Communication Technology Selection in a Young Open Source Community: A Case of the Hyperledger Project

Research-in-Progress

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Abstract

Open source communities evolve and so does their use of communication technologies. As online collaboration relies on communication technologies that provide different capabilities the choice for specific collaboration task requires careful consideration. We report on the selection processes from a young open source community, where decisions since its inception were observable. The community grew and evolved from a few founding members to several hundred contributors. We observed different selection processes at three levels: 1) community, 2) sub-groups, and 3) individual members. The selected communication technologies were sometimes replaced rapidly to support changing collaboration needs. Further, we conceptualized the open source community as a complex adaptive system and propose a theoretical extension to allow for decision making at the community and sub-group levels that will be enforced community wide.

Keywords: Open source community, Diffusion of innovation, Communication technologies, Complex adaptive systems

Introduction

Open source communities are very dynamic, as new members join, others leave, leadership changes (Raymond 2000), and their software development processes evolve (Nakakoji et al. 2002). The coordination of needs for communication technologies, however, requires careful consideration (DeSanctis and Monge 1998). Systems that help resolve conflicts need to support a collaboration process, e.g. step-by-step instructions, and thereby improve the collaboration process (Poole 2009). Selecting communication technology requires an understanding of tasks and goals because its capabilities can affect efficiency to achieve different goals (Dennis et al. 2008).

The adoption of communication technologies is informed by the research on diffusion of innovations. In summary, choosing communication technologies needs to be evaluated along several dimensions such as the history, context, and collective behavior of a community (Bok et al. 2012; Rivera and Cox 2016). Open source community members make these choices based on prior experience, conventional wisdom, and based on desired community processes (Cornford et al. 2010), but to our knowledge, no research validated this assumption for newly found communities. Because the communication technology selection is most visible in a new open source foundation, we formulate our research question:

How does a newly founded open source community choose communication technologies?

Diffusion of Innovations

The diffusion of innovations theory is informative to understand how new technologies, such as communication technologies, are adopted (Rogers 2003). Innovations are ideas, practices, or objects that are perceived as new and thus communicated among community members with the goal of gaining a shared understanding and ultimately deciding to adopt or reject the innovation. In organizations, innovations are either enforced by management or organically adopted by employees. Leading up to the decision of adopting an innovation, the members would be expected to consider the organizational needs and problems (Rogers 2003). After the decision to adopt an innovation, members negotiate how the innovation needs to be re-invented to fit the organization, clearly define the innovation and organization relationships, and adopt the innovation in ongoing activities (Orlikowski 1992; Rogers 2003).

The choice to adopt a communication technology is subject to many factors. Evaluating all information concerning the selection is impeded by time, pressure, and complexity (Bok et al. 2012). In a study with managers, the selection of communication technologies for urgent and complex tasks was often less than ideal (Bok et al. 2012). This demonstrates that at times, selection is subject to heuristics and the task at hand. Even in open source communities, the selection of communication technologies can be made under stress and has to balance organizational needs (Cornford et al. 2010). The communication infrastructure provides the means for open source communities to collaboratively develop software (Scacchi 2002). However, the communication technology only provides the means to an end and a community is likely to use several technologies to achieve a single task. For example, "a task might begin with a message on a mailing list, continue through posts in a tracker, then involve a patch, a CVS check-in, and finally a functional change to the application itself" (Howison and Crowston 2014, p. 32).

The Evolution of Open Source Communities

To understand the changing communication technology selection in open source communities, an understanding of the evolution of these communities is necessary. Open source communities are "internet-based communities of software developers who voluntarily collaborate to develop software that they or their organizations need" (von Hippel and von Krogh 2003, p. 209). Open source communities are changing and evolving, for which Kelty (2008) introduced the concept of a recursive public (p. 3):

> *A recursive public is a public that is vitally concerned with the material and practical maintenance and modification of the technical, legal, practical, and conceptual means of its own existence as a public; it is a collective independent of other forms of constituted power and is capable of speaking to existing forms of power through the production of actually existing alternatives.*

This definition highlights that open source communities maintain and modify their technical means of their own existence. The need to adapt arises from changes in the software development processes

(Cornford et al. 2010), changes in the community composition (Nakakoji et al. 2002), and changes in the environment. The community continuously adapts its practices.

