What do we have in common? Collective action among heterogeneous actors in a meta-organization

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ABSTRACT

We study the development process of common resources in Helix Nebula. Helix Nebula is a meta-organization of highly heterogeneous collaborating actors, including scientific organizations like CERN, EMBL, and ESA, commercial cloud providers and public infrastructure organizations. The actors in Helix Nebula collaborate to establish a European open science cloud that can be used by scientific institutes to flexibly buy cloud computing resources from different commercial organizations. This requires the development of common resources to allow demand and supply actors to use the cloud computing infrastructure effectively. We study the process of development of common resources in Helix Nebula as an exemplary meta-organization. Our study illuminates that in the crystallizing process of common resources different development options emerge that trigger the surfacing of differences and dependencies. This leads to a reconfiguration of the development options, around which clusters of decision-making actors and clusters of legitimating actors shape emerging micro-alliances. Thus, our study explains that the development of common resources in meta-organizations of highly heterogeneous actors without hierarchical means is an organizing process that includes a continuous reconfiguration of crystallizing development options and respective micro-alliances of decision-making and legitimating actors.

INTRODUCTION

Organizations become increasingly interconnected in their value creation processes, and as a consequence the resources of multiple organizational actors get embedded into inter-organizational arrangements. Some scholars study collaborations (or ecosystems) of actors constituted of a central coordinating firm and peripheral complementor organizations (Wareham, Fox, & Cano Giner, 2014). Other scholars study larger organized networks that are constituted of different autonomous organizational actors with distributed power relationships (Ansari, Garud, & Kumaraswamy, 2016). Gulati, Puranam, & Tushman (2012) use the term *meta-organizations* to describe such inter-organizational arrangements where formal hierarchy to coordinate and ensure cooperation from member organizations is absent.

The establishment of *common resources* is an effective substitute for hierarchy as they allow actors in meta-organizations to substantiate collaboration through self-organizing actions, agree on common goals, and coordinate activities towards realizing those common goals (Fjelstad, Snow, Miles, & Lettl, 2012; Ostrom, 1990). Examples of such common resources are common infrastructures (Star & Ruhleder, 1996), common standards (Garud, Jain, & Kumaraswamy, 2002), or membership protocols and processes (Gulati et al., 2012; Ostrom, 1990). We add to this emerging literature by studying the process by which meta-organizations develop *common resources* without the use of hierarchy to catalyze collaboration between autonomous member organizations.

Prior studies on organizing collaboration between multiple autonomous actors have focused on cases with a relatively homogenous group of actors, such as open source software developers (von Hippel & von Krogh, 2003; O'Mahony & Ferraro, 2007), online communities (Bauer, Franke, & Tuertscher, 2016; Faraj, Jarvenpaa, & Majchrzak, 2011), cooperative technological organizations (Leiponen, 2008; Rosenkopf & Tushman, 1998), or relatively homogeneous actors in an industry that are connected through ecosystem platforms (Boudreau, 2012; Thomas, Autio, & Gann, 2014). Furthermore, extant literature only explores how common resources help organizing collaboration in meta-organizations once they are established (Fjelstad et al., 2012; Ostrom, 1990), but do not explain how these come into being in the first place. Organizing collaboration between multiple autonomous actors has been proved challenging in complex settings where new common resources need to be developed by a group of autonomous actors. Tuertscher, Garud, & Kumaraswamy (2014), for example, explain how the ATLAS

Collaboration at CERN, a large scientific meta-collaboration involving physicists from 175 autonomous research institutes, continuously contested the emergent technological and organizational choices when developing common resources for their physics experiment. Adding to that, when a meta-organization of highly *heterogeneous* actors requires new common resources to be developed, differences and dependencies are prone to arise as a result of actors' potentially conflicting expectations and requirements (Carlile, 2002, 2004).

How do highly heterogeneous actors collaborating in a meta-organization organize the development of common resources? The intricacy of this question lies in the heterogeneity of actors and the lack of hierarchical authority. First, the diversity of backgrounds entails different and potentially conflicting expectations and requirements towards the development of common resources. Second, in traditional inter-organizational forms the legitimacy for making decisions on the development of common resources is based on hierarchy structures established in the organizational design or governance models. However, when hierarchy is absent, what is perceived a legitimate development option is not as clear cut.

To answer our research question we performed a longitudinal case study of Helix Nebula. Helix Nebula is a meta-organization with more than 50 highly heterogeneous member organizations. These include the three largest scientific research organizations in Europe (CERN, EMBL, and ESA) and the largest European commercial cloud providers (e.g., Atos, CloudSigma, and T-Systems). The members of Helix Nebula collaborate to develop a European science cloud where the scientific organizations on the *demand-side* can flexibly buy cloud computing resources from different commercial cloud providers on the *supply-side*. Developing this cloud computing infrastructure is a high-stake and complex endeavor as it requires addressing of the different expectations and sometimes conflicting requirements of the scientific, commercial, and public infrastructure organizations.

After this introduction we start with laying out the theoretical background to describe how our study is embedded in and builds upon the literature. Thereafter we provide details on the research methods used, which is followed by the case description. Next, we provide the findings section where we describe the development of one of the common resources in Helix Nebula, in a four-part narrative. We conclude with providing our process model of organizing the development of common resources in meta-organizations of heterogeneous actors in the discussion section and mention the implications of our study for relevant literatures.

THEORETICAL BACKGROUND

Collaboration between multiple autonomous organizations requires dealing with the problems of coordination and cooperation (Gulati, Wohlgezogen, & Zhelyakzow, 2012). While coordination is about the division of labor and how to effectively integrate the activities of actors towards a common goal, cooperation is about aligning interests of collaborating actors towards the creation of a common goal (Puranam, Alexy, & Reitzig, 2014). Like all organizations, effective collaboration between multiple autonomous actors requires the use of appropriate organizational structures and processes that facilitate coordination and cooperation (Lawrence & Lorsch, 1967; Mintzberg, 1983; Perrow, 1967). The dominant coordination and cooperation practice is embedding hierarchy in the organizational structure (March & Simon, 1958), which gives some actors the legitimate power to make decisions that others are obliged to follow (Adler, 2001; Simon, 1962).

Along with a renewed interest in organizational design, a recent research stream emerged suggesting that complex multi-party collaborations require different organizing mechanisms than traditional organizations (Puranam et al., 2014). In particular hierarchical mechanisms, the primary means of coordination in traditional organizations (March & Simon, 1958), are not suitable because they overly constrain collaboration within and across firms (Fjeldstad et al., 2012). Instead, this research proposed the concept of meta-organizations as a new organizational form suitable for collaboration in such dynamic settings. Specifically, "*meta-organizations comprise networks of firms or individuals not bound by authority based on employment relationships, but characterized by a system-level goal*" (Gulati et al., 2012: 573).

Meta-organizations provide value for constituent member organizations by expanding the availability and use of relevant knowledge and resources (Baldwin & von Hippel, 2011; Fjelstad et al., 2012). Instead of using hierarchies to enforce coordination and cooperation necessary for optimal use of resources, meta-organizations rely on a decentralized approach of organizing (Gulati et al., 2012). Specifically, Fjelstad et al. (2012) suggest that meta-organizations use an actor-oriented architectural scheme as a substitute for hierarchy to support collaboration. This actor-oriented architectural scheme is composed of actors who have the capabilities and values to self-organize in order to effectively collaborate using common resources. Common resources are assets that collaborating actors in meta-organizations develop to accomplish shared goals. Examples of such common resources are shared infrastructures (Star & Ruhleder, 1996), common technologies and standards (Garud et al., 2002), or membership protocols and processes (Gulati et al., 2012; Ostrom, 1990).

