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Toward Temporally Complex Collaboration in an Interorganizational Research Network

SIRKKA L. JARVENPAA

University of Texas at Austin

McCombs School of Business

Center for Business, Technology, and Law

2110 Speedway, Stop B6500

Austin, TX 78712

Tel: (512) 471-1751

E-mail: Sirkka.jarvenpaa@mcombs.utexas.edu

LIISA VÄLIKANGAS

Hanken School of Economics

Department of Management and Organization

Arkadiankatu 22

00100 Helsinki

Finland

E-mail: liisa.valikangas@hanken.fi

&

Technical University of Denmark

DTU Management

Akademivej. Building 358

DK-2800 Kgs. Lyngby

Denmark

Tel. +45 93 51 18 13

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ABSTRACT

Prior research suggests interorganizational collaboration faces temporal challenges but also opportunities yet is scarce on the role of time enabling – more often deterring - collaboration for collective benefit. Our contribution is highlighting how a large industry-academic research

network developed temporally complex collaboration through varying temporal rules and relationships. The three network-developed collaborative repertoires, with their particular temporal rules and relationships, complemented the externally imposed calendar repertoire: (1) sprint repertoire, following a familiar agile method for joint research, (2) narrative time repertoire, enabling sharing research results across various events at the program level, and (3) “right” time repertoire that turned research results into action in emerging business ecosystems. With these collaborative repertoires, both the temporal diversities of home organizations and the asynchronies of the network activities were resolved for collective benefit. We contribute to the intersection of the literatures on interorganizational networks and temporality as befitting collaboration.

Introduction

Interorganizational networks take many forms, including large-scale, cross-sector research programs that bring together participants both from industry and from academic organizations (Gulati et al., 2012; Koschmann et al., 2011; Powell et al., 1996; 2005; Provan et al., 2007). These networks are formed for their collective potential beyond what any one participating organization would achieve on its own. Such interorganizational networks manifest diversity in ideals, interests, and orientations (e.g., Bonneau, 2007; Hagedoorn et al., 2000; Mannak et al., 2019). Beck and Plowman’s (2014: 1235) definition points to the challenges of heterogeneous networks: “a cooperative, interactive process in which participants from different [home] organizations, relying neither on markets nor legal hierarchy mechanisms, develop shared rules, norms and structures to act and decide on issues related to a shared problem.” Managing this diversity falls to the network participants and their actions when a network eschews organizational hierarchy and singular

authority (Reypens et al., 2020), including the roles of timekeeper or instructor. Temporal challenges, as well as opportunities, become particularly critical to realize network collaboration for collective potential (Provan et al., 2007); yet the management of these challenges and opportunities remains poorly understood in heterogeneous networks (Lumineau and Oliveira, 2018; Castañer and Oliveira, 2020).

Temporal challenges in network collaboration are initiated both by the home organizations and by the network collaboration activities. First, diversity in home organization temporal orientations create discrepancies as network participants try to collaborate (Reinecke and Ansari, 2015). These temporal orientations vary in the way the participants view the world, value different activities and outcomes, and have expected paces and rhythms (Zerubavel, 1981; Schriber and Gutek, 1987; Shipp and Jansen, 2021). The differences are exacerbated in cross-sector network collaboration. The academic participants may value learning events and preserving the past for the future, whereas the industrial participants value efficient task execution for outcomes in the present (Barbour et al., 2017). While industrial organizations may expect results from network collaborations in less than a year, universities or research institutes are inclined to sustain collaboration efforts for multiple years (Leven et al., 2014; Gustafsson and Jarvenpaa, 2018). These asynchronies prevent a “sense of concert of time” (Yakura, 2002; 958) and can hinder collaboration. Adding to temporal asynchronies is that some network activities oscillate according to the strategic interests of home organizations (Deken et al., 2018; Danner- Schröder, 2020).

Second, the network collaborative activities themselves pose varying demands for time (Dille et al., 2018; Reypens, 2020) that, if not met, can become a deterrent to network collaboration and collective benefits. In networks for innovation, joint activities include visioning, task execution,

learning, and value creation (Browning et al., 1995; Kaplan and Orlikowski, 2013) – not just with their own clock and subjective times (Yakura, 2002; Orlikowski and Yates, 2002), but with different temporal orientations toward past, present, and future (Ofori-Dankwa and Julian, 2001). As the network engages in collaboration, the various activities may coincide – for example, execution taking place along with learning (Beck and Plowman, 2014); this correspondence complicates temporal orientation at the network level (Deken et al., 2018) as these activities require coordination and integration.

Amidst such temporal complexity, how can network stakeholders prevent collaboration from stalling and potential benefits from dwindling (Provan et al., 2007)? The literature on time acknowledges the benefits of complexity, including “different combinations and patterns of time orientations emerging as time passes” (Ofori-Dankwa and Julian, 2001, p. 425). A related literature on sustaining innovation in organizations emphasizes complexity in combinations of practices, or *complexity arrangements*, to allow many events and activities simultaneously in response to the nonlinear character of innovation (Garud et al., 2011). In the single organization context, such complexity arrangements may involve relationships where senior management brings together experts from different units for new knowledge combinations. The authority structures can institute rules that help overcome differences in the temporal orientations of experts, including the resulting time lags and possible delays. In addition, independent of the interacting experts, organizations have structures (e.g., narratives) that can preserve intermediate outcomes for germination into the future when “...the time is right” (Garud et al., 2011: 757) for a particular innovation to materialize.

In interorganizational networks that lack this single authority, the complexities of temporal demands are exacerbated by the lack of settlement mechanisms; also problematic is that our understanding of how the complexity in temporal differences may be harnessed in network collaboration for the collective benefit is limited. The existing literature suggests that the networks often fail in their collaboration for collective benefit as time is used to deter rather than enable collaboration: For example, interorganizational networks may stall collaboration to serve the status quo interests of one or a few of the participants (Zietsma et al., 2018) or impose temporal pressures to privilege powerful coalition members or stakeholders (Schildt et al., 2020; Granqvist and Gustafsson, 2016). For the interorganizational networks formed for their collective potential, including joint research pursuits, the question then is this: How does an interorganizational network generate temporal responses complex enough to accommodate diverse temporal requirements, so that the network collaboration is enabled and sustained rather than curtailed?

We empirically examined this question, following a large-scale interorganizational network for four years, during most of its existence. The network engaged in cross-industry research as the participant companies were transforming their business models and technologies and as leading research institutions joined the quest for cross-industry innovation. The case illuminates how the network participants proactively managed the temporal demands in network collaboration: In order to accomplish joint research, the network participants had to comply with the external calendar-time demands imposed by the public funder *while* developing additional collaboration-enabling repertoires – both temporal rule- or relationship-driven - to accommodate diverse temporal demands of their home organizations. The network continued to evolve these collaborative repertoires during its existence, initiating temporal relationships for rule-driven repertoires and calling for temporal rules for relationship-driven repertoires during its existence.

The emergent and sustained complexity in temporal responses allowed the network to realize its ambitions of engendering multiple ecosystems.

We contribute at the intersection of the literature on interorganizational networks and the literature on temporality in three ways. First, the literature on interorganizational networks essentially has been silent on time. Castañer and Oliveira (2020: 93) recently summarized that “[e]mpirical research has... been slow in examining issues of timing.” Our findings shed light on how an interorganizational network overcomes time as a deterrent by developing a combination of different temporal responses that move the collaboration away from familiar relationships or siloes and from one temporal orientation or dominance (McGivern et al., 2018). Second, the findings underscore the need for the network to actively manage complexity in temporal responses in order to move the network toward its collective potential. The resulting repertoires render collaborative temporality both rule- and relationship -based, neither of which alone was sufficient to ensure progress for the collective benefit. Third, the active management of the repertoires was enabled by a number of conditions including participant openness to multiple temporalities and their capacity to cope with them. Our contributions shed light on poorly understood areas in the intersection of interorganizational collaboration and temporality for collective benefit, offering a deeper understanding as called for in the extant literature (Lumineau and Oliveira, 2018; Ahuja et al., 2012; Provan et al., 2007).

