards, W.K. Edwards, Newman, M.W. and Ducheneaut, N. The Work to Make a Home Network Work *European Conference on Computer-Supported Cooperative Work*, Springer, Paris, France, 2005, 469-488.

Chetty, M., Sung, J.-Y. and Grinter, R.E., How Smart Homes Learn: The Evolution of the Networked Home and Household *Proc. 9th International Conference on Ubiquitous Computing (Ubicomp 07)*, Springer-Verlag (2007), 127-144.

Shehan, E. and Edwards, W.K., Home Networking and HCI: What Hath God Wrought? *Proc. ACM Conference on Human Factors in Computing Systems (CHI 07)*, ACM Press (2007), 547-556.

APPENDIX I

Workshop Participant Bios
Co-chairs:

David Clark is a Senior Research Scientist at the MIT Computer Science and Artificial Intelligence Laboratory, where he has worked since receiving his Ph.D. there in 1973. Since the mid 70s, Dr. Clark has been leading the development of the Internet; from 1981-1989 he acted as Chief Protocol Architect in this development, and chaired the Internet Activities Board. His current research looks at re-definition of the architectural underpinnings of the Internet, and the relation of technology and architecture to economic, societal and policy considerations. He is helping the U.S. National Science foundation organize their Future Internet Design program. Dr. Clark is past chairman of the Computer Science and Telecommunications Board of the National Academies, and has contributed to a number of studies on the societal and policy impact of computer communications. He is co-director of the MIT Communications Futures Program, a project for industry collaboration and coordination along the communications value chain.

Helen Nissenbaum is Professor of Media, Culture and Communication and of Computer Science at New York University, where she is also Faculty Fellow of the Information Law Institute. Her areas of expertise include social, ethical, and political implications of computing and information technologies. Grants from the National Science Foundation, Air Force Office of Scientific Research, Ford Foundation, and U.S. Department of Homeland Security have supported research projects on privacy, trust online, security, intellectual property, and several projects investigating political values in information systems, including search engines, video games, and facial recognition systems. She has produced three books and over 40 research articles, which have been published in scholarly journals of philosophy, political philosophy, law, media studies, information studies, and computer science. Nissenbaum holds a Ph.D. in philosophy from Stanford University and, before joining NYU, served as Associate Director of Princeton University's Center for Human Values.

Participants

Yochai Benkler is the Berkman Professor of Entrepreneurial Legal Studies at Harvard, and faculty co-director of the Berkman Center for Internet and Society. Before joining the faculty at Harvard Law School, he was Joseph M. Field '55 Professor of Law at Yale. He writes about the Internet and the emergence of networked economy and society, as well as the organization of infrastructure, such as wireless communications. In the 1990s he played a role in characterizing the centrality of information commons to innovation, information production, and freedom in both its autonomy and democracy senses. In the 2000s, he worked more on the sources and economic and political significance of radically decentralized individual action and collaboration in the production of information, knowledge and culture. His work traverses a wide range of disciplines and sectors, and is taught in a variety of professional schools and academic departments. In real world applications, his work has been widely discussed in both the business sector and civil society. His books include The Wealth of Networks: How social production transforms markets and freedom (2006), which received the Don K. Price award from the American Political Science Association for best book on science, technology, and

politics, the American Sociological Association's CITASA Book Award an outstanding book related to the sociology of communications or information technology, the Donald McGannon award for best book on social and ethical relevance in communications policy research, was named best business book about the future by Stategy & Business, and otherwise enjoyed the gentle breath of Fortuna. In civil society, Benkler's work was recognized by the Electronic Frontier Foundation's Pioneer Award in 2007, and the Public Knowledge IP3 Award in 2006. His articles include Overcoming Agoraphobia (1997/98, initiating the debate over spectrum commons); Commons as Neglected Factor of Information Production (1998) and Free as the Air to Common Use (1998, characterizing the role of the commons in information production and its relation to freedom); From Consumers to Users (2000, characterizing the need to preserve commons as a core policy goal, across all layers of the information environment); Coase's Penguin, or Linux and the Nature of the Firm (characterizing peer production as a basic phenomenon of the networked economy) and Sharing Nicely (2002, characterizing shareable goods and explaining sharing of material resources online). His work can be freely accessed at benkler.org.

