Making Space for Values: Communication & Values Levers in a Virtual Team

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ABSTRACT

The infrastructure underlying the Internet continues to evolve, with ramifications for not only the technical protocols that govern network functions, but also implications for social, economic, and legal issues. This paper uses ethnography to examine how and why ethical and social issues arise during the design of Named Data Networking, a new approach to Internet architecture. By focusing on communications modes among a distributed team of network architects, it investigates how particular modes may enable or constrain *values levers:* practices which encourage discussion of values during design. While face-to-face retreats encourage interdisciplinary work and subsequent discussion of moral values, mediated modes of communication tend to constrain values levers. These limitations may be overcome by encouraging communications techniques such as scenarios and demos, which can be used in both face-to-face and mediated settings.

Author Keywords

Values in design; Internet architecture; technology ethics; virtual community formation, ethnography

ACM Classification Keywords

K.4.2 Social Issues.

General Terms

Human Factors; Design.

INTRODUCTION

The Internet transformed the ways in which individuals, communities, and organizations present and transmit knowledge. The infrastructure underlying the Internet continues to evolve, with ramifications for not only the technical protocols that govern the way it functions, but also implications for social, economic, and legal issues. Internet protocols affect debates about values such as

privacy and autonomy, intellectual property, and cybersecurity, as well as the basic performance and reliability of Internet services. Engineers making technical choices weigh moral values when working on Internet infrastructure both consciously and unconsciously. *Values* can be defined as "what a person or group of people consider important in life" [9:349]. They are significant goals ascribed to by individuals or a group. Moral values are often broadly construed under the categories of social justice, welfare, and virtue, and stem from a variety of ethical perspectives including deontology, utilitarianism, and virtue ethics. Decades of research in engineering ethics, science and technology studies, and information science have made the point that values like *privacy*, *consent*, or *openness* can be enabled by a system's features or rules, and are partially shaped by technical choices made during the design process [1,3,9,10].

Previous research has emphasized that the structures and practices of design teams affect the values expressed and debated during design [8,12,28]. One way that this occurs is through *values levers*: work practices that open new conversations about values during technical work, and encourage consensus around those values as design criteria [29]. Previous research on values levers focused primarily on co-located teams, documenting design practices that occurred primarily in a face-to-face setting. Little is known about how values emerge in the discussions of distributed teams, or how values levers are enabled or constrained in virtual groups mediated by information and communication technologies (ICTs).

This paper begins this discussion by analyzing data gathered from an ethnography of a virtual group. It addresses the following research questions:

1. What communications modes and work practices encourage values levers on a virtual team?

2. What communications forms and work practices constrain values levers on a virtual team?

We address these questions through a qualitative analysis of ethnographic field notes and meeting transcripts gathered during a year as embedded researchers in the Named Data Networking project (NDN). The NDN team is geographically distributed over twelve campuses

throughout the United States. The structures and practices of this team are quite different from those of traditional design laboratories because of its primarily virtual nature. This project explores whether the virtual nature of the NDN project impacts the emergence of values levers.

We begin the paper with background on the NDN project, and the study of social values within that project. We then discuss the links between social values and communication practices in the values in design and virtual teams literatures. We describe our method and data analysis before proceeding to findings, discussion, and conclusions.

BACKGROUND

Considering values during design of a new technology, instead of after deployment, is a growing area of interest in technology ethics [8,15,17,27]. This project is an investigation of, and an intervention into, values in the Named Data Networking project: a pioneering approach to redesigning how the Internet operates.

Named Data Networking

The Named Data Networking project is a multi-campus research collaboration funded by the National Science Foundation as part of the NSF's Future Internet Architecture program. The team is led by Principle Investigators from PARC and the University of California, Los Angeles, and incorporates networking research faculty and students from eight other institutions including University of Arizona; University of California, Irvine; University of California, San Diego; Colorado State University; University of Illinois, Urbana-Champaign; University of Memphis; Washington University; and Northeastern University.

The goal of the NDN project is to research, design, and evaluate a replacement for the current foundational layer of the Internet, known as Internet Protocol (IP). IP relies on addresses to route packets across a global network. Addresses are assigned to hosts across the network by domain registrars, and data is retrieved according to *where* the data is located. NDN changes this equation by making hosting of data irrelevant. Instead, content can be cached anywhere in the network, and is retrieved by the *name* of the data rather than its location in the network [14].