Time Deterring and Resolving Interorganizational Network Collaboration

Research on interorganizational collaboration points to time as a deterrent but also as a resolution to the temporal complexities stemming from home organization diversity and the network activities themselves.

Time as a Collaboration Deterrent Time can be a deterrent to collaborating: the home organization diversity may lead to differences in time horizons of short- versus long-term goals and expectations and time orientations of past, present, and future. Prior research has found that participants in industry and academic collaboration networks, in particular, diverge in their conceptions of time and pacing norms (Bjerregaard, 2010; Perkmann et al., 2013; Barbour et al., 2017). Such divergence undermines cross-industry collaboration. New relationships may not form that would enhance outputs including innovation. The divergence also complicates a settlement or consensus on joint goals and delivery expectations (Garud et al., 2013; Reypens et al., 2020). As the home organizations' interests and demands may change (Doz, 1996; Deken et al., 2018), new temporal norms and relational arrangements are needed (Fortwengel and Sydow, 2020; Staudenmayer et al., 2002). The changes can further complicate arrangements that benefit network collaboration in particular when the network membership is fluid.

Moreover, time can be a deterrent to network interaction (Cipriani, 2013). Network participants are under various time constraints by their home organizations. "Time famine" (Perlow, 1999) can lead to the use of familiar and well-worn repertoires that sacrifice network collaboration.

Interaction also may be reduced by opportunism, particularly in fast-paced, short-duration relationships (Das, 2006; Bakker and Knoben, 2015; Garud et al., 2013), or by goal displacement among participating organizations (Grodal and O'Mahoney, 2017). Without a shared culture or past, interaction is challenging as collaborators have no temporal norms or joint understandings of references, such as timelines (Yakura, 2002), that can help to cue them on the need for transitions and shifts in activities (Reinecke and Ansari, 2015). Prior research has suggested the introduction of a "boundary organization" so that there is no need for direct interactions (Perkman and Schildt,

2015). Mediation eases collaboration, but it also undermines the very essence and intent of forming a research network (Jarvenpaa and Välikangas, 2016).

Time as a Collaboration Resolution Besides serving as a deterrent, time is also depicted in the interorganizational literature as part of a resolution, overcoming temporal challenges to access the collective potential of the network. Several scholars writing about temporality call for responses that highlight temporal complexity (Dille et al., 2018), temporal reflexivity (Reinecke and Ansari, 2015), and multiple modes of collaboration (Reypens et al., 2020). Dille et al. (2018: 684) found that inter-institutional projects required “coming to terms with diverse time-reckoning systems that challenge entrained time orientations with regard to phasing, speed, and timing.” In temporal reflexivity, Reinecke and Ansari (2015) refer to sensemaking that begins to consider the accommodation of multiple temporalities that broaden the temporal stance in the areas of conflict. Reypens et al. (2020) describe how innovation trajectories require switching between dominating actor orchestration versus consensus-based orchestration.

For time to offer collaborative resolution, the network participants must be open to multiple temporalities and have capacity to navigate different temporal requirements simultaneously. This capacity goes beyond a singular conceptualization of time (Arino and de La Torre, 1998; Davis and Eisenhardt, 2011), criticized by Lumineau and Oliveira (2018), and beyond the collapse of time into a dominant, potentially handicapping entrainer (McGivern et al., 2018). Ofori-Dankwa and Julian (2001: 427) discuss “the relative ease at which individuals shift or adjust their time orientations to effectively entrain or detrain.” In the same spirit, Waller et al. (2020: 265) discuss the simultaneous cycling among and attending to the past, present, and future in dynamic team

collaboration. Network collaboration, to benefit the network rather than its privileged members, requires the progressive accommodation of complexity in temporal responses.

This accommodation of complexity in temporal responses has been noted in prior research on interorganizational networks. Beck and Plowman (2014) report on a crisis organization that engages in proactive experimentation in the collective interest of a fast response: Here, it is the various organizations' members participating in the crisis response that navigate much complexity in action and create a collective rescue response without a concern for "who gets the credit" (p. 1246). Ofori-Dankwa and Julian (2001) emphasize the collective potential in strategically harnessing temporal complexity to shift and adjust to competing demands and to maintain institutional support. Such complexity in temporal responses for collective potential is particularly critical in networks that operate without an authoritative intermediary-based orchestration (Giudici et al., 2018) or externally dominant interests (Browning et al., 1995).

But temporal complexity must also be sustained for collective benefits. In cases where there are externally influential interests or other power structures dominating the network, complexity has been reduced for their particular benefit. Dille et al. (2018: 682) found that when temporal responses moved away from "temporal avoidance" and "temporal splitting," the responses did not produce a "cooperative solution." In fact, "management... tried to match and coordinate by playing constituencies off against each other" (Dille et al., 2018: 682). Other studies have suggested that temporal framing or norming has been co-opted to pursue particular interests (McGivern et al., 2018; Granqvist and Gustafsson, 2016). Zietsma et al. (2018) found industry incumbents resorting to unobtrusive time-based actions in defending the status quo and foregoing the collective benefits by stalling change. In this line of research, the resolution comes at the

expense of network benefits, and temporal complexity is strategically harnessed to benefit a single organization and its particular interests.

Collaborative Temporal Repertoires as Complexity Arrangements

We take inspiration for sustaining temporal complexity from a study of 3M corporation. Garud et al. (2011) argue for such temporal complexity in describing how the company proactively manages innovation through “complexity arrangements.” The complexity arrangements require multiple temporal relationships and rules for innovation to happen: When people from different units are summoned together and local interactions take place, novel and diverse knowledge combinations are generated. Some of these combinations lead to innovations, and managers at 3M are thus “encouraged ... to cultivate events driven by serendipity and opportune moments” (Garud et al., 2011: 738) to foster relationships between ideas and people while also waiting and stretching time until “...the time is right” for the innovation to be realized (Garud et al., 2011: 757). According to Garud et al. (2011: 739), such rules and relationships create the routines and “grammar that governs how elements may be combined and used.”

In interorganizational networks, temporal rules and relationships also speak to the valued uses of time and shape the meanings and expected behavior patterns (Schriber and Gutek, 1987). Yet, rules and relationships are challenging to develop in an interorganizational network. A passage of time may be needed for the relationships to be “cemented” (Ahuja et al., 2012:441). While serendipity and diversity are associated with novelty, relations that leverage them can be viewed as illegitimate if they are too far removed from those in the past. New relationships can be also inefficient if there is no time for the ideas born of the relationship to mature or for the relationship to be strengthened. Collaborative time is limited: Relationships may be short-lived if

participants' home organizations change strategic interests and if network members change. The luxury of a lax temporal rule like at 3M (Garud et al., 2011) may not exist in a network with a finite beginning and end. Time is differently valued: The temporal rules need to stimulate or invite participants into temporal relationships to compress time and create, rather than wait for, the right time for innovation.

What is particularly poorly understood is how interorganizational networks resolve temporality for the benefit of their collaboration *and in the interest of the collective*. Beck and Plowman (2014: 1238) report on the "chaos of early hours" in relation to the interorganizational response to the Columbia shuttle disaster. The emergent response included setting goals, co-locating, deploying standard responses, and developing collective identity. Organizations resorted to spontaneous experimental responses even when "any plan... was lacking" (Beck and Plowman: 1241). Yet, they had no time to develop network level awareness of progress and benefit because the crisis was more complex than anything they had experienced before. Responding fast was of primary importance. Beck and Plowman (2014: 1242) state that interviewees emphasized a "try it and see if it works" attitude. Gaining an overall view of the crisis and gauging the effectiveness of the response had to wait as organizations coped with the immediate urgencies. Deken et al. (2018) report that managers participating in a collaboration were unaware of the capabilities needed for effective partnerships (e.g., data analytics) and only gradually discovered the resources that would be required; these discoveries eventually led to their preference of one partner over another as the network collaboration progressed. Non-preferred partners felt the network had failed them, as the siloed collaboration lacked means to translate and integrate network efforts into collective benefits.