Although we acknowledge the value of the actor-oriented architectural scheme for explaining how organizing happens in meta-organizations, we problematize its conception in prior research by asking how common resources are developed in the first place. Prior research has focused on explaining organizing in a meta-organization after it has developed common resources for coordination and cooperation among its members (Gulati et al., 2012; Fjelstad et al., 2012). Surprisingly, these studies do not explain how the initial development of the common resources took place. We are concerned with explaining how the process of organizing the development of common resources happens and not the value of existing organizing resources in use or the allocation of maintenance thereof.

Our inquiry links two adjacent literatures that inform our study on how highly heterogeneous actors collaborating in meta-organizations develop common resources without the use of hierarchy. First, prior research on organizational resourcing has emphasized the idea that in order to collaborate material, cognitive, social, or emotional resources are required that substantiate collective action (Feldman, 2004; Quinn & Worline, 2008). In a similar vein, actors collaborating in meta-organizations require common resources that work as a catalyst for collaboration between multiple autonomous actors (Fjelstad et al., 2012). Leblebici et al. (1991) showed how the changing of configurations of collaborating actors affected the value of particular resources over time. This view on the *mutability of resources* means that in meta-organizations the value of common resources is not stable but is determined by the members as they collaborate over time. Feldman (2004) complemented this dynamic view of resources by showing that actors in organizations actively create resources (i.e. resourcing) to enact particular schemas that create change and generate new resources. Specifically, both tangible (e.g. common network infrastructure) and intangible (e.g. trust or narratives) resources can be generative for enabling collaboration between multiple actors (Feldman, 2004; Quinn & Worline, 2008). In the context of meta-organizations similar mutable and dynamic characteristics pertain to common resources. As a result, different options may emerge for common resources or their projected value changes during the development process. This means that in a meta-organization a new technology or a narrative is only a valuable common resource when the other members support or endorse it as such (Garud & Rappa, 1994; Garud, Schildt, & Lant, 2014).

Although a resourcing perspective is useful for looking at the development of common resources in meta-organizations it also brings up the question how the heterogeneity of the members is dealt with. Many settings in which creation of common resources has been studied, collaborating actors are relatively homogeneous. In open source software communities, for example, the decision for a common resource (e.g. the licensing structure for the source code) is considered equally legitimate by the project's code developers (O'Mahony, 2003; O'Mahony & Ferraro, 2007). However, once commercial companies become involved in the project, the nature of the collaboration changes into a meta-organization of heterogeneous members – in such a setting, not all actors may consider the current licensing structures legitimate and new common resources will have to be developed (O'Mahony & Bechky, 2008). This is because in meta-organizations, the different backgrounds and heterogeneous interests of actors gives rise to alternative expectations and requirements (Gulati et al., 2012). Differences and similarities across these expectations, in turn, affect what the members define as being legitimate development options for common resources (Ansari et al., 2016; Ansari, Wijen, & Gray, 2013; O'Mahony & Bechky, 2008).

From a perspective of institutional theory legitimacy is considered "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995: 574). Legitimacy, and thus what is "common", is stable but also mutable within a particular institutionalized system (Leblebici et al., 1991). Specifically, changing what constitutes as "common" requires altering institutionalized accounts of pragmatic, moral, or cognitive legitimacy (Suchman, 1995). The heterogeneous interests and backgrounds of members in meta-organizations more readily shift the defining parameters of legitimacy. As each member is autonomous (Gulati et al., 2012), what constitutes a legitimate development option for the common resource and what doesn't is in constant flux. In other words, the members of a meta-organization not only need to get their act together to make decisions on the development of a common resource without the use of hierarchy but during that process also overcome their different considerations of legitimacy.

Our problematization of the literature on meta-organizations, organizational resourcing, and legitimacy allows us to further refine our research question: *How do highly heterogeneous actors collaborating in a meta-organization organize the development of common resources when* *these inherently emphasize actors' different expectations and requirements and legitimacy incongruences?*

RESEARCH METHODS

To answer our research question, we used an inductive research design to study the processes *how* the highly heterogeneous actors in Helix Nebula were governing the development of common resources. Our "how" question was a first reason to employ qualitative research procedures (Yin, 2013). Second, our focus required detailed processual accounts, for which qualitative data sources lend themselves well (Langley, 1999). Third, our theory development aim required an open and iterative approach to data collection and analysis, also because of our focus on exploring and conceptualizing process dynamics. Finally, qualitative research allowed us to use multiple complementary data sources to generate a comprehensive chronological account (Yin, 2013).

Data collection

We selected Helix Nebula as a revelatory case (Siggelkow, 2007), because it is an exemplar of a meta-organization with very heterogeneous participants and high stakes involved. This collaboration had to be developed from scratch and we had in-depth access to trace a significant part of its development. Therefore, the phenomenon of interest, the development of common resources in such an emergent meta-organization, was transparently observable in this case (Pettigrew, 1990).

Our study of Helix Nebula is supported by multiple sources of longitudinal qualitative data. We collected contemporary data through semi-structured interviews (*N*=26), observations of (conference call) meetings (N=46), face-to-face meetings at for example conferences (N=22) and informal conversations with members (N=85) during 10 field visits all lasting multiple days.

Another important data source was archival data covering the period June 2011 and December 2016. These archival data sources were generated by the participants in real-time and therefore represent unobtrusive measures. The archival data included Helix Nebula public and membership-restricted (draft) documents (N=330), presentations (N=233), meeting agendas and detailed minutes (N=448), internal documentation and reports on Helix Nebula of single member organizations (N=8), press releases by and on Helix Nebula (N=52) video member statements

(N=80), and audio- or video recordings of webcasts (N=6). Another valuable data resource was the archived e-mail correspondence of more than 6000 e-mails sent between demand- and supply-side members of Helix Nebula. Given that the members of Helix Nebula were dispersed around Europe, e-mail was a frequently used communication medium.

Data analysis

Our analysis followed several steps in which we discerned multiple levels of analysis: development trajectories of specific common resources, comprised of multiple episodes, each consisting of multiple events. Thus we deployed temporal coding as well as thematic coding (Miles & Huberman, 1994; Van de Ven, 1992), to develop a theorized, processual account. Below we explain the different steps in our analysis.

We started our data analysis with the identification of *common resources* that were developed in Helix Nebula. We defined common resources as assets that collaborating actors in meta-organizations develop to accomplish shared goals (Feldman, 2004; Fjelstad et al., 2012) where actors cannot be excluded from the development process (Ostrom, 1990). To identify common resources we looked into those things that were at stake for the members, triangulating between retrospective and real-time data sources. For example, we examined records of meetings to identify what the members reported as resources that were collectively developed and we asked interviewees to identify and verify common resources developed in Helix Nebula. Our analysis identified 11 common resources that were developed by the Helix Nebula members between June 2011 and December 2016. Among others examples are a common technical architecture, procurement contracts, and a business model. The development of common resources stretched across different time periods, each having fluctuating levels of energy traceable by the excitement of members involved in the development process, collaborative efforts, competitive stances, contrasting development paths, and overall degree of illumination in the Helix Nebula conversation.

Our access to abundant data sources allowed us to trace the development of these common resources in Helix Nebula with a high level of granularity and allowed us to understand how and when development ideas and options for common resources emerged. Our analysis yielded insights into the complex mix of actors involved in decision-making processes around common resources. What we found striking was the fluctuation of involvement of partners for different common resources and during different moments in time, constituting changing constellations of '*micro-alliances*'.