In more detail, a consumer sends an Interest packet specifying the name of data they wish to receive. The interest packet is forwarded by a series of routers, each seeking a node which has the requested data. Each router remembers only the last interface from which it received the request using a Pending Interest Table (PIT), leaving a single hop-by-hop trail to the data consumer. When the interest packet reaches a router which has the requested data, the router sends a data packet back along this trail, consuming the interest 'breadcrumbs' along the way. Routers can cache copies of the data packet in their memory, creating multiple copies of data to satisfy potential future interests across the web.

The data packet is made up of the name of the data, the content, and a signature verifying the producer of the data using a producer's private key. In this way, NDN also builds security features directly into packets. Each packet must be signed with its producer's public key, thereby verifying its source [14]. This key securely links the name to the data, authenticating that the data is what it purports to be. It ensures that a consumer can trust the data they receive, regardless of where it was stored.

The Values in NDN Project

The NDN team is segmented into groups performing research in routing and forwarding, application development, security, and information theory. Working alongside these groups is the Values in NDN project. The Values in NDN project is funded to analyze and comment on the values and impacts of technical NDN changes during the research and design phases of the project. With its emphasis on packet provenance, multiple copies, and Internet-wide caching, NDN produces many changes for technical aspects of the Internet, from routing to security to application design. These changes in turn will produce changes for the social aspects of the Internet, including privacy, law enforcement, governance, and political economy. If we take seriously the notion that technical protocols, expressed in *code*, shape rights, behavior, and governance [21], then analyzing how NDN would alter such codes is an important task.

Before code and technical infrastructure can shape social impacts, collective values – what a group considers important – shape the design of that infrastructure [11,17,29]. The intersection of information systems and values is an important question facing both social scientists and engineers. The design of technology is never value-neutral, and questions of what, and whose, values are embodied in software and system architecture have been controversial for decades [2,11]. Affordances built into a technology may privilege some uses (and users) while marginalizing others, highlighting values as a critical if sometimes invisible influence on the design process. Internet architecture, in particular, carries a number of questions about values in its design. Challenges and social debates like network neutrality [20], wiretapping backdoors [18], and cybersecurity [4] would all be affected by the implementation of Named Data Networking. Historically, these issues have been examined and addressed after networks were built and running [6]. The Values in NDN project seeks to explore values at the point of design, to make explicit social considerations a part of design practice.

To explore the ways in which values manifest in, and are challenged and changed by network architecture, the Values in NDN project employs a theoretical framework based in

values in design or *value-sensitive design* [9,17]. These traditions explore the ways in which moral values become part of technological artifacts. Values are understood to contribute to technology design, to shape system affordances which in turn mediate technology use, and to pervade the social contexts which technology mediates [16,30]. Values are also personal, shaping how people evaluate their behaviors, respond to others, and make judgments [24,25].

Tying Values to Communication: Values Levers

Values change from personal concerns of individuals to concerns of teams or collectives through social, communicative processes [26]. In an ethnography of software design culture, Coleman [5] describes how shared values are learned among hackers through processes of both acculturation (gradual learning of collective values) and punctuated crisis (events which force groups to debate and reconcile conflicting values). Both modes rely upon ongoing communication among a group. In similar investigations into how values surface in design settings, the authors have described the role of values levers in encouraging new conversations about values during design and enabling designers to consciously embed values in technologies [29]. Such levers encourage the acculturation of group members into a set of collective values, as well as spark crises in which teams discuss and debate values. Values levers help start conversations about values, enable designers to discuss values as part of their technical practice, and ultimately contribute to values-based design decisions and affordances in the technology under development [29].

Values levers are work practices (something that a team does together as part of design), but they are dependent upon communication. Modes of communication can enable or constrain values levers; and values levers in turn enable or constrain values-based design. The relationship between communication, levers, and values is illustrated in Figure 1.
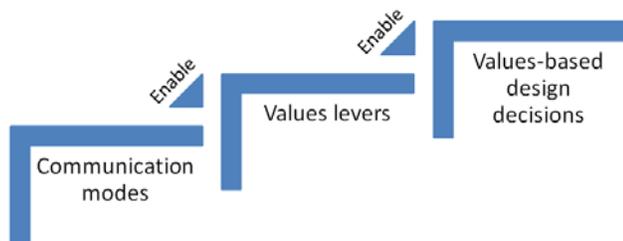
Figure 1. Relationship between communication, levers, and values.