We now turn to the empirical study of how an interorganizational network created sufficient complexity in temporal arrangements to respond to its collaborative demands and realize its collective ambitions.

Methods

Research Setting

Our research findings emerged from an inductive study of a four-year national research program focused on the future of cloud software in a Nordic country. The study was part of a broader research program on open innovation networks and their collaboration approaches undertaken by the first author. As the software program started, the field researcher had already completed studies on other similar research programs that involved industry/academic network collaboration. The field researcher was invited to present the research findings from studying these other programs at an early meeting of the software program. At this presentation, the field researcher gained permission to attend and observe future gatherings of the program. Seeking to understand collaboration practices and how they evolved as research progressed from ideas to pilots and then to ecosystem formation, the field researcher found the diversity and the large number of different organizations surprising, compared to the other research programs that the field researcher had observed. The diversity and size of the program would challenge network collaboration.

The cloud software program brought together more than 100 different organizations in the program visioning stage. 30 industrial organizations and 8 research institutions (universities and national laboratories) participated in at least some part of the program after it was formally funded. This four-year program (2010–2013) was the largest study of information and

communication technologies (ICTs) ever conducted in the country and had a budget of 72 million euros. The program was characterized by high ambition: Participants were pioneering new business models, lean organization transformation, and emergent infrastructures in software. The research had to be useful and value-creating for firms' competitiveness and also was expected to make academic contributions. Yet, foreseeing how to accomplish the academically respectable research while driving an industry-wide capability shift was difficult. The research network, observed for most of its existence, provided a unique opportunity to examine time in its manifestations in interorganizational collaboration. The attempts at collaboration were visible, as were the variety of time orientations, time pressures, and ambitions of the heterogeneous participants and stakeholders. Although the network activities – including visioning, execution, learning, and value creating – represented major challenges due to program diversity and ambition, this prestigious and high-visibility program eventually was considered successful by an external assessment committee.¹

The network initially was structured as a traditional industry research program, based on the expectations of the public funder and the conventions of joint research programs. Such traditional programs generally include strategic research agendas (SRAs), with overall goals split into sub-goals. In addition, such research work is organized in work packages and follows a carefully constructed roadmap over the period in question – four years in the current case. Annual output reports manifest progress, which then releases public funding for the following year. Initially, the temporal conception for this project was linear; the research was planned in calendar time, with regular meetings, work package target dates, and the assumption that research was to be

¹ The authors neither belonged to nor participated in this committee.

conducted over the pre-set period. However, using this approach made prioritizing collaboration and dedicating time for it difficult for the program participants. How to accomplish the ambition of cross-industry innovation and what this ambition meant in practice was unclear. What kind of software transformation was needed and when? How were the project's goals "different from the Internet"? How would a meaningful strategic research agenda even be produced? A project coordinator described the situation:

Taking the objective of creating new cloud-business, it's certainly not crystal-clear [laughing] what kind of business should be targeted or specific objectives set. The aims are rooted in the goals of the participating organizations and the world surrounding them. Of course, we do have some very specific goals – like we want an open cloud stack."

To highlight program specifics, there were nearly 400 researchers from industry and research organizations. Many more participated in early preparations, prior to program funding. A research program board comprising senior executives and directors from industry and academia was responsible for advising the participants and helping them connect the research outputs to business ecosystems. It should be noted that the academic and industry directors and the program managers changed during the program. Hence, there was much fluidity in the network though the program coordinator remained the same individual from the beginning of the funded research program to the end. The research program attracted highly qualified researchers who had both academic and corporate work experience and who came from companies and research organizations. The industrial companies varied considerably in size, as well as in lines of business. The relevance of the program for the participants' core business also varied. Industrial companies included device manufacturers, network providers, software development houses, consulting

organizations, content developers, and gaming companies. The research institutions included the top research universities in the country, as well as the newly formed applied science schools.

Data Collection: Observations, Interviews, and Documents

In addition to interviews, data for our analysis came from research program presentations and from our observation of groups of researchers interacting around a demo and exchanging ideas in various gatherings and meetings. The field researcher initially took notes and later expanded them into field notes.

The field researcher interviewed 22 different individuals in the cloud research program in the course of the study (see Table 1). Several of them were interviewed repeatedly. The interviewees included the program leaders (i.e., board members, directors, coordinators, and managers) and researchers from industrial companies and academia. The interviews involved individuals from a wide variety of backgrounds, positions, and levels. To ensure that the sample included the most knowledgeable informants, the researcher used a “snowballing technique,” asking initial informants to recommend others who could offer further insights. While snowballing technique tended to favor those most committed to the program, the method was complemented with informal discussions in workshops, where the encounters were random in the sense that they did not depend on prior introductions (Heckathorn and Cameron, 2017). Thus, the vertical sampling was complemented with horizontal interviews of participants, including those who may have attended just one or two workshops (Geddes et al., 2018). We spoke with those who had positive experiences and those who had negative experiences with the program. We also selected informants who came from different home organizations and represented both large and small industrial companies, as well as universities and applied science schools. The program leaders,

from both academia and industry, served as the initial informants. We recorded most interviews, except when they took place during a meal or during coffee breaks. For unrecorded interviews, we captured detailed, written notes.

---Insert Table 1 here ---

The interviews varied in length from 30 to 120 minutes. The interviewees were asked to share openly what they felt was important to understand about the program and its way of working. They were asked to reflect on the research process and outcomes, on balancing the interests of their home organizations with the collective interests of the program, and on the sharing and protection challenges they faced. We did not specifically probe for time-related factors or how their time was spent. Nevertheless, time emerged as a critical element during the observations and in our analysis of the data. The transition from calendar-based, linear time to fast-paced, agile-like sprints in 2010 became particularly visible. This shift to the three-month research collaboration caused the questions in the interviews to focus more intently on the use of sprints and their effect on research collaboration. Over time, participants' discussions in various gatherings allowed them to narrate themes - translate, connect, and integrate research results across the program. The themes then contextualized into business cases in emerging ecosystems; questions in interviews then reflected sharing and ecosystem activities. As the interviews continued, ongoing interactions with participants probed for the network research progress including the network's collective benefits.

In addition to our meeting attendance and interviews, we collected archival data to trace the program planning, key decisions, meeting agendas, presentations at various gatherings, and the

program evaluation by external evaluators for the study period (see data sources in Table 2).

During the final year of study, as the participants' activity moved toward forming the ecosystems with proprietary concerns, the field researcher had less direct access to the activities taking place.

The second author participated in the data analysis stage, providing an outsider's point of view (Rerup and Feldman, 2011).

---Insert Table 2 here ----

Analysis

We began our analysis by developing a timeline of the program, including its key events, such as meetings and workshops. Because our data analysis approach was inductive, we relied on four rounds of coding the data, in concert with reviews of existing literature, to identify themes and concepts. As our understanding of the network activities improved, our conceptual and theoretical frames changed (Elwood and Horner, 2020). After drawing a chronological representation of the network events, we focused our first round of analysis on temporal capability; we bracketed the data using the framework of Huy (2001), whose categories include commanding, engineering, teaching, and socialization interventions. This round of analysis provoked the question of how a large-scale program develops temporal capability (beyond calendar-based planning) and changes from one temporal intervention to another in a fluid network.