As a next step in the analysis, we identified events in the development of each of the common resources and clustered events into episodes. For each of the common resources we identified events, defined as moments of change regarding participation in, and development of, decision-making processes and outcomes with regard to a common resource. For example, when a demand-side partner would suddenly take part in what had previously been a supply-side actors dominated conversation we coded this as an event. Similarly, when a supply-side actor that had not been actively involved but legitimated prior discussions suddenly opted a new development option we coded this as an event.

Related, consecutive events were then grouped into episodes, exemplifying a temporal bracketing strategy (Langley 1999). Combinations of events resulted in changes in the configuration of micro-alliances related to common resources in development. Therefore, we defined episodes as a reconfiguration from one set of micro-alliances to a different configuration of micro-alliances.

The identification of episodes and events iterated with data collection. We asked our interviewees to confirm whether the events or episodes had been critical moments in developing the common resource. We subsequently asked them to confirm if our analysis of the different development options that emerged for the common resource was correct, and if our specification of an actor's position towards these options was valid. Triangulating across the data sources and iterating between data collection and analysis we created a chronology of events and episodes to understand the mechanisms the members of Helix Nebula used to govern the development of common resources.

Finally, we performed pattern coding to identify emergent themes and explanatory constructs (Miles & Huberman, 1994). We conceptualized processes by moving between levels of granularity of the data (events, episodes, trajectories) and between different common resources at stake in the collaboration process. A set of codes emerged that allowed to explain the development of episodes as well as the overall progression of development trajectories in the case, culminating in a theoretical process model of the development of common resources in a meta-organization. Before we turn to those theoretical findings, we first offer more background on the nature of the Helix Nebula collaboration and the aims of the heterogeneous organizations involved.

CASE DESCRIPTION

Helix Nebula is a collaboration between big science and big business in Europe whose actors set the high-stake goal to develop a commercial cloud computing infrastructure for science in Europe. The scientific demand-side members of Helix Nebula are the three largest intergovernmental scientific research organizations in Europe: CERN (European Organization for Nuclear Research), EMBL (European Molecular Biology Laboratory), and ESA (European Space Agency). On the supply-side, prominent members are large commercial cloud computing companies like Atos and T-Systems, small-medium enterprises such as SixSq that deliver cloud brokerage or orchestration services, and public infrastructure organizations such as EGI for grid computing resources and GÉANT for providing high networking connectivity. Helix Nebula was established in June 2011 and by June 2012 the members received a 2 million euro, two-year FP7-coordination fund from the European Commission to aid the members in the collaborative development of common resources needed for the creation of a commercial cloud computing infrastructure for science in Europe. Figure 1 depicts the Helix Nebula collaboration and its most prominent members.

Insert Figure 1 about here

Demand-side of Helix Nebula

All the demand-side partners in Helix Nebula have significant needs for commercial cloud-computing capacity that they can provide to aid the researchers in their respective organization and scientific communities in the analysis of their data. While CERN, EMBL, and ESA have similar institutional backgrounds and organizational structures they work in different scientific disciplines with inherently different cloud computing requirements. Research at CERN focuses on high-energy physics experiments. With the Large Hadron Collider in full operation, the different experiments at CERN require approximately 275,000 server instances at any one moment and create up to 10 GB of data per second. CERN's main cloud computing requirement in Helix Nebula is access to high-throughput computing power, which is required for testing parameters using Monte-Carlo simulations, data filtering, processing, and analysis.

Research at EMBL is on molecular biology sciences. A spur of innovation in DNA sequencing techniques and the establishment of a reference genome in the early 2000s, have lead to big scientific leaps being made in recent decades. The main cloud computing requirements of EMBL in Helix Nebula are memory based (a combination of computing and storage in laymen terms) used for modeling DNA strings and sequences.

The research at ESA is in the space sector, including earth observation sciences that builds on on data created by satellites. In order to fund future satellite missions it is important that ESA can show to its members states that public value is created. One way of doing so is giving external commercial parties access to ESA satellite data using open policies, and allowing for downstream value creation. Therefore, the main cloud computing requirement of ESA in Helix Nebula is storage of satellite data on commercial clouds.

Although they share the need for commercial cloud computing resources, the different science communities that are addressed by CERN, EMBL, and ESA make that the details of their cloud computing requirements are different. Whereas CERN and EMBL share the need for buying commercial cloud computing power, ESA's requirements mostly storage-based. Furthermore, whereas CERN and EMBL approve of buying cloud computing power from American commercial vendors this is less of an option for ESA. Taking a different turn, data security and privacy is a high-stakes concern for EMBL, whereas the data of CERN and ESA is less sensitive to those issues.

Supply-side of Helix Nebula

The supply-side of Helix Nebula consists of large commercial cloud computing providers such as Atos, CloudSigma, and T-Systems who deliver Infrastructure as a Service. Also part of the supply-side of Helix Nebula are small and medium enterprises, some that provide Infrastructure as a Service as well, such as ExoScale, others who specialize in cloud brokerage and multi-cloud orchestration, SixSq, for example. For the commercial actors in Helix Nebula, delivering cloud computing resources to science organizations was a greenfield market in 2011. By and large, the cloud computing requirements of CERN, EMBL, and ESA far exceeded the requirements of existing customers, and thus meant huge market potential for the suppliers.

In order to serve the nascent market of scientific cloud computing, the supply-side organizations in Helix Nebula needed to collaborate to meet the requirements of CERN, EMBL, and ESA. It goes to say that the collaborative requirements ran parallel to competitive tensions on the Helix Nebula supply-side as each of the commercial providers used incommensurable proprietary technologies and architectural systems. The main requirement of CERN, EMBL and ESA from the supply-side was to find a way that they could flexibly buy from different providers without being locked-in or high switching costs. Meeting those requirements demanded the competing commercial suppliers to collaborate, which found a head-start in June 2011 during a meeting at the ESA facility in Frascati, Italy. In an internal company blog post, a representative of one of the commercial cloud providers described what happened at that meeting:

> "*We found ourselves in a seminar of around 50 people: several major research organisations – CERN and EMBL, as well as the hosts ESA themselves – as well as representatives of most of our European competitors. There followed an uneasy three days, where the Demand side described what was required; the suppliers each worked out whether and how they could go some way to meet it, tried to exude confidence in front of their peers, and to work out whether those competitors were bluffing, too. Following a quiet huddle in the bar on the last evening, between some of the more major suppliers present, we informally agreed that we would work together, over the following two years, in "cooperative competition" to produce what was required.*"

FINDINGS

Hauling from a process perspective, we investigate organizing the development of *common resources* in Helix Nebula. This concerns common resources that the members in Helix Nebula determine as being 'at stake'. Our study finds that what is at stake is defined over time in the development process of the common resource where the process of *crystallizing of common resources* causes the *surfacing of differences and dependencies*, resulting in reconfiguring of development options and ultimately the clustering of decision-making and clustering of legitimating actors foregoing emerging *micro-alliances*.

Our analysis of episodes shows four reconfiguration patterns of development options of common resources in Helix Nebula: (1) *merging* of development options, (2) *forking* of development options, (3) *altering* of development options, and (4) *annexing* of development options. Table 1 provides an overview of the reconfiguration patterns found through analysis of the development of common resources in Helix Nebula.