Open source communities can be understood through complexity theory as complex adaptive systems (CAS) (Agnihotri et al. 2012; Muffatto and Faldani 2003). Complex adaptive systems rise from the interaction of connected members with each other (Anderson 1999). CAS provides a theory to model complex behavior and understand how communities evolve, as understood through four elements: members, self-organizing networks, co-evolution of members, and system evolution (Anderson 1999). Individual members, including users, developers, and corporate and foundation employees (Muffatto and Faldani 2003), influenced the current state through past decisions. The technologies members choose to use for communication will shape the future communication patterns of the community. The network of members is self-organizing even though members are only partially connected and may act within different sub-groups. Core-maintainers might only interact with a select set of trusted community members who might be responsible for different aspects of the project (Crowston and Howison 2005). The community co-evolves with its communication technologies as members change their communication behaviors (von Krogh et al. 2012). The community evolves over time because the interaction between members is likely to change as some members take on new responsibilities, some choose to contribute in different ways, and others reduce their involvement (Nakakoji et al. 2002). Throughout this evolution, the choice for communication technology changes accordingly to accommodate every new situation.

Method

Our methodological approach is Netnography (Kozinets 2015), an ethnographic approach adjusted to learning and understanding online environments. A fundamental idea is for the researcher to be fully immersed and learn by being part of the community. To represent our Netnography, we utilize impressionist tales (van Maanen 1988), the creation of representations and the process necessary to illustrate observations. The reader of impressionist tales is abstracted from the actual events as the researcher gives a representative view of the situations. “An impressionist tale is not defined by the amount of time spent or the volume of data collected regarding a community, and time/volume should not serve as a proxy measure for the quality of the data, engagement with a social network, or communal understanding of a social network” (Germonprez and Hovorka 2013, p. 531). Rather, the purpose is to tell a rich story that connects the reader to the observed community. We tell the impressionist tale of the Hyperledger Project community to understand the selection of communication technologies.

Our Netnographic context is the Hyperledger Project community, which is a collaborative project hosted by the Linux Foundation. This open source project, initiated in December 2015, was announced on February 9, 2016, as an industry collaboration to advance blockchain technology. Founding members of the initiative represent a diverse group of stakeholders, including: ABN AMRO, Accenture, ANZ Bank, Blockchain, BNY Mellon, Calastone, Cisco, CLS, CME Group, ConsenSys, Credits, The Depository Trust & Clearing Corporation (DTCC), Deutsche Börse Group, Digital Asset Holdings, Fujitsu Limited, Guardtime, Hitachi, IBM, Intel, IntellectEU, J.P. Morgan, NEC, NTT DATA, R3, Red Hat, State Street, SWIFT, Symbiont, VMware, and Wells Fargo (Hyperledger Project 2016). The blockchain technology became well known through the implementation of Bitcoin (Bheemaiah 2015; Nakamoto 2009). Blockchains are distributed databases that store transaction data in a tamperproof format. The description of the underlying technology is outside the scope of this paper. The important thing to understand is that many organizations are investing in research and development in blockchain technology because it has the potential to disrupt many industries. The Hyperledger Project provides a forum for these research efforts to converge and potentially create an industry standard. At the project’s inception, communication technologies were provided and others were added as the project progressed. Thus, the selection of communication technologies was observable from the start.

The Hyperledger Project

When the official announcement about the founding of the Hyperledger Project was made on February 9, 2016, the website listed three means of connecting with the Hyperledger Project community. First, two mailing lists *hyperledger-tsc* for the Technical Steering Committee (TSC) and *hyperledger-technical-*

discuss for general technical discussion. Second, the GitHub code repository contained a readme file with a link to the website. Third, a weekly TSC conference call on GoToMeeting was listed.

The GitHub history dates back to November 3, 2015, when Daniel O'Prey, an employee with Digital Asset Holdings, had pushed the initial commit with a readme that referred to a website on the company's domain. Digital Asset Holdings is a founding member of Hyperledger and donated the name. On February 2, 2016, a week before the official announcement, Mike Dolan, an employee of the Linux Foundation, changed the readme and linked to the new Hyperledger Project domain. The first issue on the issue tracker, was in response to the announcement, Angel Leon asked: "Where is the Code?"

During the first TSC weekly conference call on February 11, 2016, the TSC decided to add several new communication technologies. The IRC channel #hyperledger was created on freenode.net to provide synchronous communication technology. A Slack channel, also providing synchronous communication, was added because some members use it in their organizations. The community members commissioned the Linux Foundation to set up a wiki. Additionally, the person taking the minutes decided unilaterally and unopposed to adopt Google Docs as the communication technology to take the meeting minutes.