Our second round of analysis focused on collaborating in the network. The analysis leveraged the work of Staudenmayer et al. (2002) and De Rond (2014) on how organizations and networks become "poised" for serendipitous discovery (or develop *kairos* as described by Garud et al., 2011:738). In this stage, we focused on understanding differences in the ways participants

experienced the collaboration. The participants' experience of the start of the program was "painful" and lacking direction: "We could not find a 'red thread' in the draft plan. We threw away the draft and decided to start over." There was a move to three-month sprint cycles. Sprint collaboration reduced reliance on trusted relationships and encouraged openness and risk-taking in forging new relationships that involved new knowledge competencies. Yet, the program participants found that developing coherence across different research results was difficult. Next, different community events took place with trusted experts translating and connecting results into larger themes. As the urgency to develop business cases grew, the thematic opportunities were contextualized and made actionable in emerging ecosystems as pilots and experiments. The key observation in the analysis was that time was experienced and valued differently while collaborating by the diverse network members.

The third round of analysis focused specifically on time in interview transcriptions and in meeting and workshop notes. In our preliminary analysis in this round, we linked the participants' actions to different conceptions of time (e.g., linear, episodic, or event time) and considered their responses in terms of collaboration. The participants met diverse temporal demands, such as the adoption of the three-month sprints or organizing events. Among the time-related categories that emerged were temporal rules, such as those deployed in SRA or a business case, and temporally structured relationships, whether top down, ad hoc, or community-based. We considered the difficulties in collaboration, such as stalling and fragmentation of research results. We followed intermediary outcomes, new ways of working together, and generalizing knowledge. We positioned the interviews in a timeline, taking into account the perceived collaborative difficulties the interviewees described as well as the collaborative responses in terms of temporal rules and relationships.

We next revisited prior literature, examining the role of time in interorganizational networks to interpret our findings. Time's deterring of collaboration was evident in the difficulties of getting started in joint research and in making sense of the research progress across the network. Time's resolution of collaboration was evident in participants' development of temporal rules and relationships across the network.

In the fourth coding, we went through our data again and tagged interview quotes, first on the basis of temporal rules (e.g., the uselessness of research that produces results beyond executive tenure) and then on the basis of relationships (e.g., a company partner had to participate in all joint research). The data were seen as responses for coping with the diverse temporal demands of interorganizational networks. We focused on elements related to norming and governing of the network collaboration and categorized these elements as rules (e.g., the imperative to share results of joint research, but not the method). We categorized elements that described the interdependencies between people, programs, and goals (to what end) as relationships (e.g., experts convening in events or expressions of a desire to learn to work together in temporally diverse ways). We coded participants' difficulty in following research progress and its business implications across the network. For example, we found references in interviews to the difficulty of moving beyond existing research and of achieving collective benefit.

We then focused on coding for the collaborative repertoires involving temporal rules and relationships, keeping an eye on the network's collaborative benefit. We revisited the rules and relationships emerging from the data in order to understand how they produced collaboration. We paid attention to the order of rules and relationships that emerged in the collaborative

repertoires. We identified the related ways in which the network moved toward its collective potential and “translate[d] insights from one situation to another and over time” (Garud et al., 2011: 759). This aggregation highlighted how collaboration and its temporal repertoires are constructed, with the participants as proactively managing network temporality as the network moves toward its ambitions. According to our data, these repertoires together constituted temporally complex collaboration – something akin to what Garud et al. (2011: 741) found in a single company context and referred to as complexity arrangements, in that “actors can potentially engage in a variety of activities and events simultaneously, each with its own temporal rhythm,” and to what Ofori-Dankwa and Julian (2001) referred to as climbing the ladder of complexity. Our theorizing, which focuses on temporally complex collaboration, results from four empirical rounds of coding; particularly in the final, fourth round, we considered the results in the context of interorganizational networks and the collective potential. Appendix 1 summarizes the four rounds of coding.

Findings: Developing Complexity in Temporal Responses for Network Benefit

Our study shows how a large heterogeneous interorganizational network engendered collaborative repertoires in network collaboration to realize the collective potential. To meet home organization demands, along with the mandates of the public funder, and to accommodate varied activities in network collaboration, network participants developed collaborative repertoires with different temporal rules and relationships, thereby engaging in temporally complex collaboration. Importantly, no one single action was necessarily complex; it was the combination of collaborative repertoires together that made the network participant responses altogether temporally complex. These temporally complex repertoires developed over time and were used simultaneously across the network. With these multiple collaborative repertoires, the

network was able to remain open to new opportunities and to achieve its ambitions of multiple ecosystem formation.

The analytic narrative is structured as a set of complexity arrangements: We start by describing the externally imposed collaborative repertoire of rules and relationships in response to temporal demands of home organizations and the public funder. This repertoire did not develop network collaboration nor produce any collective benefit. We then describe three collaborative repertoires that were developed and sustained within the network to progress on joint research and to move toward network ambitions.

These repertoires, emerging over time, differed in terms of whether temporal rules or relationships were evoked first: In the sprints repertoire, the temporal rule of three-month collaborations mandated new collaborative relationships; in the second narrative time repertoire, the temporal relationships focused on sharing results from sprints through narrating thematic opportunities in event-ruled network collaboration; in the third “right” time repertoire, the results were contextualized as business cases and put into action in emerging ecosystems when the time was ripe from the perspective of ecosystem participants. Throughout the network’s existence, external temporal demands from home organization priorities and internal temporal demands implicit in the network activities caused the network to struggle to realize its collective potential, first in collaborating at all and then in making sense of fragmented research results across the network. In realizing network collaboration for collective potential, temporal complexity increased as collaborative repertoires multiplied and overlapped (see Figure 1). Eventually, five ecosystems emerged out of the network’s research collaboration.

---Insert Figure 1 here ---

We start by describing the initial temporal demands that acted as deterrents to network collaboration. We then explain how changes in and additions to temporal repertoires kept the network from failing, eventually creating collective benefits in ecosystem formation.

Temporal Demands Deterring Network Collaboration

When participants joined the network, they brought along their home organization temporal demands. While private company representatives talked about the need to show research results in the short term, researchers in universities thought in terms of multi-year research programs. As one company executive noted, “there is no use talking about research results beyond three years; no one here is interested as they will have moved to different positions by then.” Another researcher had a target of results within a year. A research institution participant lamented that “real research” could not be done in a very short time frame. Small and large companies had their own temporal expectations in terms of the “right time” (Garud et al., 2011: 742).

In addition to home organizations’ temporal demands, the public funder articulated temporal demands as well. The research program had been formed as a four-year program, but the government funding was dependent on the development of SRAs and then on annual program reports, contingent on the demonstration of progress. Without government funding, the companies were unwilling to provide matching funds. The program coordinator recalled that “[o]ver 400 people and 10,000 hours was spent on planning how to proceed during 2009 alone” in order to meet the chronological, calendared timeline. An academic researcher rejoined that it was “[a] damn long planning phase, a truly long and tiring phase [discussing] how to move forward.”

The planning preempted any joint research. Meetings were driven by sizing research targets to work packages and then fitting the work packages to the annual calendar-time expectations of the public funder. However, such linear timing failed to ignite the new research collaborations needed for realizing the ambitious research targets. An industry researcher stated: “We spend too much time planning rather than carrying out research.”

Little new joint research was materializing. Participating companies were reinterpreting their existing projects and failing to make new connections or to make progress toward the program goals. A research coordinator noted that much of the discussions were between two partners that already knew each other. “More ecosystem formation should happen in my view as that is the intent of this program. Now [company x] is collaborating with [research institute y] just like before.”

There was an emerging realization among the network participants that they were failing to collaborate for collective benefit. The network was making no progress toward new research results, cross-industry innovation, or, ultimately, forming business ecosystems. The home organizations’ research agendas dominated the discussions as participants tried to comply with the public funder’s calendar time as a technical requirement. The companies that collaborated did so based on prior intellectual property sharing agreements and their particular temporal demands. Expediency in light of the time pressure was preventing new research collaboration from emerging. Because the network was simply mirroring existing relationships, without igniting any new joint research, industry interest began to fade, and funding was soon at risk.