Insert Table 1 about here

In the rest of our findings section we focus on the development process of one of the first and severely important common resources developed by the Helix Nebula members called the "*Blue Box*". The Blue Box was the outcome of the development of a technical architecture to provide a common cloud interface for CERN, EMBL, and ESA to connect with the different supply-side organizations. We engage with the analysis by providing a narrative of the development process of the Blue Box. The narrative consists of four parts that itemize the episodes we identified in our analysis of the common resource. Figure 2 provides an overview of the crystallizing development options for the Blue Box common resource worked on by varying sets of actors and specifies the four narratives.

Insert Figure 2 about here

The development process of the Blue Box as a common resource in Helix Nebula

Blue Box Narrative Part 1

After starting the Helix Nebula collaboration in June 2011 a shared requirement of CERN, EMBL, and ESA to realize in Helix Nebula was the ability to flexibly switch between different European commercial cloud providers. At that point in time the commercial suppliers used different proprietary technologies that were incompatible, leading to customer lock-in and high switching costs. The substantial demand of CERN, EMBL, and ESA provided sufficient incentives for the suppliers to alleviate their competitive tensions and collaborate on fulfilling the demand-side requirements. All demand- and supply-side actors agreed that the suppliers would start developing a "*common technical architecture*".

Discussing what constituted a "common technical architecture", the supply-side members of Helix Nebula crystallized a development option for a software piece they called the "*Blue Box*". The Blue Box would provide a common interface software layer on top of which CERN, EMBL, and ESA could get access to the individual companies' clouds underneath. As one of the original developers of the Blue Box explained:

> *"So someone invented something called the 'Blue Box', so-called because it was drawn on a whiteboard with a blue pen. And the Blue Box was sort of defined initially by "techies" but basically it was to provide a common, originally technology, interface so when a customer wanted to use a cloud they could come into one place and get through to any of the clouds underneath." (Supplier Interview; 9/25/15).*

Over time, CERN, EMBL, and ESA caught wind of the supply-side's crystallizing Blue Box, the idea and design of which seemed too complex for them to use in practice. To ensure that their expectations and requirements would also have a place in Helix Nebula, CERN, EMBL, and ESA started crystallizing the specifics of an alternative common technical architecture. Their main requirement became the development of a common application programming interface (API) that would be supported by all suppliers.

Whereas the supply-side took notice of the development work being done by CERN, EMBL, and ESA, and did not object to them working on a different development option, the commercial cloud providers did not legitimate their option for developing a common API. Rather, the suppliers kept crystallizing the details of their Blue Box through discussions in (conference call) meetings and exploring and documenting required or optional technical functionalities. The suppliers acted carefully in their wordy communications and presented only stylized depictions of the Blue Box to the demand-side while continuing development. One of the suppliers e-mailed its peers:

> "*At CERN, when John showed the blue box slide... Luke almost had a heart attack ;-) We need to [be] careful if/when we show this to the Demand-side, so that they don't think that we're proposing a chemical plant (French expression ;-)*" (Supply-side e-mail distribution list; 03/27/12)

Throughout the crystallizing process, one of the larger cloud suppliers in Helix Nebula started mentioning the relevance for developing a service architecture to complement the technical architecture that was the Blue Box. Although the idea of developing a service architecture was not supported by the majority of Helix Nebula actors it was nevertheless deemed legitimate for the suppliers to start exploring a service architecture.

During the first Helix Nebula General Assembly between 5 and 7 July 2012 both the demand- and supply-side micro-alliances communicated their development options for the common technical architecture. Subsequently, the stark differences between the development options surfaced, and a pragmatic solution that merged the conflicting alternatives was difficult to create or comprehend. The demand-side actors favored integration using a common API and the supply-side favored abstraction using the Blue Box. As a representative of a demand-side organization remembered:

> "*The Blue Box was supposed to abstract all the different individual clouds and interfaces in one thing. We very quickly found out that this is really a "showstopper" to innovation because if one of the vendors has innovations that they rapidly want to bring on the market but the Blue Box cannot support it that just kills the business of this company.*" (Demand-side organization interview; 10/15/12)

Despite their differences the actors in both micro-alliances were also strongly dependent on each other to make progress. During the three-day General Assembly, which included heated discussions, a development option crystallized merging the requirements of both supply-side and demand-side micro-alliances. By making the differences the two alternatives more ambiguous the actors decided that future development should focus on "*simple image provisioning as a common service*". The General Assembly summary states:

> "*The demand-side members questioned the need for the "blue-box" as described in the document at this stage. It was suggested to start with simple image provisioning as a common service across all the suppliers and put this in place for the flagships by December 2012.*" (Summary document first Helix Nebula General Assembly held at CERN in Geneva on 5–6 July 2012)

Analysis Blue Box Narrative Part 1

Our analysis of Blue Box Narrative Part 1 reveals three episodes of reconfiguration of development options: two episodes of merging and one episode of forking. When the demand- and supply-side actors started Helix Nebula the differences between their requirements and expectations could be alleviated by agreeing on the legitimacy of developing a "common technical architecture". The degree of details remained ambiguous, which allowed for the merging of the alternatives and the separate micro-alliances to give legitimacy to the same outcome.

After agreeing on a common technical architecture as a legitimate outcome, alternative development options crystallized: the Blue Box and a common API. This led to the surfacing of differences between them inducing a forking reconfiguration pattern of both development options. Subsequently, supply-side actors started clustering around making decisions on developing the

Blue Box and demand-side did the same for the common API alternative. Furthermore, one supply-side member mentioned the relevance of developing a service architecture to complement the technological functionalities of the Blue Box. As an outcome this did not receive much support, but the the actors did saw legitimacy of process for further crystallizing of the idea. Legitimacy of process was given by all actors to the crystallizing of three development alternatives for the same common resource through collaboration in separate micro-alliances.

Despite the stark differences between the Blue Box and common API development options, actors in both micro-alliances were dependent on each other to make progress. This surfacing of dependencies triggered the actors in both micro-alliances to overcome their differences by making them more ambiguous. Specifically, all actors gave legitimacy of outcome to start with "*simple image provisioning as a common service*". The merging of the two development options led to the subsequent integration of the two micro-alliances.

Blue Box Narrative Part 2

After the July 2012 Helix Nebula General Assembly the commercial cloud providers in Helix Nebula suppliers continued developing the Blue Box knowing the conflicting requirements and expectations of the demand-side on its details. After five months of initial exploration the suppliers now started exploring the specifics of the Blue Box on a more granular level. This led to the emergence of three disambiguated development options and the subsequent formation of micro-alliances of actors crystallizing these. One of these micro-alliances was by two decision-making organizations crystallizing an option for '*building the Blue Box*'. The second micro-alliance was crystallizing '*external funding for building the Blue Box*'. The third micro-alliance collaborated on crystallizing the development option of '*buying the Blue Box*', instead of building it. Each of these micro-alliances acted as distinct groups of actors. The micro-alliance on building the Blue Box, for example, was referred to as the "technical architecture committee" (or "TechArch") that held separate meetings and periodically reported to the other suppliers. The supply-side meeting minutes of 27 July 2012 note:

> "*Matthew led an update of the latest status and findings of the technical architecture committee. A call took place early this week and as a result the 'blue box' definition was progressing. A nucleus group was created to allow strong focus on results and key decision making with a wider group reviewing progress.*" (Supply-side meeting minutes; 07/27/12)

Next to having a distinct cluster of decision-making actors each micro-alliance had a cluster of legitimating actors, which included the actors that were "*reviewing*" the progress made but did not actively participate in the decision-making process. These legitimating actors sometimes supported multiple development options simultaneously, often from a viewpoint of moving forward "*whatever works best*". As the efforts put into crystallizing the three development options became more significant, some suppliers started doubting whether these efforts were worthwhile if the demand-side would not support eventual outcomes. CERN, EMBL, and ESA had indeed not given legitimacy of outcome at that point in time, and their involvement as legitimating actors was ambivalent. One supplier proposed to test their legitimacy by asking CERN, EMBL, and ESA to sign a letter of intent for future buying of commercial cloud resources in Helix Nebula. Other suppliers rejected this idea as this would require the suppliers to consent with prior demand-side requirements.