Noshir Contractor is the Jane S. & William J. White Professor of Behavioral Sciences in the School of Engineering, School of Communication and the Kellogg School of Management at Northwestern University, USA. He is the Director of the Science of Networks in Communities (SONIC) Research Group at Northwestern University. He is investigating factors that lead to the formation, maintenance, and dissolution of dynamically linked social and knowledge networks in communities. Specifically, his research team is developing and testing theories and methods of network science to map, understand and enable more effective networks in a wide variety of contexts including communities of practice in business, science and engineering communities, disaster response teams, public health networks, digital media and learning networks, and in virtual worlds, such as Second Life. His research program has been funded continuously for over a decade by major grants from the U.S. National Science Foundation with additional funding from the U.S. National Institutes of Health (NIH), U.S. National Aeronautics and Space Administration (NASA), the Rockefeller Foundation, and the MacArthur Foundation. Professor Contractor has published or presented over 250 research papers dealing with communicating and organizing. His book titled Theories of Communication Networks (co-authored with Professor Peter Monge and published by Oxford University Press in English and scheduled to be published by China Renmin University Press in simplified Chinese in 2008) received the 2003 Book of the Year award from the Organizational Communication Division of the National Communication Association. He is the lead developer of CIKNOW (Cyberinfrastructure for Inquiring Knowledge Networks On the Web), a socio-technical system to enable networks among communities, as well as Blanche, a software environment to simulate the dynamics of social networks.

Wendy Hui Kyong Chun is Associate Professor of Modern Culture and Media at Brown University. She has studied both Systems Design Engineering and English Literature, which she combines and mutates in her current work on digital media. She is author of _Control and Freedom: Power and Paranoia in the Age of Fiber Optics_ (MIT, 2006), and co-editor of _New Media, Old Media: A History and Theory Reader_ (Routledge, 2006). She has been a fellow at the Radcliffe Institute for Advanced Study at Harvard, a Wriston Fellow at Brown, and Visiting Associate Professor in the History of Science Department at Harvard. She serves on numerous advisory boards of journals and is currently a co-PI on a Mellon Planning Grant to transform Visual Culture Studies. She

is also completing a monograph entitled _Programmed Visions: Software, DNA, Race_ (forthcoming MIT, 2010).

Rebecca E. Grinter (Beki) is an Associate Professor of Interactive Computing in the College of Computing at the Georgia Institute of Technology. Her primary research interests lie at the intersection of computing and humanity, exploring the human-centered problems of technology production and consumption. Her research has been published in Human Computer Interaction, Computer Supported Cooperative Work, Software Engineering, Security, and most recently Networking conferences. Before joining the faculty at Georgia Tech, she was a Member of Technical Staff at Bell Laboratories, Lucent Technologies (and briefly AT&T Bell Laboratories), and a Member of Research Staff in the Computer Science Laboratory of Xerox PARC. She holds a Ph.D. & M.S. in Information and Computer Science from the University of California, Irvine, and a B.Sc. (Hons) in Computer Science from the University of Leeds.

Jon Kleinberg is a Professor in the Department of Computer Science at Cornell University. His research focuses on issues at the interface of networks and information, with an emphasis on mathematical models for social and information networks, and algorithms for problems in search, data analysis, and network optimization. He is a member of the National Academy of Engineering and the American Academy of Arts and Sciences, and serves on the Computer Science and Telecommunications Board of the National Academies and the NSF CISE Advisory Committee. He has received a MacArthur Foundation Fellowship, Packard Foundation Fellowship, and Sloan Foundation Fellowship, NSF CAREER and ONR Young Investigator Awards, the Nevanlinna Prize from the International Mathematical Union, and the National Academy of Sciences Award for Initiatives in Research.

Jinyang Li has been an assistant professor in computer science at New York University since 2006. She is interested in distributed systems and networks, especially how to build reliable large scale systems. She received the NSF CAREER award in 2008. Her group is currently working on making peer-to-peer systems more trustworthy and applicable to a variety of applications such as censorship circumvention and cooperative storage systems. She received a Ph.D. from MIT in 2005 and was a postdoctoral researcher at UC Berkeley from 2005-2006. While at MIT, she worked on scalable lookup protocols for large distributed systems and multihop wireless routing.