Emergence of a Temporal Rule Catalyzing Joint Research

Despite difficulties of moving toward joint research, the participants appreciated the potential of working together. “Yes, [we] do understand that when we do things jointly, we achieve much bigger things.... The cake is bigger” (research coordinator). The academic leader was hopeful that “eventually we will learn to work together.”

In the pursuit of collaboration, open research-oriented workshops were organized in which participants made presentations of their research interests. In one workshop, a participating company aroused interest in agile ways of working (Fitzgerald et al., 2006; Conboy, 2009). This workshop echoed an earlier presentation by a lean startup “guru.” The presentations led to ad hoc experimentation with “agile-type” development cycles as a means to increase researcher engagement and to create outputs that could be used to manifest progress. “We... came up with this... joint [sprint] idea even if it was not written in any vision statement,” reported the academic program director. These discussions led to a restructuring of the program into fifteen different rapid research cycles for the remainder of the program. The emphasis was on the *temporal rule* of a three-month period during which to work together:

You got the idea that sprints are not about who is doing it; they’re primarily time periods, so the cloud software program is doing three-month sprints that have technology and business aspects to it...” (industrial researcher).

The introduction of three-month sprints as a temporal rule catalyzed joint research and hence mobilized the collaboration, albeit in small teams. Yet the temporal rule was contested – and this contestation spanned academic and industry boundaries. One program manager recalled a storm of opposition: “We kept hearing: ‘How is it possible to do real research in three months?’” Resistance also came from industrial researchers; one remarked that “I found the ‘sprint’ concept unnatural to research. I am a physicist by training. You cannot get anything meaningful done in

three months.” However, as an industry program manager acknowledged, “no one came up with anything better.” Sprints supported joint research because they required minimal planning and focused on working on a targeted research idea. Because of the concreteness and the fast delivery of actionable results, the time seemed to be well-spent. According to an industry program manager, “sprints were a marvelous idea. Particularly as we don’t have the faintest idea of whether we are still in this company in three years or not. What I try to do is to work on things that can be realized within one year.” The results in each research cycle – every three months – included new concepts, prototypes, test results, and use cases that began to provide network benefits in joint research. Each research cycle ended with a quarterly workshop where results were showcased in various sessions, including a research bazaar.

New Temporal Relationships Ignited By The Temporal Rule

Sprints led to new relationships in the network. No one was allowed to “sprint” alone: Working with a partner company in the network became mandatory. Each sprint team had to include researchers from both industry and academia. Sprints soon became the dominant way of conducting research together: “If you are not involved in a sprint, working together with others, you cannot be part of this program,” the program coordinator reported. The program coordinator mapped out who collaborated with whom: “We created a template to map all the relationships between companies working together.... The map allows us to see how the networks are changing and whether the smaller companies are joining in.”

Researchers had to learn how to work with other researchers across the network. Finding a collaborator was not always easy because participants did not know each other. According to one researcher with a public organization, “we very much want to work together... but sometimes it is

hard to find a company able to understand the competences we offer.” This challenge remained, even though the three-month sprints reduced the level of commitment needed to start a collaboration. Relationships between sprint teams were based initially on prior acquaintances, but later relationships were formed quite fortuitously – from chance meetings in a taxi, for example. New relationships were brokered as additional partners engaged in joint research, and the content of the collaboration changed to include their interests. Network benefits began to materialize in terms of new collaborative relationships.

Despite the energy created by the sprints and their follow-up quarterly workshops, researchers began to complain about fragmentation. Knowing what was going on across the network was difficult, as was understanding how the research results related and connected to each other. One industry researcher noted that “last time, we talked about the need to develop more coherent perspectives and outcomes.” One company leader noted that “it would be great to have more visibility to the research conducted in the network so I could tell my senior executive that, look, we invest not so much but gain access to all these research results.” Another industry program manager pointed to a missed opportunity in network benefits: “Some sprints came as a surprise to me; we should have been involved. One university was doing something that was very research-driven, but the area was exactly what we were doing also. We could not find technical competence to join our program, which this university could have offered.”

In part, the difficulty in achieving collective potential – of seeing what was going on across the network – resulted from a lack of time for engaging with what others were doing. The quarterly workshops were too time-compressed for integrating ideas and seeing network-level research

progress, despite offering an opportunity to review the various sprint results from the previous three months.

The challenge was in seeing the big picture: “You have 150 people in any single meeting, [so] how are you going to get these people and the remaining 250 people in the program [who did not attend the workshop] to understand what the big picture is, I think that’s the challenge...” (board member). Without the big picture, network members had difficulty understanding the collective benefits and translating and linking them to ecosystem formation. Another challenge entailed maintaining openness to changes in direction: “Let us not lock in what the research in the next quarter will be. We do a fast proto, share in quarterly sessions, then we find some new things that were in no one’s plan, or that could not be identified or articulated earlier” (industry program manager). The purpose of the network, after all, was to develop joint innovation across the industries and participating organizations; an awareness of the ongoing research and its business implications among participating companies was important. According to one industry program manager: “We were discussing... that we need joint demos and integrated business cases that go through entire supply chains... not just bits and pieces here and there....” Another industry program manager stated that “we should have a clear map of all competencies in quarterly reviews – here is the next sprint; what competencies are available for it?”

As the novelty of sprints as a temporal repertoire was waning, participants’ feelings began to intensify that too much “now or near term-time perspective was favored in choosing what to do in sprints” (academic program director). The dominant criticism was related to the outcomes generated by the ad hoc nature of the sprint cycles: “I think the research in this field is basically

not very useful. What I mean is the single instance examples...” (program manager). The academic program director stated:

It’s somewhat one-sided, limited in visibility, this perspective.... It’s difficult to draw any common architectural map for the whole program. This is not simply about technological solutions but also about business opportunities. So the picture is multifaceted with cloud technology, cloud services, and related cloud businesses more generally moving together, hand-in-hand.

From Research Fragmentation to Benefits Across the Network

The second collaborative repertoire was a response to the fragmentation of the research progress across the network. Developing a network-level view of progress and emergent cross-industry opportunities was challenging. The temporal repertoire that emerged built on temporal relationships followed by temporal rules.

Narrating Experiences in Relationship-Driven Events

As the network faced difficulty in assessing its research progress, technical experts in the network began to have thematic discussions around their particular areas of interest. The first such an event was formed by the participants of various sprints whose interests were related to “lean software organization.” This event brought together subject matter experts from academic and industrial organizations. The event was followed by other such gatherings that examined themes including strategic lean organizational transformation and the lean way of working in software development teams.

The idea of focused events began to spread; at one point, five different event “series” existed, with interests ranging from business models and cloud software development to cyber

security. The temporal repertoire began relationship-based as subject matter experts invited other network experts to the events. These events took the form of a morning or afternoon meeting or seminar. The cloud software development “series” also organized a successful “hack-a-thon” in order to evaluate and apply the research results in specific cases. Books were published on joint work (e.g., *Value Driven Business in the Cloud*, *The Secure Agile Software Development Lifecycle*, *Landmarks for the User Experience in the Cloud*).

New Temporal Rule for Narrative Time

Although researchers were also still engaged in sprints, spending time together in focused gatherings allowed translating experiences from sprints and more open discussion of shared issues of concern to the researchers, “[T]he community of practice [events] were important as people were able to [really] discuss with each other and build collaboration networks” (industrial program manager). Because of “great bonding,” as one academic researcher noted, “participants were more willing to share company-specific knowledge in the community.” An industry program manager appreciated the progress: “We are moving from a long corridor with closed doors to people standing around the table.” The main content of the seminars and meetings was oriented to program research, and for these events, a future-focused and implicit temporal rule was operative: The participants, as subject matter experts, could trust their peers, sharing knowledge during the events without damaging future confidentiality or risking that the information would be shared after the event in an improper way. Thus, the events instituted an implicit temporal rule involving knowledge sharing. An academic researcher noted: “There has been a lot of trust in researchers and autonomy – go ahead full speed.” The program coordinator appreciated the emergence of coherence in that “we are finally in the same box.” (Still, some participants

complained about reports that were “written too academically [for me to] share them with our leadership,” which negatively affected comprehension.)