The IRC and Slack channels have similar capabilities, which led to the abandonment of one of them. The Internet Relay Chat (IRC) protocol dates back to 1988 (Pingdom 2012) and has been used extensively in open source communities for quick communication, instantaneous help, and online meetings. The #hyperledger IRC channel was set up out of the tradition. With the advent of alternative technologies, IRC use has been on the decline in recent years (Pingdom 2012), which is directly observable in the Hyperledger Project, where only about a dozen members are online in the IRC channel and almost no communication occurs. In contrast, the busiest communication channel is Slack (www.slack.com), a cloud-based team collaboration tool that launched in 2013 and has since received much attention, especially in corporate settings. Slack was originally based on the IRC channel but evolved to use a proprietary protocol that allows integration with many different technologies. Within the first day of opening the Hyperledger Project Slack channel more than a hundred members joined. As of this writing, it has grown to over 3098 members with more than a hundred users online around the clock. The communication in Slack is frequent and informal. Within Slack, channels can be created by anyone for special topics, such as for workgroups, for developers, or for infrastructure discussions. Some channels are created to move discussions off of the main channel. Some channels are unutilized.

Interestingly, the wiki on GitHub is used even though the TSC had decided that the Linux Foundation would set up a wiki for Hyperledger. The wiki on GitHub was readily available from the code repository and members just started using it. At first, the wiki contained links to the weekly call minutes in Google Doc minutes as well as audio recordings. Later, actual work results such as the code of conduct and use case descriptions were added. The wiki has turned into the central knowledge base for the project. It contains the project charter, the scope description, information about how to become engaged, and when public meetings such as conference calls are scheduled.

The use of Google Doc allows simultaneous collaborative writing in the same document. This supported the writing the code of conduct, where different people simultaneously made changes to the document. Comments were added to start a discussion about a certain topic without changing the text of the document until a consensus was reached. The finished and approved text was then moved to a wiki page.

While Hyperledger Project is an online based open source community, digital communication is not always the best option. The community facilitated a face-to-face meeting less than two months after initiation. The meeting from March 22 to March 25, 2016, in Brooklyn, NY was technology oriented and anyone interested could engage in a hackathon to create the first code base to be incubated into the project. Side discussions about the project advanced the understanding of requirements that the Hyperledger Project community wanted to set for its self.

A requirements workgroup was formed to continue the work online and document the requirements for all community members to see. The requirements workgroup is charged with writing use case descriptions that outline where blockchain technology would be used and what requirements are inherent to these uses. The workgroup considered using Google Doc but felt more comfortable using the wiki directly. Collaborative writing occurs directly in the wiki, a weekly conference call is used to coordinate efforts, and a Slack channel supports sporadic discussions. A separate mailing list was discussed as an option but not implemented because they felt all communication needs were already met.

Starting with the face-to-face hackathon, collaboration on code development occurs in the GitHub code repository. GitHub was an easy solution to start with since it has a low barrier, most developers have an account with GitHub, and know how it works. Coordination on issues and features occurs through the issue tracker that is integrated on GitHub. After the initial code base was accepted into the official code repository, activity in the community and the frequency of communication increased.

The Technical Steering Committee started discussing legal requirements for the collaboration on the development of the code. On April 21st, A comprehensive discussion took place on a conference call with technical experts from the Linux Foundation. The legal issue is to have a disclaimer of ownership (DCO) for all contributions. GitHub does not enforce the contributors to have issued DCO's, which creates the problem that Hyperledger cannot be certain that their code does not violate copyright. Another reason for looking into alternatives was to ensure quality and security. Gerritt was proposed as the technology for managing code development and ensure review processes. The community has been slow to adopt this new technology due to conflicts with migration.

Since the project is still in an early phase, the code base and documentation are not mature. Developers often come across issues that are not documented properly. To address these issues, they turn to the mailing list or more often to Slack. On April 21st, the member @mcrafols suggests on Slack, to create a Stack Overflow type platform for Hyperledger, which would be used for asking and answering questions. Stack Overflow is widely used by developers around the globe for all kinds of questions and it has turned into an often checked knowledge base for solutions. Member @ry asked in response, why not use Stack Overflow directly. On April 25th, @mcrafols asks if someone can create the tag since they do not have enough accumulated reputation on Stack Overflow. Member @dmurk replies that they created the tag. By April 28th, 7 out of 18 questions and by May 8th, 14 out of 34 questions on Stack Overflow concerning Hyperledger use this new tag, which shows that the tag is used for new questions.

Use of the employed communication channels changed in the few months of the Hyperledger Project's existence. The Website, as the communication technology that is most outfacing and the initial point of contact for many new members, continues to provide high level information on the community. Detailed information, such as how to join the weekly TSC call was removed from the website and moved to the Wiki, which also includes information on how to collaborate in multiple workgroups. Without discussing a strategy, individual community members continuously update the wiki and change its structure as new content is added. Community members initially used the weekly TSC calls to discuss which communication technology to use, the creation of the code of conduct, and coordinate the face-to-face hackathon. With the evolution of the Hyperledger Project and the introduction of workgroups, the community now uses the weekly TSC calls less for discussion and more to report progress from workgroups and make decisions for the community. Detailed discussions occur in specialized workgroups that are formed as needed and who employ different communication technology, depending on what the workgroup members are most comfortable with.