As the crystallizing of the three development options progressed one supplier organization became situated in a difficult position as it was part of the cluster of decision-making actors in all three micro-alliances. This overlap made the organizations having to deal with the surfacing of differences and dependencies between the alternatives, leading to decision-making conflicts. The following e-mail send between suppliers on 21 August 2012 shows the differences and dependencies emerging between the different Blue Box development options:

> *"Monty, I fully understand and support your desire to get a fast-track start on getting the Blue Box built, but I fear that your intention to delegate so much of the design and decision-making to TechArch may be misplaced. I have had more than one member of that team (no names ;o) express fears that you were trying to railroad them into something they had no intention, capability or even desire, of fulfilling. And if they did produce something, how much credibility would you put into it?*" (Supply-side distribution list; 8/21/12)

After a period of three months of building the Blue Box, external funding for building the Blue Box, and buying the Blue Box development options, the need to make progress led to the surfacing of dependencies between the options. Throughout the crystallizing process it appeared the building of the Blue Box was an unrealistic development option as Helix Nebula was not an entity that could legally own intellectual property on the Blue Box. Also external funding was found difficult to realize on a short-term notice. As these consequences became clear some legitimating actors that had previously supported building the Blue Box and external funding for building the Blue Box started voicing support for buying the Blue Box in the supply-side meetings.

CERN, EMBL, and ESA stated their concerns regarding the extent of progress made by the supply-side and gave notice of their intent to reevaluate their involvement in Helix Nebula. A supplier reported to its fellow suppliers:

> "*The Demand side are concerned about the Blue Box decision, which they had expected to be made by the end of September [...] We discussed some of the issues, both technical and commercial, regarding use of an open source vs. COTS [commercial] solution, including the influence of HN not being a legal entity. We assured them that, whatever the decision, the Supply side would ensure that the service had a proper production status and was fully supported. They want to go into full productive use at the end of the year, and fear HN losing credibility if the solution did not function as required.*" (Supply-side distribution list; 10/5/12)

In order not to lose the support of the demand-side actors for testing and using the Blue Box the suppliers decided to agree on the most supported legitimated development option, which was to proceed with buying the Blue Box. This led to the merging of three development options into buying the Blue Box as well as integrating the three respective micro-alliances.

Analysis Blue Box Narrative Part 2

Our analysis of Blue Box Narrative Part 2 reveals two episodes of reconfiguration of development options: one episode of merging and one episode of forking. As the suppliers collaborated on the Blue Box different development options crystallized: building the Blue Box, external funding for building the Blue Box, and buying the Blue Box. Throughout this crystallizing process differences and dependencies surfaced between the three alternatives. For example, building and buying the Blue Box were conflicting development options, but both were also dependent on the availability of external funding opportunities to legitimate progress on the Blue Box. The surfacing of differences and dependencies conditioned a forking reconfiguration pattern, which in turn triggered the clustering of decision-making actors and legitimating actors around the development options. These clustering dynamics gave input to the emerging of three distinct micro-alliances.

Whereas not all actors engaged in decision-making in the micro-alliances, all suppliers saw legitimacy of process for the forking of three different development options and related micro-alliances crystallizing them. Over time, surfacing of dependencies partially triggered by pressure from CERN, EMBL, and ESA prompted the merging of three development options into buying the Blue Box as the respective micro-alliances of decision-making and legitimating actors agreed on the most legitimated alternative.

Blue Box Narrative Part 3

The agreement by the suppliers on the development option of buying the Blue Box did not last long as further crystallizing of the buying the Blue Box option led to the emergence of two separate development options: buying a *commercial software Blue Box* or buying an *open source software Blue Box*. Despite that both the development options were crystallized development options of the same generic Blue Box idea, differences between the two options were a source of frequent and heated discussion. Around the two development options two micro-alliances with the same suppliers in the both clusters of decision-making actors but large variety between the clusters of legitimating actors of both options. Unlike previous moments when progression had been halted, this time there was little overlap between legitimating actors or a pragmatic justification to bring about merging of the two development options. Rather, differences between both development options dominated as the following e-mail on the supply-side distribution lists shows:

> "*I think we can determine a suitable plan between us [for delivering a Blue Box], and one which does not involve handing the keys over to any one of us, let alone anyone outside our current circle. […] This is admittedly ****not***** a deterministic approach I am suggesting: there are no provable right or wrong answers, just answers which are good enough for us to make progress. I just think we need a glass-half-full, rather than glass-half-empty, attitude. I even wrote down on my piece of paper what I think everyone's hidden agendas are, but I am keeping that bit to myself, for now. ;o)"* (Supply-side distribution list; 10/08/12)

With no provable right or wrong answers, more personal and morally-vested arguments of the legitimating actors in both micro-alliances became part of the crystallizing process of the Blue Box. Between the different commercial and open source software Blue Boxes there were both American and European solutions present. A group of suppliers did not agree with the process of making a decision for the Blue Box based on just technical functionalities, and wanted the "*Europeanness*" of the Blue Box also to be taking into account. As one supplier recalled:

> *"We were judging on different criteria. I mean my view here was that: If we are building an "Open European Cloud", there is no way we are going to do it with proprietary American software. Whereas people in the other camp were saying: "We just want something that works." And at that stage [European open source software Blue Box]*

wasn't seen as something that was proven to work well enough, so they wanted to just go and buy the American software." (Supplier interview, 09/08/16)

Another group of suppliers did not agree with using the Europeanness as a legitimate parameter in the crystallizing process. To counter the argument of Europeanness the proponents of American software found legitimate backing in the Helix Nebula membership documents, where the definition of the European identity of the collaboration was ill-defined. Heated discussions were held in conference and telephone calls and by e-mail, where the legitimating actors of both micro-alliances disputed each other's statements on the (ill-)legitimacy of process. An example such a dispute this:

> "*Dear Harry, There is no concept of European and American tools and collective voting like this. In any case an analysis of the various tool providers hasn't been done regarding whether they pass the requirements for inclusion in Helix Nebula regarding Europeanness. This requirement is clearly set out in black and white in the membership requirements document.*" (Supply-side distribution list; 10/12/12)

Despite the commercial arguments becoming part of the discussion, the decision-making actors part of both micro-alliances remained committed to giving the best technical recommendation for the Blue Box. In October 2012 a voting procedure among those decision-making actors ended in the decision that an American commercial software Blue Box was the most advanced technical solution. Despite this being contested by the proponents of the European open source software Blue Box, CERN, EMBL, and ESA went with earlier agreements and wrote a formal endorsement they would continue with testing the American commercial software Blue Box. Within a day this decision was contested (on a Saturday) by the legitimating actors part of the micro-alliance around the European open source software Blue Box development option. Recalling this episode the main proponent of the European open source software Blue Box stated:

> "*But that is also a general underlying issue that if you are not empowered and inclined to take solid decisions then all things are possible and it is a case where over a period of time it will emerge what actually works and what doesn't. But it is going to take a time to do it rather than that you take a binary decision; because taking the decision for one thing means taking the decision against something else, and stopping it. And this was a case where I was not prepared to stop the open source option.*" (*Supplier interview; 09/08/16*)