Through the events, the subject matter experts were able to assess network-level progress. “[We can] look for [the] competencies we might require that are available in universities” (industrial program manager). Another industrial program manager stated that, “[i]n the community of practice workshops, people were able to discuss with each other and build collaboration networks. The workshops gave a better foundation for the joint research work.” Reflection on emergent research themes and perspectives was particularly appreciated. As one industrial program manager pointed out, the events could lead to benefits when participants combined one company’s concept with another’s concept that “we had not even thought of yet.” An industrial researcher noted that a joint retrospective examination of research results was useful for understanding what had been accomplished, how to comprehend progress at present, and what changes might be needed to attain the program’s ambitions. This narrative time promoted network-level understanding.

Still, articulating this network-level view was not without difficulty. One participant described his effort to integrate research results and communicate to his company management. “I gave a talk to our leadership [about] how to advance lean thinking in our company. This attracted a lot of attention, and other participants wanted to see the powerpoint presentation. So we made a presentation template, which required filling in the information regarding one’s own firm for the presentation.” The narrative time also shifted network ambitions. To gain wider perspective, a group made an 11-day trip to Silicon Valley, which resulted in the realization that much of the open cloud stack had already been developed by others around the world. This work

of others could be used and adapted quickly, with potential for network collaboration to make a “quantum leap in work progress” (Waller et al., 2002: 1048).

Impending Urgency to Realize Network Benefits

During the course of our study, the national economy began to deteriorate, leading to threats to the program’s budget. In response, the participants faced pressures to link the thematic knowledge themes from expert events to business cases that could be acted on in the emergent ecosystems. Executable business cases became important to ensure that the themes were linked to a temporal benchmark, indicating that the time was “right” from the business perspective, for experimenting on and adopting ecosystem cloud services or concepts.

“Right” Timing of Ecosystem Formation

The cross-industry innovation emerged through the clusters of companies that had identified related, executable business cases. These clusters, based on the business cases, eventually developed into the ecosystems that continued the collaborative potential engendered by the interorganizational network. For example, one ecosystem developed from multiple different business cases that together formed a new approach to cybersecurity in the cloud.

The temporal demands were articulated in the “right timing” of the business cases that formed the ecosystems. The right timing triggered the emergence of temporal rules and relationships more simultaneously than in the case of other two collaborative repertoires. The “right timing” involved organizations’ committing to pilot projects that included live demonstrations of new service concepts based on cloud technologies. The work was structured according to what the pilot projects specifically needed. For example, developing a cloud-based service to help consumers make “an

informed choice” about a product might be based on consumers’ preferences for sustainability. Ecosystem members invited other organizations, such as manufacturers and retailers, to participate in the ecosystem pilots as needed, but only if they were ready for “live” experimentation. The experimentations required considerable commitment from the organizations involved and were less visible to those not participating.

Restructuring Relationships for Ecosystems with a Right-Timing Norm

“Right timing” was not just about gathering a group of participants ready to commit to experimentation. It also required that the companies participating in the ecosystems share both the underlying service concepts and the technological tools and platforms developed for the ecosystem pilot project. This sharing represented a high cost for some network participants, and network relationships changed as a result. Some organizations exited, while others remained. For example, industrial organizations exited if they could not accept the broad sharing of intellectual property that the ecosystem pilot projects required. In addition, small firms were particularly concerned about losing the exclusive rights to their tools and technologies. Some organizations left because they had no available business cases that they were ready under the short time window to prepare for the ecosystem pilot projects.

Despite the remaining relationships being restructured around the emergent ecosystems, the ecosystem pilots benefited the collective. Results from high-level pilot results were shared in the network’s quarterly workshops. Additionally, efforts were directed to support future ecosystems yet to be envisioned. The network curated an asset management system that would convey the research results from the 15 sprint research cycles during the interorganizational network’s existence: “We need to have a way to manage the results so that people can find value afterward”

(program coordinator). The “billion dollar business challenge” based on network research remained.

Table 3 summarizes the collaborative repertoires that emerged, including their rules and relationships. Collectively, these collaborative repertoires constitute temporally complex collaboration across the network. The network began its collaboration with the external calendar-imposed repertoire; it then developed its first temporal rule to catalyze joint research. The rule-driven sprint repertoire led to new collaborative relationships across the network. This temporal repertoire was followed by two additional collaborative repertoires. The narrative time repertoire emerged as expert events were held to make sense of fragmented results and find themes across the network. Finally, the “right” time temporal repertoire grouped those participants not just interested in narrating common themes but to contextualize business cases and act on them in emergent ecosystems.

Throughout the program, the participants leveraged multiple collaborative repertoires simultaneously. Certainly, they had to comply with the public funder’s calendar time for annual reports. But rather than merely being structured as traditional siloed work packages, all research results informed the overall program ambition for cross-industry innovation. The participants initiated complex arrangements to cope with the temporal rules of calendars, sprints, events, and finally the temporal demands imposed by emerging ecosystems. They also maintained multiple relationships across the network in sprint research cycles, expert events, and eventually as members in one of the five ecosystems that were formed. Collectively, temporally complex collaboration accommodated varying temporal demands of home organizations while innovating to realize the network’s potential (see Table 3 for a summary timeline).

---Insert Table 3 here ---

Discussion and Implications

Interorganizational networks are formed for the collective potential; that is, the network is expected to accomplish what the single organization cannot. The existing interorganizational literature acknowledges that the collective benefit often remains unrealized because the heterogeneous networks struggle to form (Järvi et al., 2018) and because they easily unravel or fail (Human and Provan, 1997). A network might not be able to begin its collaboration at all (Schrack and Whitford, 2011). Network goals might get compromised, or displaced, by the different strategic agendas of the participants (Grodal and O'Mahony, 2017), with anti-competitive implications (Hagedoorn et al., 2000). Prior literature offers few solutions for creating collective benefits in interorganizational networks under such pressures. Time and its complexities have been suggested as one of the enablers for collaboration (Castañer and Oliveira, 2020) yet research is still scarce.

Our study of an interorganizational network for the cloud software program over a four year period illuminates participant actions that strategically organize time and are sufficiently complex to enable network collaboration for the benefit of the collective. We demonstrate how the participants overcome time as a deterrent, managing to work productively with the temporal demands from home organizations while contributing to the network's ambitions. After the externally imposed calendar-based repertoire failed to produce collaboration, the network instituted a rule-driven sprint repertoire. The repertoire catalyzed joint research and generated a plethora of research results. The sprint repertoire was also critical in igniting new research relationships. The subsequent

relationship-driven temporal repertoires – narrative time and ‘right’ time - were critical to translating, connecting, and integrating results from sprints at the program level to emerging ecosystems. The collective potential of the network was realized despite the initial uncertainty of the network’s goals, how the network might accomplish its ambition, what research activities would occur, and how joint research time should be allocated. The network had no central timekeeper or instructor and hence had to cope with its temporal challenges internally.

The realization of the network ambition – the emergence of multiple, innovative ecosystems -was a major collective achievement in the network that had no organizational or technological infrastructure in place (contrary to prior research, see Garud et al. (2011: 758–59). As noted, the high collective ambitions likely contributed to the participants openness to emerging repertoires and their capacity to evolve them. Much was at stake for the participants individually as well as for their organizations. The large and diverse network gave the participants unprecedented and novel opportunities for new collaborations which the repertoires helped to make possible. The time-boundedness of the network likely also impacted participants’ focus from home organization temporal demands to the progress at the program level.