Values levers discovered in the first author's previous study of a co-located design group included:

- *Working on interdisciplinary teams*: when technologists worked with statisticians, social scientists, or ecological scientists, *data* (rather than software or infrastructure)

became a primary topic of conversation. This attention to data in turn surfaced values concerns about data representation, fairness, and surveillance and privacy.

- *Gaining funding*: when projects gained funding, they expanded their teams, leading to more interdisciplinarity and broader conversations about values.

- *Experiencing self-testing*: when technologists used their own systems to test for bugs or reliability, they also experienced their software as a user. When individuals experienced concerns about privacy and consent, they raised these in group discussion.

- *Internalizing leader and team member advocacy*: both leaders and concerned team members could be powerful advocates for values, by raising values as legitimate topics of conversations, and also by imposing reporting procedures that explicitly asked designers to consider the values impacts of their research.

- *Designing around constraints*: the imposition of ethical constraints or mandates by leaders and team members led to new project creativity, as team members responded with new privacy protection measures and creative consent mechanisms [29].

Together, this set of work practices functioned as values levers by highlighting contradictions in the design space, materializing the interpretive flexibility of the technologies under construction, and inspiring simultaneous moral and technical imagination. The Values in NDN project asks whether there are similar values levers in the virtual design setting of the NDN project.

Values Levers & Communication in Virtual Teams

Virtual teams such as the distributed NDN research group have a number of structural differences when compared to traditional teams, which may complicate the operation of values levers during technology design processes.

Virtual teams face challenges while forming a shared context and shared norms. There is often less interpersonal familiarity and friendship on virtual teams [13]. But because of this distance, virtual teams are often less homogenous than in-person teams [13]. This might, for example, encourage interdisciplinarity as a values lever.

The technological mediation necessary for distributed teams to operate creates its own challenges to values levers. Technological mediation is needed to facilitate boundary-crossing interactions, which in turn can facilitate trusting relationships [22]. But reduction in social cues due to asynchronous communication can be a challenge in mediated teams. So too can information sharing. Mediated teams often suffer from unevenly distributed information (due to exclusion), unevenly weighted information (due to misunderstandings about salience), and information that resists distribution (e.g. qualitative or tacit information) [13]. These problems can be mitigated by choosing richer technologies, or by adapting existing technologies to the

purposes of the team. Research by Leenders et al. stipulates:

> …in general it has been found that [electronic communication] is less preferred by team members for tasks that require creativity and deal with complex problems. Computer-mediated [new product development] teams tend to take longer to complete a complex creative task, and when holding time constant, engage in less communication [19:83].

Values-related discussions and tasks, which frequently engage with complex problems, may therefore suffer as a result of technologically-mediated communication. However, Leenders et. al write:

> …virtual teams that use periodic face-to-face encounters or information technologies that simulate face-to-face contact, or both are more likely to be creative as a team [19:84].

As a result, NDN team members may make more progress on values issues during face-to-face interactions such as meetings and retreats.

Finally, the literature on virtual teams emphasizes that shared purpose is critically important to virtual teams because they are less regulated by traditional bureaucratic structures and forms [22]. To thrive, the NDN team will need to establish and maintain a shared purpose – a values-laden activity. The necessary intertwining of values, project identity, and communication suggests that communications modes will likely influence how and where values emerge on the NDN team.

METHODS

This paper reports on data collected and analyzed using ethnographic methods during the first year of the Values in NDN project. The project embeds two values researchers (a principal investigator with an information studies background as well as an information studies graduate student) as participant-observers within the larger NDN project. During the first year of the project, the values researchers attended NDN application and architecture team meetings via videoconference, traveled to three NDN all-hands meetings to engage with the design team, and participated in and obtained transcripts of 11 teleconferences. The Year 1 data corpus (August 2011-December 2012) consists of approximately 30 hours of field notes and transcripts from these interactions.