The subsequent discussion in virtual conference meeting became remembered by the actors as the most difficult moment of four years of collaboration in Helix Nebula.. Whereas before only technical and commercial considerations had been deemed valid sources of legitimacy, moral and emotional arguments also became part of the discussion. This continued CERN, EMBL, and ESA realized their support for solely the American commercial software Blue Box would cause a break-up of the Helix Nebula collaboration, which led them to retract their endorsement. Remembering this event a supplier recalled:

> "*I sort of played my 'Trump card' of saying: "Well, if you guys go for this [American commercial software] tool we are withdrawing from Helix Nebula" […] I figuratively 'threw my toys out of the pram at some point when this decision was taken, just to try to get them… We had been being like a sort of friendly family, but when one member says: "I am leaving this family if you do this", then that brings home quite how strongly you feel about it. [...] You know I brought things to a head to make sure that they understood quite how strongly some of us feel about these things.*" (Supplier interview; 09/25/15)

As a result of the retracted legitimacy by CERN, EMBL, and ESA the suppliers became concerned the demand-side were backing out of their commitments to Helix Nebula, leading the members to put both Blue Box development options back on the table. A public infrastructure provider who had until then been legitimating the European open source software Blue Box, found the time was ripe for proposing an additional development option: the "*Public Blue Box*". Despite being a competing development option for the other two Blue Boxes, further crystallizing of the Public Blue Box was deemed a legitimate process by all actors but neither supply-side nor demand-side clustered as legitimating actors for it.

As a result of the surfacing differences coming from the crystallizing of the Public Blue Box as a development option, dependencies surfaced between the American commercial and European open source software Blue Boxes. This led to a merging of the two alternatives, which induced a moment where the two micro-alliances found "*instant unity*" in agreeing to stop the search for an integrated solution and instead move forward with testing and running both the American commercial and European open source Blue Boxes with integration of the Public Blue Box. A supplier's personal notes stated:

> "*We could consider re-running the [Blue Box] decision process, about which no-one seems happy, but that may still not produce a unanimous position; there are degrees of both commitment to and involvement with both solutions. We will only achieve unanimity if some players either drop out or fall back to a passive role, which is in no-one's interests. Rather than just keep discussing, we propose to keep working, to see what works, then hope for pragmatic acceptance of the result.*" (Personal notes supplier; 10/18/12)

Analysis Blue Box Narrative Part 3

Our analysis of Blue Box Narrative Part 3 reveals five episodes of reconfiguration of development options: one of merging, two of forking, one of altering, one of annexing. After a lengthy process leading to buying the Blue Box, subsequent crystallizing led to forking reconfiguration pattern of two development options: a commercial software Blue Box and an open source software Blue Box, around which a clustering of decision-making actors and clustering of legitimating actors created two emerging micro-alliances.

Whereas the process of crystallizing different development options for the Blue Box was deemed legitimate by all actors, the subsequent process merging the two alternatives into a legitimate outcome was not. Specifically, legitimating actors of the European open source software Blue Box micro-alliance found it illegitimate to take only technical parameters into account in the decision-making process and not the "Europeanness" of the proposed Blue Box. This reconfiguration pattern is what we describe as "*altering*" of development options, where surfacing of differences on decision-making parameters change development options resulting in conflicts on the legitimacy of process. In the particular Blue Box episode the legitimacy of the Europeanness argument and the Helix Nebula membership documents reconfigured two altered development options: American commercial software Blue Box and European open source software Blue Box.

A third reconfiguration pattern of micro-alliances that showed in the Blue Box Narrative Part 3 is the "*annexing*" reconfiguration pattern which we analyzed in the episode where CERN, EMBL, and ESA stated legitimacy of outcome for solely the American commercial software Blue Box. Actors in the micro-alliances on the European open source software Blue Box, however, did not provide legitimacy of outcome.

The retraction of the statement led to the re-instantiating of the American commercial and European open source Blue Boxes and induced crystallizing of the Public Blue Box as a third development option. This forking pattern, caused by the surfacing of differences, was followed by by a merging pattern from the surfacing of dependencies leading the actors in the different micro-alliances to find legitimacy of outcome on testing both Blue Boxes in parallel with integration of the Public Blue Box.

Blue Box Narrative Part 4

After consensus had been reached in October 2012 on testing and running the American commercial and European open source Blue Boxes in parallel, surfacing of differences remained absent for some time. Alongside the Blue Box development, the one supplier working on a service architecture had remained committed creating a document. In December 2012 this service architecture document was published as a formally endorsed Helix Nebula document. In a burst of excitement, one demand-side organization stated support saying that the service architecture was more in line with the expectations and requirements of all demand-side organizations and suggested the suppliers to stop working on the Blue Box and further develop the service architecture. The legitimating actions by the demand-side for the service architecture rekindled the differences between the American commercial and European open source software Blue Boxes. As the supply-side meeting notes of 9 December 2012 show:

> "*The discussions about potential multiple Blue Boxes had calmed down a bit, but was re-energised by an email from Lucas [demand-side organization] this week. Monty since spoke Lucas and reports a slightly different intention: we will perform both demo's in January, and will then re-run the PoC's on both, serially.*" (Supply-side distribution list; 12/9/12)

In the first six months of 2013 the plan to test and run both Blue Boxes in parallel remained committed to by all actors in Helix Nebula. However, until then only little business had been generated by the suppliers from collaborating in Helix Nebula, which led the suppliers to further crystallize the Blue Box common resource to force the demand-side to start buying commercial cloud computing resources. In so doing, dependencies between the European open source software Blue Box and the service architecture surfaced merging them into the development option for an "*Helix Nebula Marketplace*". As the two micro-alliances merged no opposition was being voiced by other actors in Helix Nebula, which was interpreted by as that all Helix Nebula members agreed on the legitimacy of outcome. In order not to be accused of colluding, the micro-alliance of actors collaborating on the development of the Helix Nebula Marketplace developed a memorandum of understanding, which also meant they used separate communication threads not available to all suppliers.

On 9 November 2013 CERN, EMBL, and ESA and other suppliers were informed of the intentions for the deployment of the Helix Nebula Marketplace. The decision not to support the American commercial software Blue Box in Helix Nebula Marketplace was not harmoniously received by CERN, EMBL, ESA, and other suppliers. One supplier stated that this process of making decisions was not deemed good collaborative behavior, and rejected the actions of its fellow suppliers. Subsequently, this supplier started crystallizing the development option of integrating both the American commercial and the European open source software Blue Boxes in the Helix Nebula Marketplace, and in so doing was being endorsed by CERN, EMBL, EGI, and ESA.

The surfacing of differences between these two alternatives came to a hold in December 2013, a few months before the intentions of going live with the Helix Nebula Marketplace. In order to progress the development of the common resource the actors had to find an outcome legitimated by all members of the collaboration. Actions that realized this focused on making the differences between the development options more ambiguous by agreeing to first testing the Helix Nebula Marketplace with just the European open source software Blue Box and later integrate other Blue Boxes as well.

Analysis Blue Box Narrative Part 4

Our analysis of Blue Box Narrative Part 4 reveals four episodes of reconfiguration of development options: two of merging and two of forking. The first episode of forking re-instantiated the prior configuration of two conflicting Blue Box development options, with an additional third option and respective micro-alliance emerging on the service architecture development option being legitimated by CERN, EMBL, and ESA. All actors legitimated the process of crystallizing multiple development options.