Deirdre K. Mulligan comes to the UC Berkeley School of information from the Berkeley School of Law, where she was a clinical professor of law and the director of the Samuelson Law, Technology & Public Policy Clinic. She served previously as staff counsel at the Center for Democracy & Technology in Washington. Through the clinic, Mulligan worked to foster the public's interest in new computer and communication technology by engaging in client advocacy and interdisciplinary research, and by participating in developing technical standards and protocols. The clinic's work has advanced and protected the public's interest in free expression, individual privacy, balanced intellectual property rules, and secure, reliable, open communication networks. Mulligan writes about the risks and opportunities technology presents to privacy, free expression, and access and use of information goods. Professor Mulligan holds B.A. from Smith College (1988) and J.D. from Georgetown University Law Center (1994).

Paul Ohm joined the faculty of the University of Colorado Law School in 2006. He specializes in computer crime law, information privacy, criminal procedure, and

intellectual property. Prior to joining Colorado Law he worked for the U.S. Department of Justice's Computer Crime and Intellectual Property Section as an Honors Program trial attorney. Professor Ohm is a former law clerk to Judge Betty Fletcher of the U.S. Ninth Circuit Court of Appeals and Judge Mariana Pfaelzer of the U.S. District Court for the Central District of California. He attended the UCLA Law School where he served as Articles Editor of the UCLA Law Review and received the Benjamin Aaron and Judge Jerry Pacht prizes. Prior to law school, he worked for several years as a computer programmer and network systems administrator, and before that he earned undergraduate degrees in computer science and electrical engineering.

Judith Olson is the Donald Bren Professor of Information and Computer Sciences, with appointments also in the Paul Merage Business School and the School of Social Ecology at the University of California at Irvine. She was just recently the Richard W. Pew Professor of Human-Computer Interaction at the University of Michigan. She was a professor in the School of Information, the Business School, and the Psychology Department. She got her Ph.D. in Psychology at the University of Michigan then held a postdoctoral fellowship at Stanford University before returning to Michigan as a faculty member. Except for three years at Bell Labs and a year at Rank Xerox Cambridge, UK, and now at UC Irvine, she had been at Michigan her entire professorial life. Her research focuses on the technology and social practices necessary for successful distance work, encompassing both laboratory field study methods along with agent based modeling. She has served on a number of editorial boards and panels for both the National Research Council and the National Science Foundation. In 2001, she was one of the first seven inductees into the CHI Academy. In 2006 she and her husband Gary were awarded the 2006 CHI Lifetime Achievement Award.

Larry Peterson is the Robert E. Kahn Professor of Computer Science at Princeton University. He is also Department Chair and Director of the Princeton-hosted PlanetLab Consortium. Peterson is co-author of the best selling networking textbook Computer Networks: A Systems Approach (4e),* and chaired the initial planning efforts that led to NSF's GENI Initiative. His research focuses on the design and implementation of networked systems.
Professor Peterson recently served as Editor-in-Chief of the *ACM Transactions on Computer Systems*, he has been on the Editorial Board for the *IEEE/ACM Transactions on Networking* and the *IEEE Journal on Select Areas in Communication*, and he has served as program chair for SOSP, NSDI, and HotNets. Peterson is a Fellow of the ACM. He received his Ph.D. degree from Purdue University in 1985.