As a first step in looking for values levers in NDN design, we qualitatively analyzed these field notes for modes of communication, and the types of interactions that these modes encouraged. It was clear from the literature review that modes of communication would be a key to understanding interaction and (eventually) values discussions on this virtual team. Because communication is a basic requirement inherent in all values levers, analyzing

communication by the team was an important place to start. Building on foundational virtual teams literature, we analyzed the various media and communications modes which linked NDN participants. Finding the media most frequently used to build relationships [22] will provide insight into where and how to look for values levers in NDN design.

We developed an initial coding framework of five common modes of communication familiar to both researchers: presentations, conference calls, videoconference calls via Skype, face-to-face meetings, emails, and listservs. We also operationalized the concept of "communication mode" to allow additional codes to emerge. Using the initial coding scheme, we each coded the same subset of the field notes (approximately two hours of notes from two meetings). After comparing codes, we discussed differences and came to full agreement on how to use the basic set of codes, and how to identify emergent codes. After this consensus-building exercise, each researcher coded half of the remaining field notes. We used a collaborative coding tool called Saturate (http://www.saturateapp.com/) to support the dual-coding process. As one researcher added an emergent code to the rubric, the other researcher was able to see this and discuss the change. In this way, we developed new codes in parallel. At the completion of the coding process, emergent codes included exchanging academic papers, using a shared code library, co-authoring papers, sharing diagrams, using demos, and using scenarios. The codes (summarized in Table 1) demonstrated the range of communication modes used by NDN researchers.

Face-to-Face	Mediated	Spanning
Break, meeting, meal, presentation, retreat	Co-authored paper, code repository, conference calls, Skype, wiki, Powerpoint, reports, sharing papers	Demos, designs, diagrams, scenarios

Table 1: Coding scheme for communication modes

FINDINGS

A number of themes emerged across the communication modes and interactions identified. First, communication on a distributed team is unsurprisingly difficult. As on any virtual team, communication is a challenge for the distributed researchers of NDN. An email from a project leader marking New Year's Day set the tone: "2013 has come!" she wrote,

> One change personally I would like to see in the new year is increased communications on this mailing list, everyone informs each other of his/her own work, brings up issues, questions as well as new ideas.

Although it continues to be a challenge, the NDN team has developed a broad variety of ways to close the distance between the team. NDN modes of communication can be grouped into three broad categories: face-to-face modes; mediated modes; and communications techniques that can be used in either setting.

Face-to-Face Communication

Many of the field notes document face-to-face modes of communication. These are typically retreats, generally held 3-4 times per year. The retreats include presentations, discussions, meals, and breaks.

At face-to-face meetings, presentations are the norm. Generally each of the 12 project leaders, and some students, will give a formal presentation about their work and progress. Presentations almost always involve a set of slides with diagrams and other illustrations of current work. At internal retreats, these presentations are to update the other project team members on ongoing projects. At retreats held with funders and other network architects working on Internet redesigns (roughly twice a year), presentations are used to explain the principles of NDN and tout the success of the project. Presentations are often grouped around themes: work in application development, security, or routing, for example. Occasionally a theme is harder to find. During one retreat, a principal investigator (PI) started her talk by explaining that she was leading a set of talks that did not fit in anywhere else in the day, declaring, "I'm the leader of the misfits."

While the reliance on presentations at internal retreats results in dense information dispersion, some PIs have expressed frustration with the emphasis on presentations rather than conversations. At the end of a long day of presentations at a 2012 retreat, a PI complained:

> What is missing is unhurried discussion, without this Powerpoint engineering. If we could simply discuss the issues and shoot things back and forth, rather than this rigid format…

This prompted another PI to chime in: "We just need more face time." To which the first responded, "But scheduling breakout face time will be harder. We're already here." This conversation highlighted a common tension between the equally difficult tasks of scheduling face-to-face meetings and increasing information sharing on the team.