In the subsequent merging episode the European open source software Blue Box and the service architecture documents were perceived by the actors of respective micro-alliances as legitimate outcomes, with surfacing dependencies leading to the merging of the development options into the Helix Nebula Marketplace. To avoid the risk that the process of exploring the development option was considered illegitimate, the micro-alliance remained somewhat silent and cautious in communicating the development work on the Helix Nebula Marketplace to the rest of the consortium. In so doing, the American commercial software Blue Box remained a legitimate development option in Helix Nebula despite not being further crystallized.

When CERN, EMBL, ESA, and other suppliers discovered in November 2013 that over the summer a separate micro-alliance started working on the Helix Nebula Marketplace, they posed strong objections against the legitimacy of this outcome. One suppliers started a separate micro-alliance exploring the possibility of having a Helix Nebula Marketplace that integrated both the American commercial and European open source software Blue Boxes. This constitutes another instance of forking of development options. Whereas all actors endorsed legitimacy of process for crystallizing this development option, the eventual legitimacy of outcome by CERN, EGI, EMBL, and ESA made the actors agree on merging into the development of the Helix Nebula Marketplace with the European open source software Blue Box as a temporal, but in the end enduring, common resource.

DISCUSSION

Prior studies mentioned the establishment of common resources as an effective substitute for hierarchy in meta-organizations. Common resources allow actors in meta-organizations to substantiate collaboration through self-organizing actions, agree on common goals, and coordinate activities towards realizing those common goals (Fjelstad et al., 2012; Gulati et al., 2012). In our study we problematize this understanding by asking how these common resources are developed and become established in the first place without the use of hierarchy or a readily available substitute therefore.

Our study on the meta-organization Helix Nebula offers several important findings to address this puzzle. One of the findings is that we show that the development of common resources is a process where different development options are continuously emerging, triggering the surfacing of differences and dependencies between them. Specifically, our analysis shows multiple configuration or re-configuration patterns, namely the *merging, forking, altering, and annexing* of development options for common resources. These patterns recurrently emerged as actors explored and developed options for common resources. This process of exploring and analyzing the details of a development option, documenting and presenting those, and discussing the viability with the other Helix Nebula members ultimately led to the *crystallizing of common resources.*

A second finding relates to how actors in Helix Nebula deal with the differences and dependencies between emerging development options for common resources. Our analysis of Helix Nebula shows that, given the lack of hierarchy, interdependent actors resort to the creation of *micro-alliances* that cluster around the different development options for a common resource. These micro-alliances consist of two types of actors: *decision-making actors* and *legitimating* *actors*. The decision-making actors are those members that directly involved and actively deal with exploring a development option. Legitimating actors provide endorsement or support for a crystallizing development option, which are essential for being adopted as a common resource. What is striking is that despite their indirect and passive involvement legitimating actors take an important role in the development process of as they conceive legitimacy for common resource options.

A third finding of our study is our analysis of the different sources and objects receiving legitimacy in a meta-organization like Helix Nebula. In more traditional inter-organizational collaborations, such as alliances or joint ventures, decision-making power vested in hierarchical authority determines what is legitimate and not. In a meta-organization like Helix Nebula, where hierarchy is absent, sources of legitimacy are the support or endorsement actions by members in the crystallizing of common resources. The object of legitimacy here is not only the development option itself but also the process in which these development options emerge, are selected, and endorsed. Specifically, in meta-organizations like Helix Nebula there is a difference between *legitimacy of outcome* and *legitimacy of process* in the development of common resources. For example, when two contrasting development options for a common resource emerged, Helix Nebula members held different views about which one pertained a legitimate outcome. However, all members gave legitimacy of process to the forking of options during development, legitimating this as a way to create a common resource that would be endorsed by the meta-organization.

We synthesize the findings of our study on Helix Nebula into a process model of organizing the development of common resources in meta-organizations (see Figure 3). Our analysis of the development of the Blue Box in Helix Nebula shows that the *crystallizing of common resources* is an important process where the exploration and explication of details gives rise to the emergence of different development options. The crystallizing of common resources triggers the *surfacing of differences and dependencies* between development options. The surfacing of differences and dependencies provokes a process of reconfiguration of the development options for common resources. From the analysis of a total of fourteen episodes we find four reconfiguration patterns of development options: (1) *merging* of development options, (2) *forking* of development options, (3) *altering* of development options, and (4) *annexing* of development options. The process of reconfiguration of development options provides sufficient conditions for the *clustering of decision-making actors* and the *clustering of legitimating actors* around the development options.

The clustering of these two types of actors in turn provides input for the establishment of *emerging micro-alliances*. The decision-making actors and legitimating actors in these emerging micro-alliances then proceed with the crystallizing of common resources.

Insert Figure 3 about here

Our study includes contributions to several literatures. First, our findings link to organizational decision-making literature by showing that in line with the garbage can model (Cohen, March, & Olsen, 1972) decision-making on common resources is nondeterministic in meta-organizations such as Helix Nebula. We contribute to this literature by illustrating the importance of *legitimating* as a separate activity from decision-making that gives direction in the development process of common resources.

A related second contribution is to legitimacy literature (Suchman, 1995; Suddaby, Bitektine, & Haack, 2016). Our study shows that legitimacy can have different manifestations when used to organize the development of common resources. We find that endorsing and supporting actions can be accounts of *legitimacy of outcome* or *legitimacy of process*. The development of common resources comes with different patterns of crystallizing development options which in turn come with different accounts of legitimacy.

Third, our study contributes to studies on collective action (Quinn & Worline, 2008). Through our analysis of the development of a common resource by highly heterogeneous actors collaborating in a meta-organization we find that collective action may not necessarily need to be a fully collective endeavour. Specifically, our findings show that to collectively advance common goals may require legitimacy of process to split up into distinct micro-alliances in order to find through progress and reconfiguration patterns the legitimacy of outcome required to realize common goals as a collective.

A fourth contribution of our study is to literature on the role of resources in organizations. The premise of the resource-based view (Barney, 1991; 2001) is that actors have resources that provide them with competitive advantage. On the other hand, in the organizational resourcing perspective (Feldman, 2004) actors enact resources to create organizational change and foster collaboration. Our study on the development of common resources in meta-organizations shows that *resources have actors*. Specifically, resources have micro-alliances comprised of clustered decision-making and legitimating actors.

Synthesizing the above contributions affects the conception in the literature of the link between organizational decision-making and resources. Prior literature generally follows the notion that actors with resources allow for decision-making, where for example financial or knowledge resources allow organizations to make decisions. To the contrary, we find that *resources with actors allow for decision-making*. Our study on the meta-organization Helix Nebula shows that the crystallizing of common resources includes the process of decision-making and legitimating actors clustering around development options in micro-alliances.

Our contributions furthermore affect the link in the literature between legitimacy and resources. A common notion in prior literature is that resources give actors legitimacy, where for example hierarchical or institutional norms give organizations legitimacy for certain activities. We find that *actors give resources legitimacy*. Our study on the development of common resources in Helix Nebula shows that the crystallizing of common resources includes the process of legitimating actors clustering around development options.

Closing the loop of our research inquiry we go back to where we started off. Recent studies have recognized that the value creation processes of organizations become increasingly interconnected and as a consequence the resources of multiple organizational actors get embedded into inter-organizational arrangements. Scholars have shown particular interest in explaining collaboration in meta-organizations, which are complex settings where multiple autonomous organizational actors collaborate (Fjelstad et al., 2012; Gulati et al., 2012). Such authors suggested that the establishment of common resources can be a valuable substitute for hierarchy, which prompted us to ask the question how these common resources are developed in the first place. Our study shows that to answer "*What do we have in common?*" in a setting where highly heterogeneous actors are collaborating in a meta-organization requires a continuous reconfiguration process of emerging micro-alliances and crystallizing of common resources where legitimacy of process gives room to explore different options and legitimacy of outcome allows common resources to establish.