Theoretical Implications

Our study advances three crucial implications. First, we focus on how interorganizational networks strategically complexify time for their benefit, thus overcoming time as a deterrent to interorganizational collaboration. Second, we advance the understanding of time as a resolution to collaboration, articulating temporal collaborative repertoires with rules and relationships that are sufficiently complex to accommodate network diversity while enabling collaboration for collective

potential. Our third implication is contingency-oriented: Such temporally complex collaboration is not independent of the network context, and it requires proactively authoring the repertoires.

Overcoming Time as a Collaborative Deterrent

Interorganizational networks tend to be characterized by temporal diversity. Yet the existing literature reports cases of a singular temporal structure being imposed whether the calendar time of the formal research plans or the temporal orientation of the privileged or the powerful (McGivern et al., 2018; Schildt et al., 2020; Fortwengel and Sydow, 2020; Granqvist & Gustafsson, 2016). Such suppression tends to harm the network's ability to collaborate for collective benefit, in particular, to innovate (Garud et al., 2013). The network thus has to overcome the imposition to structure time as something one-dimensional or singular (Lumineau and Oliveira, 2018). Overcoming time as a deterrent requires accepting and inviting the multi-temporality (Garud et al., 2013) of home organizations and of the network activities themselves as part of the network collaboration.

Sufficiently Complex Collaborative Repertoires

To go beyond the deterring singularity of network temporality (Lumineau and Oliveira, 2018), we contribute a temporal view that is rule- and relationship-based for interorganizational collaboration. Although the initial collaborative temporal repertoire was rule driven, relationships were also impacted. The relationship driven temporal repertoires had associated rules. However, the participants did not engage with one repertoire only, but with multiple collaborative temporal repertoires in parallel: producing fast results with one or two partner organizations, reflecting on their thematic significance in events with other organizations, and contextualizing the themes and purposing them for emerging ecosystems. Thus temporal complexity in collaborative repertoires comes from this capacity to simultaneously enable the activities of joint research: visioning,

execution, reflection, and field implementation and their varied temporal (past, present, future) demands.

Collaborative actions reflect temporal complexity. As Ofori-Dankwa and Julian (2001) describe, the participants “climbed the ladder of complexity” from calendar-driven time to episodic time to multi-temporality. But at times, the participants in the network also needed to come down the ladder to simplify and translate for other network participants. As one participant observed: “There has been various means to present progress and results, which I find laborious. Please choose one format (or a fixed set of formats) for future use.” The temporal simplicity of calendar-time was ever present in funding, even as other temporal repertoires added complexity to sustain the collaboration. Yet, no repertoire suppressed the others, which allowed the network to avoid obstacles discussed by Okhuysen and Waller (2002).

The Network Context for Authoring Collaborative Repertoires

For an interorganizational network to develop capability to create and cope with temporal complexity, certain enabling conditions need to be present. Attending to multiple collaborative repertoires requires, first, that the participants are open to such temporal complexity. (Some participants left the network blaming ‘chaos’).

Second, the network participants must be genuinely motivated to pursue collective network level benefits, not just collaborate for the strategic interests of their home organization. Such a network motivation can be enforced by making the collective ambition visible – in our case the network was a high stakes national project with leading companies and universities participating. The initial frustration of how to turn the ambition into joint research was eventually replaced by the

enthusiasm for working together with its varying collaborative temporal repertoires. Sprinting was fast-paced while narrating business opportunities offered welcome time for reflection. Likely the internally developed nature of the temporal repertoires encouraged collaboration for the collective benefit as temporality was something that the network managed and sustained on its own rather than something that was externally imposed or entrained. Thus the temporal complexity - challenging as it may have been to navigate – offered authorship of the collaborative rules and relationships among the network researchers. There was also urgency. The network was time-bound in that it ran for four years, with high aspirations for industry change.

Our findings of temporally complex collaboration complement existing theoretical research that acknowledges complexity in temporal responses. Ofori-Dankwa and Julian (2001) note that individuals can and do adjust their time orientation. Waller et al. (2020) discussed temporal multitasking in dynamic team collaboration. Garud et al. (2011) described complexity arrangements in a multi-unit organization, where the arrangements afforded multiple time orientations were simultaneously enacted through combinations of organizational practices. Such practices incorporated varied rules, such as the “right time” to forge new relationships to build on intermediate products of past work.

Notably, this prior research has primarily discussed complexity in temporal responses in a single organization or team context. The focus of our study – a large interorganizational network that has no authoritative governance – is dramatically different. The emergence of collaborative repertoires is far from evident. Yet, what the current study shows is that network participants sought to accommodate Garud et al.’s (2011) diversity of temporal requirements; they found ways to introduce sufficient temporal complexity in support of their collaborative repertoires.

Limitations and Future Research

Despite of the generalizability limitation of our findings and implications, our study reveals aspects of interorganizational collaboration that may be more broadly construed. For example, we found that a shared national context, the network's external temporal markers, and the professional customs and local practices were insufficient to catalyze collaboration. Multiple collaborative repertoires were needed to realize the network's potential and to shift time from deterring collaboration to supporting it.

In addition, this study highlights the necessity of a variety of temporal repertoires. We focused on a particular inter-organizational network targeting cross-industry innovation. Although the network consisted of diverse companies from different industries, ranging from telecommunications to cybersecurity, the initial remedy came from a development method emergent in the software industry that may have appealed to the participants more broadly because they shared an interest in agile practices (Fitzgerald et al., 2006; Conboy, 2009). In other industry contexts, different temporal repertoires are likely to be needed and found. The particular remedies are thus idiosyncratic and specific to the network. However, the complexity of such remedies in terms of temporal rules and relationships likely is generalizable to interorganizational networks. The difficulties of developing network-level collective benefits also are common to interorganizational networks, so that remedies rooted in temporally complex collaborative repertoires may make intermediary outcomes visible and relatable.

Future research ought to explore in more detail how participants' attitudes and motivation, and network context affect the outcomes of the network. We found the network developing and

authoring collaborative repertoires of its own, to complement the externally imposed calendar. To what extent and under what conditions do such internal repertoires provide a resource for interorganizational networks, making a difference in the novelty of outcomes and their commercialization? How does innovating with temporality – such as agile methods – enable or impede the fluidity of collaboration in networks? More research is needed to understand how temporally complex repertoires emerge over time, including their new temporal rules, relationships, and network benefits. How do these new repertoires address prior shortcomings and add new temporal collaborative capacity, but also complexity? What are the limits of collaborative repertoires based on temporal rules and repertoires? What are the boundaries for temporally complex collaboration in terms of its capacity to benefit the network?

As these questions show, our research opens up numerous new avenues for future research on interorganizational networks. As research is scarce on the capacity of such networks to work for the benefit of the whole network, rather than for a subset of external or dominant members, we bring attention to the collaborative potential of networks as a whole (Provan et al., 2007). Such potential is often left unexplored as various temporal and other interests become imposed. We thus invite future research to study network collaboration from the collective perspective, rather than from the point of view of a single organization's interests, beyond structural connections (Ahuja et al., 2012). Beck and Plowman (2014: 1246) underscore such collaborative potential in their study of a crisis organization: One leader emphasized that “we’ll all step back and not worry about who is getting the credit for what’s being done, but that it’s being done.”

Furthermore, our study suggests that temporal diversity – rather than being a deterrent – is an effective resource for developing collaborative repertoires that are sufficiently complex to

accommodate the diversity of network participants and activities (Ofori-Dankwa and Julian, 2001). Prior interorganizational literature has suggested the need to study temporality as something that goes beyond singular or static notions of time (Lumineau and Oliveira, 2018). Rather than seeking unifying or entraining behavior within the network, we find maintaining multiple temporal rules and relationships crucial for collaboration across diverse networks. How do such collaborative repertoires become catalyzed and sustained by participants in networks that are not time-bounded or infused with ambition? Following Garud et al. (2011), more needs to be understood in terms of how variability in network contexts affects responses to temporal demands.