Despite the PI's objections, informal communication does occur in these meetings, especially during meals and breaks. For example, when a retreat discussion of trust models for the architecture became heated, a PI diffused the situation by tabling the conversation for a more informal venue, saying: "Ok, this is a conversation for beer. Let's move on." Another example of the relaxed dynamic at face-to-face retreats was illustrated late in the day on the first day of a retreat. By 4:00 PM, several of the team members, including the most senior person in the room, had removed their shoes. The retreat format – where the entire team is sequestered together away from home – tended to produce increased informality, and subsequently informal modes of communication.

Although face-to-face meetings are often highly valued in the virtual organization literature, they are also not a perfect solution for all types of NDN work. For example, when a debate over next steps became detailed and technical, a PI volunteered: "We're not going to converge on this in an open meeting." Retreats did not facilitate smaller working groups; break-out project groups often relied on technologically-mediated modes of communication.

Mediated Communication

Because of their dispersal over twelve campuses, NDN participants use many technologically-mediated modes of communication to stay current with project work. These included conference calls, videoconferencing via Skype, and the occasional pre-recorded video presentation. NDN participants also used a number of asynchronous mediated modes of communication, including sending individual and group emails (note that we only had access to group emails for this study; individual emails remained private between sender and receiver), sharing papers, co-authoring papers, posting on wikis, sharing slide decks, writing proposals, writing reports, and contributing to a shared code library.

Conference calls were a very common communication mode for NDN researchers. Early in the project, research leaders had a monthly call to update each other. Though this lapsed due to busy schedules, reviving a set call time was a frequent topic of conversation. Ad hoc calls were also organized to work on specific project items. Though calls were mostly held over a traditional conference line (with slides distributed in advance when applicable), occasionally Skype was used if one or two people needed to join a live meeting remotely.

Co-authoring papers was one asynchronous way that project members communicated with each other. For example, co-authoring papers on a project topic often topped to-do lists at the end of presentations, which was not surprising among a group of academics. Occasionally, papers were also used as an excuse *not* to share information. As one project leader stated in his presentation, he would not go into detail on an aspect of his work "because it's not yet published in dead tree media."

Similarly, exchanging academic papers was a common form of information exchange among this group of researchers. It was frequently used to inform others of detail too complicated to discuss face-to-face. For example, group members often said things like:

> This doesn't mean that [digital rights management] is problematic or can't be done in NDN - I can probably share with you a white paper [explaining this]…

Or:

> I can send you the link and the presentation that gives the motivation behind the NIST [National Institute of Standards and Technology] effort.

Occasionally, slides (and the diagrams embedded in them) were used as shorthand for summaries, details, or ideas not developed enough for a paper. If a topic was difficult to understand, a participant might request the speaker "put together a slide" to illustrate the point. At one retreat, a very senior leader stated, "I'm looking for a volunteer to put together a slide with what we learned from each of the seven questions." Slides were used as a primarily visual mechanism for exchanging discrete chunks of information before a paper was written.

The team's shared code repository also functioned as a mediated communication mode. In an early retreat, the team discussed how to manage issue tracking with regard to its code base. Staff member K asked:

> Are there particular tools that people are using? It could just be a page on the wiki, but we might want to consider using some issue tracking, but I know that this can get to be a bit of an overhead…

A student suggested using cloud-based service GitHub's built-in issue tracking because the shared code was already hosted in GitHub. But this raised an organizational challenge, as Project PI K pointed out: "[To do that], we should move everything into one GitHub repository."

As the GitHub example points out, there were challenges associated with mediated interactions. Using issue tracking features of GitHub would require making sure that all code was kept together in a single repository, which was not automatically the case in this 10-campus collaboration. A second challenge was that very few contributors relied on established listservs to update others on their work. The listservs tended to be fairly quiet, as noted by the project lead in her New Year's Day message, which led to a lack of virtual team coherence overall.

When group members did use email, it was often to alert each other to relevant work by outside scholars. For example, a group leader emailed:

> One of [grad student]'s friends told me that his group had five papers in a recent conference: [Link and list of paper titles included]. The titles look interesting, though I have not read the papers. FYI.

Such email alerts, however, were not a rich enough form of communication for some participants. A student responded:

> Wonder if we could have a series of seminars (over Skype) to read these papers and the ones collected before at [project website]. ... Each faculty/student presents one or more papers each time.

This resulted in a general round of consensus that a regular paper seminar over Skype would be useful to the NDN team; these seminars were set to begin in January 2013.