Discussion and Conclusion

In studying a young open source community for decision processes in adopting communication technologies, the phases of the innovation-decision process (Rogers 2003) were sometimes observable. The knowledge and persuasion phase were often brief as members decided quickly on which technology to use. Different workgroups chose different communication technologies for similar tasks (e.g. Google Doc vs. wiki), which was justified by comfort level of the different members. The implementation phase occurred only implicitly as the customizability of the discussed communication channels was limited and did not foster much discussion. This is even true for the wiki that gets restructured without a discussion or prior consensus. The confirmation phase is evident, as workgroups and individual members continued to employ the communication technologies that had already been successfully adopted by the community.

We observed that the innovation-decision process occurred at three levels and each is equally important. At the lowest level, individual members decide to use a communication technology, such as a new Slack channel, Stack Overflow, or Google Docs. The adoption success only occurs when other community members decide to join and collaborate through these communication technologies, which was not always the case as was observed in unused Slack channels and the abandoned IRC channel. At the next level, workgroups formed and then decided which communication technology they were most comfortable with

and that suited their needs best. Anyone who wants to contribute to the workgroup has to use these communication technologies. At the highest level, the community leaders, the TSC members, identified community needs and evaluated available communication technology options before proposing a solution that would be voted on by the community. In this discussion, any community member is invited to voice an opinion but ultimately, the identified community needs have to be met. This last process best compares to the innovation process in organizations described by Rogers (2003). Figure 1 depicts how the effect of communication technology selection at different levels effects community members.

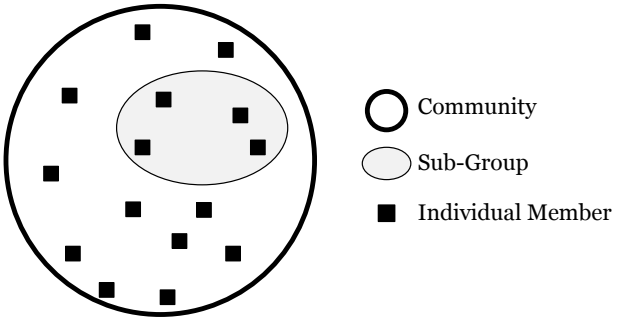

Figure 1. The levels at which communication technology selection occurs.

An interesting finding is that the communication technology selection was constantly adapted to changing requirements. The requirements work group, for example, started face-to-face and then continued work online, using multiple communication technologies for different tasks. The community also changed how it made use of the weekly TSC, focusing less on working and more on coordinating the spawning workgroups. These examples demonstrate how short-lived communication technology selections can be in open source communities, some made for only one instance of collaboration and then changed the next time community members continue the work. The quick decision process explains why the phases cannot be easily observed. However, despite the variety of possible communication technologies and the fast-past selection, the selection appears to return to previously used and established communication channels, which can be explained by the familiarity among community members that determines the selection process. The evolving use of communication technology is in line with complex adaptive system theory.

We develop complex adaptive system theory through describing an instantiation that informs an extension of the theory. We observed how the Hyperledger Project evolved from a few founding members to thousands of contributing members. The founders set up an initial structure of the community by providing a bare minimum of communication technologies. As the community grew and evolved, members individually decided on adopting new communication technologies. Some technologies were found useful by other members and others remained unused. In this manner, a self-organized structure of the community emerged with work groups organized around different instances of communication technologies. It is the continuous and changing use of these communication technologies that maintains and changes the structure of the community.

Conflicting with the complex adaptive system theory, we observed that the community as a whole, facilitated through the TSC, is reflecting on its communication technologies and considers necessary changes. With the (legal) guidance from the Linux Foundation and considering its own rules (contribution requirements for TSC members), the community evaluates potential communication technologies just like an organization. The CAS theory knows members as decision makers who make decisions based on their local knowledge and form of sub-groups who they interact with most frequently. Members and sub-groups can influence the entire CAS, however only to the extent that other members voluntarily adopt too.

From this observation, we propose to extend CAS theory to allow decisions of individual members and sub-groups to enforce changed decision rules for all members. With this extension, a code of conduct, a project charter, and the enforced communication technology for code contributions can be understood. Members continue to be the decision makers in the community, however, their choices are not only informed by what they observe in their environment, but are limited by the decisions of previous community members. The proposed extension introduces distributed decision making where the members of sub-groups agree to make a joint-decision. This consensus mechanism was only implicit in the existing CAS theory as members' decisions were most effective if reciprocated by other members.

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