Ellen W. Zegura received the B.S. degree in Computer Science (1987), the B.S. degree in Electrical Engineering (1987), the M.S. degree in Computer Science (1990) and the D.Sc. in Computer Science (1993) all from Washington University, St. Louis, Missouri. Since 1993, she has been on the faculty in the College of Computing at Georgia Tech. She served as Interim Dean of the College for six months in 2002. From February 2003 to 2005, she was an Associate Dean, with responsibilities ranging from Research and Graduate Programs to Space and Facilities Planning. Starting in August 2005, she has chaired the School of Computer Science of the College of Computing. She is the proud mom of two girls, Carmen (born in August 1998) and Bethany (born in May 2001), whose pictures had never made it onto the web until the advent of photo sharing web sites. Prof. Zegura's research work concerns the development of wide-area (Internet) networking services and, more recently, mobile wireless networking. Wide-area services are utilized by applications that are distributed across multiple administrative domains

(e.g., web, file sharing, multi-media distribution). Her focus is on services implemented both at the network layer, as part of network infrastructure, and at the application layer. In the context of mobile wireless networking, she is interested in challenged environments where traditional ad-hoc and infrastructure-based networking approaches fail. These environments have been termed Disruption Tolerant Networks.

Scribes

Solon Barocas is a doctoral student in the Department of Media, Culture, and Communication and Student Fellow at the Information Law Institute at New York University. His research focuses on the implications of predictive technologies, such as profiling and personalization, in news media, politics, national security, and social welfare provision. Solon has worked with the Stanhope Center for Communication Policy and Research, the Center for Global Communication Studies, the Berkman Center for Internet and Society, and the Russell Sage Foundation. He obtained his MSc in International Relations from the London School of Economics and graduated from Brown University with a BA in Art-Semiotics and International Relations, where he worked on the Information, Technology, War, and Peace Project at the University's Watson Institute for International Studies.

Erika Shehan Poole is a PhD student in the Human-Centered Computing program at Georgia Tech. Her research interests broadly focus on how end-users make sense of networked computing in domestic settings and in more advanced ubiquitous computing environments. Her dissertation work focuses on understanding the causes of digital complexity in the home, as well as how householders seek help from third parties in overcoming these difficulties. Erika holds a BS degree in computer science from Purdue University and an MS in computer science from Georgia Tech. She is a member of ACM and IEEE, and is actively interested in research ethics and public policy issues related to computing.

GENI Project Office (GPO) participants

Brig "Chip" Elliott is the Principal Investigator and Project Director and Chief Engineer for the GENI Project Office. As Project Director, he will assume overall responsibility for timely completion of GENI's planning, including development and management of the GPO itself and its dependent working groups and sub-contracts. Chip has nearly thirty years of experience in leading large, technically-challenging projects, both in industry and in academia, with particular expertise in routers, wireless Internet technology, mobile "ad hoc" networks, quality of service issues, advanced optical techniques, and novel routing architectures. As Chief Engineer at BBN Technologies, Chip has led the design and successful implementation of secure, mission-critical networks based on novel technology for the United States and its allies, with aggregate value above $3 billion. From 2001 to 2006, Chip served as Principal Investigator for the DARPA Quantum Network, in which he led the design and build-out of the world's first quantum cryptography network. It became fully operational in October 2003 in BBN's laboratory, and since May 2004 has operated non-stop between Harvard, Boston University, and BBN.

Aaron Falk is GPO's Engineering Architect and Lead System Engineer. Aaron works closely with the community to ensure that GENI's end-to-end architecture is fully defined, that it satisfies the community's research requirements.

Aaron is a degreed system engineer with a strong background in building and managing networking projects. An IETF leader for over ten years, Aaron managed the DCCP, PILC, and TCPSAT working groups as they developed standards-track Internet protocols and advisory documents. He received his BS, Electrical Engineering in 1992 and MS, System Engineering in 1994 from University of Maryland College Park, MD.

APPENDIX II

Agenda
Wednesday September 23

5:00–9:00 PM

Presentation on the NetSE program
Ellen Zegura, Chair, NetSE Council

Co-chair introductions, review of meeting objectives, scope, and candidate report outline
Helen Nissenbaum and David Clark

Thursday September 24

8:30-9:00 Breakfast

9:00-noon Extended introductions and identification of issues

9:00-10:15 Contractor, Olson, Grinter, Chun, Kleinberg

10:15-10:45 Break

10:45-12:00 Peterson, Li, Benkler, Ohm, Burk, Mulligan

12:00-1:30 Lunch (provided)

1:30-5:00 Discussion of issues and case studies

1:30-3:00 Identify key issues for report

3:00-3:30 Break

3:30-5:00 Charge to report writers and Conclusion