The NDN team also maintains a project wiki as a form of asynchronous communication. The wiki is generally referenced as a knowledge management system; during phone calls or meetings, team members would declare, "It could just be a page on the wiki" to indicate that work or knowledge should be captured. The wiki then served as a reference point for team members preparing reports for funders. During report writing, solicitations like "put it in [the] wiki if you're using NDN in your courses" encouraged participants to update the wiki.

Annual reports for funders served as another asynchronous form of communication. In the beginning of the project, the team tried to submit monthly reports, which project organizers felt "were helpful for getting an overall sense of what was going on." However, submission of the reports dropped off. The annual report required by the National Science Foundation instead became a yearly communication tool. Everyone was required to write and submit updates on their work, and thus it became a yearly documentation of what was accomplished in the project. However, this was seen as a less-than-ideal communication tool; several PIs complained that the annual report was too long, static, and formal to be an ideal update mechanism.

Communication Techniques

There were also communications modes that NDN members employed during both mediated and face-to-face communication. These included scenarios, a very popular communication technique, in which participants tried to demonstrate a feature of the NDN architecture by invoking a real-world scenario. These also included designing and deploying demonstration technology, and creating and sharing diagrams.

Demonstration technology, or demos, were created for important events such as conferences and meetings of network architects, and were useful to illustrate features and potentials of the NDN architecture. During Year 1, the team created at least two demos. One was designed to illustrate networking efficiency, and the other to demonstrate the applicability of NDN to building automation. Demos were perceived as successful communications tools when they concretely illustrated how well a feature of NDN worked. For example, describing a successful demo, a project leader bragged, "What really brought the demo home was the live streaming of a video performance."

Demos were largely used to reach outside audiences, rather than to communicate within the team. As a project leader put it when introducing his demo at a retreat:

> "Since our last retreat, we've done a demo. Lots of people have seen the demo but almost no one in the room [has seen it]."

However, demos might be featured at a face-to-face meeting or mentioned in phone calls as examples.

Diagrams, unlike demos, were much more integrated into internal NDN communications. As discussed earlier, diagrams were frequently featured in presentation slide decks, draft and published papers, grant proposals, and even informal conversation, for example when participants sketched something briefly on scrap paper to illustrate a point. Showing each other a picture frequently helped team members talk through their work and come to consensus on design decisions.

Scenarios were perhaps the most commonly used communications technique across modalities. We coded dozens of examples of scenario usage in the field notes. Scenarios were invoked to map existing real-world tasks onto the speculative NDN architecture. For example, team members might ask for clarification or describe a feature on which they were working by evoking reading the most current version of the *New York Times*, discussing changes when using a smartphone with NDN, or discussing how ad networks would propagate ads in an NDN world.

Internally, scenarios were used for a variety of purposes. These included imagining new features, evoking security challenges, and discussing how NDN might fit into the existing economic and political world. For example, a project PI working on applications imagined new features that NDN could enable: "If I want to know that my grandmother is well, there's a health notifier..." A research lab employee charged with discussing security challenges offers: "The most common scenario will be the honest user and the adversary connected to the same router…" And to discuss market structures and business cases during a conference call, a group of project leaders investigated social networking as a scenario:

> PI 1: "Look at Facebook or another social network for patterns and how they might be rendered in NDN….
>
> PI 2: An interesting idea but I wonder why, for example, why Facebook and Twitter didn't evolve to be peer-to-peer. P2P existed, but they don't use it. Why?
>
> PI 1: Business model reasons: their advertising and privacy models press on client-server models.
>
> PI 3: Yeah, business models. It's well-known that the people who run the servers want to [track] every click that you do.

At large meetings, people outside the NDN team tried to use scenarios to understand NDN, as well. At an NSF-sponsored retreat, a team of outside values in design researchers evoked scenarios involving hypothetical users, asking NDN developers to consider: "gamblers, Bitcoin developers, file sharers, people laundering money, nihilist anonymous pranksters, spammers and advertisers, vigilantes, Scientologists, people who want to build walled gardens, archivists…" Scenarios involving media consumption, mobile use, and other common online activities were also regularly evoked at these meetings.