Conclusion

Interorganizational networks are increasingly important for engaging in cross-industry innovation. We find temporally complex collaboration crucial for tapping the multiorganization potential for novel business ecosystem formation. By tracking progress across the network, the study chronicles temporal rules and relationships as the participants in a Cloud software program developed collaborative repertoires that benefitted the network. These repertoires allowed the network to escape an externally imposed time line stalling collaboration. While engaging in joint research and overcoming its early fragmentation, the participants sustained temporal complexity sufficient to resolve the diverse temporal demands of a large number of home organizations for collective benefit. The findings contribute to interorganizational literature, emphasizing collective benefits and time-centric perspectives in their delivery.

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Table 1. Number of Interviews Conducted as Part of the Study; 22 different individuals

Interviewee's Role	2009	2010	2011	2012	2013	Total
Board Members		2		1	1	4
Academic Directors		1	1	1	1	4
Industry Directors		1			1	2

Program Coordinator		3	2	1		6
Academic Program Managers		3		2	1	6
Industry Program Managers		4		2	1	7
Academic Researchers	2	4		4	1	11
Industry Researchers	1	4		3	1	9
Total Number of Interviews per year	3	22	3	14	7	49

Multiple interviews in the same year with the program coordinator.

Table 2. Data Used in Analysis

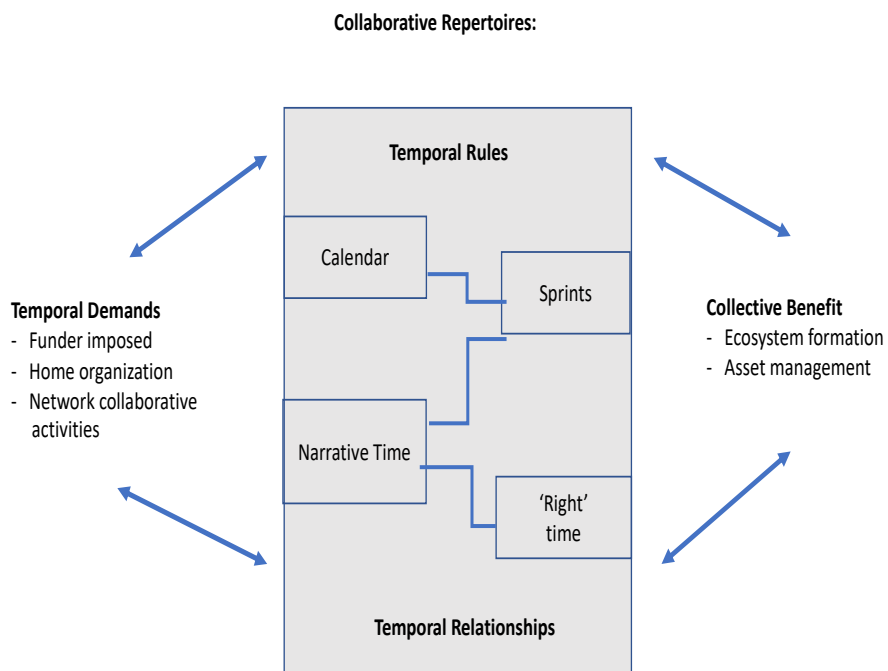
DATA SOURCES	ANALYTICAL PURPOSES
Semi-structured interviews	Participants' perspectives
- With 22 individuals in cloud program	Understanding the timeline: how temporality as calendar time, as events, as reflective process helps or fails to engender collaboration; Coping with program (temporal and other) complexities
- With 2 individuals not part of Cloud program but familiar with other national research programs	Comparison of cloud program to other national research programs
Attendance in quarterly workshops lasting 1–2 days	Event observation/Field notes
- 2010 (Summer, Fall, End of Year)	Evolution of collaboration; who joined events and when, who interacted with whom and how
- 2011 (Fall, End of Year)	Evolution of collaboration; who joined events and when, who interacted with whom and how
- 2012 (Fall, End of Year)	Evolution of collaboration; who joined events and when, who interacted with whom and how
- 2013 (End of Year)	Evolution of collaboration; who joined events and when, who interacted with whom and how
Archival documents	Research program/Issue documentation
- 2009 cloud whitepaper	Research program background; understanding program goals and methods
- Strategic Research Agenda Version 1, 2009	Understanding program goals and methods
- Strategic Research Agenda Version 2, 2010	Understanding revised program goals and methods
- Cloud program newsletters	Understanding intermediate results and what cloud program was

- Workshop presentations	Detailed data on specific activities and challenges
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Table 3. Time Line for Emergence of Collaborative repertoires with their rules and relationships.

Calendar Time	Collaborative Repertoire	Network Collaboration for Collective Benefit
Fall 2008 – Preparation of Strategic Research Agenda (SRA) and initial collaboration	Calendar-based planning based on public funder annual cycles Rule: Research targets must fit into work packages on an annual cycle Relationships: Existing partnerships, silos	Project progress deemed insufficient between Fall 2008 and Spring 2010
Spring 2010 – 2013	Fifteen three-month sprint research cycles Rule: No sprinting alone; have to include both industry and academic partners Relationships: New relationships formed	Abundance of research results (e.g., demos, case studies, research papers) Fragmented results; no network-level coherence
2011 – 2013	Various events with experts to transfer, connect, and integrate research results across the network Rule: Narrating thematic opportunity Relationships: Expert-based trust relationships	Broad knowledge sharing and interpretation of research results in the network in terms of business cases Getting company buy-in Accumulation of business cases
2012-2013	Ecosystem formation based on executable business cases Rule: Right timing (from business perspective) for “live” pilots, company-specific intellectual property sharing for pilots Relationships: Restructured relationships based on company readiness to participate in an ecosystem	Five ecosystems Asset management system for future ecosystems The challenge of billion dollar business opportunity

Figure 1: A Model of Temporally Complex Collaboration in an Interorganizational Network



Appendix 1. A Summary of the Four Rounds of Coding

First-round coding:	Second-round coding:	Third-round coding:	Fourth-round coding:
Analysis of notes and interviews in terms of Huy's (2001) temporal capability	Temporal interventions revealed different ways of collaborating	Analysis of time-related categories such as temporal orientation (e.g., linear, episodic or event time; temporal actions, temporal demands).	Analysis of complexity arrangements (Garud et al., 2011); temporal complexity as climbing the ladder (Ofori-Dankwa and Julian (2001).
Outcome: Question of how a large-scale program develops temporal capability and changes from one temporal intervention to another in a fluid network.	Outcome: How time was experienced and valued in ways of collaboration.	Outcome: Temporal demands as a deterrent leading to impending collaboration failures. Temporal actions as resolution in collaborative repertoires with temporal rules and relationships.	Outcome: Combination of collaborative repertoires with different rules and relationships comprise temporally complex collaboration over time for the collective benefit

Author bios:

Dr. Sirkka L. Jarvenpaa is Professor of Information Systems and Bayless/Rauscher Pierce Refsnes Chair in Business Administration at the McCombs School of Business, The University of Texas at Austin. At the University of Texas at Austin, she serves as the Director of the Center for Business, Technology and Law. She is a recipient of Association of Information Systems (AIS) Fellow and LEO Awards (LEO stands for Life Time Achievement of Exceptional Global Contributions in the field of information systems). Her research focuses on inter-organizational and inter-personal collaboration and innovation in fast paced and technologically advanced data and knowledge environments with regulatory and policy implications.

Professor Liisa Välikangas teaches strategic leadership at the Technical University of Denmark. She is also affiliated with Hanken School of Economics in Finland. Her current research interests include emergent leadership, digital technologies and (inter)organizational resilience and renewal. Her most recent, co-authored book is titled *The Sustainability Grand Challenge: A Wicked Learning Workbook* (Routledge, 2020).