Communication Challenges

Despite the fact that NDN team members have developed a number of ways to communicate across distance, challenges remain, both for team communication and for the implications communications practices have for surfacing values during design. The primary challenge that united both face-to-face and mediated methods was the difficulty of informal communication. Team members regularly cited challenges, such as the structured nature of face-to-face retreats as well as the lack of use of mediated channels such as listservs. This was not surprising in a virtual team – informal communication is a common challenge for distributed working groups. But the challenges to informal communication have an impact on values levers, many of which rely on informal modes of communication.

DISCUSSION: COMMUNICATION & VALUES LEVERS

The three modes of communication on the NDN team – face-to-face, mediated, and techniques that span both – lead to the question of which modalities in particular encourage values levers and communication about values, and whether communications challenges constrain those conversations. The analysis of communication modes in the distributed team suggests which values levers from previous research may be at work in NDN design, challenges to those values levers, and where new levers might be found and encouraged.

Working on Interdisciplinary Teams & Gaining Funding

Previous work has shown that both gaining funding and working on an interdisciplinary team were values levers among co-located academic design teams. Both held true for the distributed NDN team. Interdisciplinarity among the NDN PIs is relatively low. Before the inception of the Values in NDN project, only one project PI came from outside of computer science or electrical engineering, and many project leaders had studied together in the same research labs as graduate students. However, interdisciplinarity is heightened at particular times in the NDN process; in particular, during large NSF retreats in which outside advisers are invited. While some of these advisers hail from the professional and academic network architecture worlds, others are academics from law, philosophy, communication, and information studies. These large, interdisciplinary meetings regularly surface conversations about values such as privacy, security, and equity, and will be one area to continue to probe for values levers in ongoing observations.

In addition, a year ago, NDN invited four values-focused team members to join the NDN project, including the paper authors as well as a legal scholar and postdoctoral fellow

focused on the legal impacts of the NDN project. This interdisciplinarity was encouraged and enabled by new funding made available by the National Science Foundation. The resulting interdisciplinarity encourages the use of scenarios, as discussed above. For example, during a presentation, the law professor working with the team evoked a law-enforcement scenario, requesting:

> Walk me through the future investigation where someone's using NDN... So, I'm the FBI agent and I get a tip. I get a hot lead that there's this named [data], it exists and at least one person has used it as a consumer. So, what do I do next? … What's my first step as the FBI agent? Who do I call next?

This led to a long and detailed discussion of the NDN trust model, including how keys and signing would work in the context of an FBI investigation.

In previous studies, interdisciplinarity worked as a values lever by encouraging team members to talk about the sensitive data gathered by their projects, rather than focusing on the purely technical details of Internet architecture. In NDN, interdisciplinary conversation often takes the form of scenarios designed to evoke features of the architecture. Child pornography, Gmail, Netflix, FBI investigations, Tor, and Facebook have all been invoked to talk across disciplinary boundaries and to try to understand the architecture.

Another feature of scenarios seems to be that they help mitigate communications challenges and breakdowns among team insiders and outsiders. NDN is a complicated technological change to a very basic layer of the Internet. The NDN team often has trouble communicating how their protocol will work and what impacts it will have, even to others with technical backgrounds. As a prominent outside adviser put it at a PI meeting: "I'm going to have to get you guys a sign that says 'magic happens here'." Scenarios are used as a way of telling stories about the architecture, and imagining how it will impact the world. Scenarios are united by imagination – they help team members and outsiders alike imagine what could be. The Year 1 data suggests that scenarios may be a very powerful values lever in NDN design. Future work will pay careful attention to the role of scenarios – who constructs them, how they are constructed, and when and how they are effective – within NDN.

Experiencing Self-Testing

Experiencing self-testing is a values lever that was prominent among co-located teams in previous research. Self-testing reinforced a user-centric view of technology, and highlighted contradictions, tensions or ambiguities in its use. This has not yet appeared as a values lever in the NDN project, but it is likely that it will emerge as the project continues. The team has just started prototype deployment. As a first step, one campus has distributed NDN-capable boxes equipped for teleconferencing and chat to the rest of the project campuses, but they have yet to be widely utilized.

Though it has not yet come to fruition, self-testing is a recurring topic among the team. Often this is referred to by the slang phrase "eating your own dog food." In fact, modes of communication and communication challenges are seen as something that NDN can address *through* self-testing. When a student presented at a retreat on an NDN simulator with the goal of establishing a common platform to be used by the NDN community, one of the principle investigators asked: "Who's using this? We should be eating our own dog food." A similar example is a team effort to develop a test bed on which to hold conference calls. At an April, 2012 retreat, a PI argued, "Then we need our next meeting to be virtual, over the test bed, before we tell [anyone else] to use it." But because the platform is not yet fully operational, it has not yet been deployed for the team to self-test.

Designing Around Constraints

Designing around constraints is another lever which appears during NDN design, but its impact and the role it will have for the emergence and discussion of values is not yet clear. Basic NDN protocols were established over many years by a small research team, and now a much larger team is investigating, evolving, and implementing these protocols. The original protocols included a strong emphasis on the values of security and privacy [14]. These values – implemented in requirements for digital signatures and encryption – have become necessary properties in NDN design. These requirements may spawn new forms of creativity. For example, a recent NDN paper explores a Tor-like architecture for preserving anonymity even though NDN requires signed packets [7]. The development of this idea into a paper may demonstrate a link between the asynchronous communication mode of co-authorship and designing around constraints as a values lever.

Challenges to Values Levers

There is also an original lever found among co-located groups for which the influence in this virtual team is less clear, or still to be determined: internalizing leader and team member advocacy. In previous work, the values advocacy of both project leaders and team members was a critical values lever. When a few team members care about a value, they can be influential in bringing the team to consensus around that value [29]. However, this kind of interpersonal influence frequently relies on informal modes of communication – ad-hoc meetings, conversation around the water cooler, or discussions over meals. This is precisely the sort of communication that the NDN project's distributed nature makes more difficult. Finding the "shoes off" moments in NDN design will be a challenge for future work.

Similarly, it is not yet clear how tools for remote collaboration impact values levers. The mediated modes of communication used by the NDN team are diverse and

creative, and analyzing their impact as values levers, and more specifically which values they surface, will be a critical next step for this project.

And finally there is the question of where new values levers are encouraged by the communications modes adopted by the NDN team. Are certain modes of communication better at encouraging values levers than others? Scenarios rise to the top as a popular communication technique that evokes values discussions. But this analysis of communications modes in a virtual academic team suggests that demos and diagrams may be two other techniques that could be built upon to form values levers. Scenarios are popular and effective, but perhaps there is opportunity for values researchers embedded in design teams to be creative about how they talk about values. For those involved in values and design interventions [8,23,27], shaping projects to fit the modes of communication native to a team may be a powerful new way of finding and encouraging values levers.

CONCLUSIONS & FUTURE WORK

A distributed team working on future Internet architecture has a number of challenges to overcome: communications challenges, research challenges, and values and social impact challenges. An analysis of the ways that values surface, are discussed, and impact the design of this new technology will illuminate both the social impacts of a new Internet architecture, and simultaneously the nature of values work on a distributed team.

In this paper we described a qualitative analysis of field notes from the first year studying the Internet architecture design project known as Named Data Networking. We considered the role of different modes of communication among a virtual academic design team for the emergence of values levers and compared those findings to previous research on values levers with co-located academic teams. While face-to-face retreats encourage interdisciplinary work and subsequent discussion of values, mediated modes of communication tend to constrain values levers. These limitations may be overcome by encouraging communications techniques such as scenarios and demos, which can be used in both face-to-face and mediated settings.

Our analysis shows that modes of communication in the virtual team do enable some types of values levers similar to the co-located teams studied previously, while more time for the project to evolve is necessary to see whether new levers will emerge. The eventual goal of the Values in NDN project is to determine how those levers in turn encourage conversations about values themselves, and where and how central values become embedded in the design of the new Internet architecture.

We will continue to collect field notes and conduct interviews with team members for at least one more year. We will use the set of communication-related values levers identified in this paper to determine the relationship between modes of communication, values levers, and values embedded in design. This analysis will confirm or challenge what communications modes successfully enable values levers, and whether values change due to such levers on the NDN project team over time. Through such analysis, we will better understand how the codes – both technical and social – of a new Internet architecture came to be.

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