REFERENCES

Adler, P. S. 2001. Market, hierarchy, and trust: The knowledge economy and the future of capitalism. ***Organization Science***, 12: 215–234.

Ansari, S.S., Garud, R., & Kumaraswamy, A. 2016. The disruptor's dilemma: TiVo and the U.S. television ecosystem. ***Strategic Management Journal***, 37: 1829–1853.

Ansari, S. S., Wijen, F., & Gray, B. 2013. Constructing a Climate Change Logic: An Institutional Perspective on the "Tragedy of the Commons." ***Organization Science***, 24: 1014–1040.

Baldwin, C., & von Hippel, E. 2011. Modeling a Paradigm Shift: From Producer Innovation to User and Open Collaborative Innovation. ***Organization Science***, 22: 1399–1417.

Barney, J. B. 1991. Firm resources and sustained competitive advantage. ***Journal of Management,*** 17: 99–120.

Barney, J. B. 2001. Is the resource-based "view" a useful perspective for strategic management research? Yes. ***Academy of Management Review,*** 26(1): 41–56.

Bauer, J., Franke, N., & Tuertscher, P. 2016. Intellectual Property Norms in Online Communities: How User-Organized Intellectual Property Regulation Supports Innovation. ***Information Systems Research***, isre.2016.0649.

Boudreau, K. J. 2012. Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation. ***Organization Science***, 23: 1409–1427.

Carlile, P. R. 2002. A pragmatic view of knowledge and boundaries: Boundary objects in new product development. ***Organization Science***, 13: 442–455.

Carlile, P. R. 2004. Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. ***Organization Science***, 15: 555–568.

Cohen, M. D., March, J. G., & Olsen, J. P. 1972. A garbage can model of organizational choice. ***Administrative Science Quarterly***, 17(1): 1–25.

Faraj, S., Jarvenpaa, S. L., & Majchrzak, A. 2011. Knowledge collaboration in online communities. ***Organization Science***, 22: 1224–1239.

Feldman, M. S. 2004. Resources in Emerging Structures and Processes of Change. ***Organization Science***, 15: 295–309.

Fjeldstad, Ø.D., Snow, C.C., Miles, R.E., & Lettl, C. 2012. The architecture of collaboration. ***Strategic Management Journal***, 33: 734–750.

Garud, R., Jain, S., & Kumaraswamy, A. 2002. Institutional Entrepreneurship in the Sponsorship of Common Technological Standards: The Case of Sun Microsystems and Java. ***Academy of Management Journal***, 45: 196–214.

Garud, R., & Rappa, M. A. 1994. A socio-cognitive model of technology evolution: The case of cochlear implants. ***Organization Science***, 5: 344–362.

Garud, R., Schildt, H. A., & Lant, T. K. 2014. Entrepreneurial Storytelling, Future Expectations, and the Paradox of Legitimacy. ***Organization Science***, 25: 1479–1492.

Gulati, R., Puranam, P., & Tushman, M. 2012. Meta-organization design: Rethinking design in interorganizational and community contexts. ***Strategic Management Journal***, 33: 571–586.

Gulati, R., Wohlgezogen, F., & Zhelyazkov, P. 2012. The Two Facets of Collaboration: Cooperation and Coordination in Strategic Alliances. ***The Academy of Management Annals***, 6: 531–583.

von Hippel, E. V., & von Krogh, G. V. 2003. Open Source Software and the "Private-Collective" Innovation Model: Issues for Organization Science. ***Organization Science***, 14: 209–223.

Langley, A. 1999. Strategies for theorizing from process data. ***Academy of Management Review***, 24: 691–710.

Lawrence, P.R., & Lorsch, J.W. 1967. ***Organization and Environment: Managing Differentiation and Integration***. Irwin: Homewood, IL.

Leblebici, H., Salancik, G. R., Copay, A., & King, T. 1991. Institutional change and the transformation of interorganizational fields: An organizational history of the US radio broadcasting industry. ***Administrative Science Quarterly***, 36: 333–362.

Leiponen, A. E. 2008. Competing Through Cooperation: The Organization of Standard Setting in Wireless Telecommunications. ***Management Science***, 54: 1904–1919.

March, J.G., & Simon, H.A. 1958. ***Organizations***. Wiley: New York.

Miles, M.B., & Huberman, A.M. 1994. ***Qualitative data analysis: An expanded sourcebook***. Sage Publishing: London, U.K.

Mintzberg, H. 1983. ***Structure in Fives***. Prentice Hall: Englewood Cliffs, NJ.

O'Mahony, S. 2003. Guarding the commons: how community managed software projects protect their work. ***Research Policy***, 32: 1179–1198.

O'Mahony, S., & Bechky, B. A. 2008. Boundary organizations: Enabling collaboration among unexpected allies. ***Administrative Science Quarterly***, 53: 422–459.

O'Mahony, S., & Ferraro, F. 2007. The emergence of governance in an open source community. ***Academy of Management Journal***, 50: 1079–1106.

Ostrom, E. 1990. ***Governing the commons: The evolution of institutions for collective action***. Cambridge University Press: Cambridge, U.K.

Perrow, C. 1967. A framework for the comparative analysis of organizations. ***American Sociological Review***, 32(2): 194–208.

Pettigrew, A.M. 1990. Longitudinal field research on change: Theory and practice. ***Organization Science***, 1: 267–292.

Puranam, P., Alexy, O., & Reitzig, M. 2014. What's 'New' About New Forms of Organizing? ***Academy of Management Review***, 39: 162–180.

Quinn, R. W., & Worline, M. C. 2008. Enabling Courageous Collective Action: Conversations from United Airlines Flight 93. ***Organization Science***, 19: 497–516.

Rosenkopf, L., & Tushman, M.L. 1998. The coevolution of community networks and technology: Lessons from the flight simulation industry. ***Industrial and Corporate Change***, 7: 311–346.

Siggelkow, N. 2007. Persuasion with case studies. ***Academy of Management Journal,*** 50: 20–24.

Simon H.A. 1962. The architecture of complexity. ***Proceedings of the American Philosophical Society,*** 106: 466–482.

Star, S. L., & Ruhleder, K. 1996. Steps toward an ecology of infrastructure: Design and access for large information spaces. ***Information Systems Research***, 7: 111–134.

Suchman, M. C. 1995. Managing legitimacy: Strategic and institutional approaches. ***Academy of Management Review***, 20: 571–610.

Suddaby, R., Bitektine, A., & Haack, P. 2017. Legitimacy. ***Academy of Management Annals***, 11(1): 451–478.

Thomas, L.D.W., Autio, E., & Gann, D.M. 2014. Architectural Leverage: Putting Platforms in Context. A***cademy of Management Perspectives***, 28: 198–219.

Tuertscher, P., Garud, R., & Kumaraswamy, A. 2014. Justification and interlaced knowledge at ATLAS, CERN. ***Organization Science***, 25: 1579–1608.

Van de Ven, A.H. 1992. Suggestions for studying strategy process: A research note. ***Strategic Management Journal***. 13: 169–188.

Wareham, J., Fox, P. B., & Cano Giner, J. L. 2014. Technology Ecosystem Governance. ***Organization Science***, 25: 1195–1215.

Yin, R. 2013. ***Case study research: Design and methods***. Los Angeles, CA: Sage Publishing.

FIGURE 1
Depiction of Helix Nebula

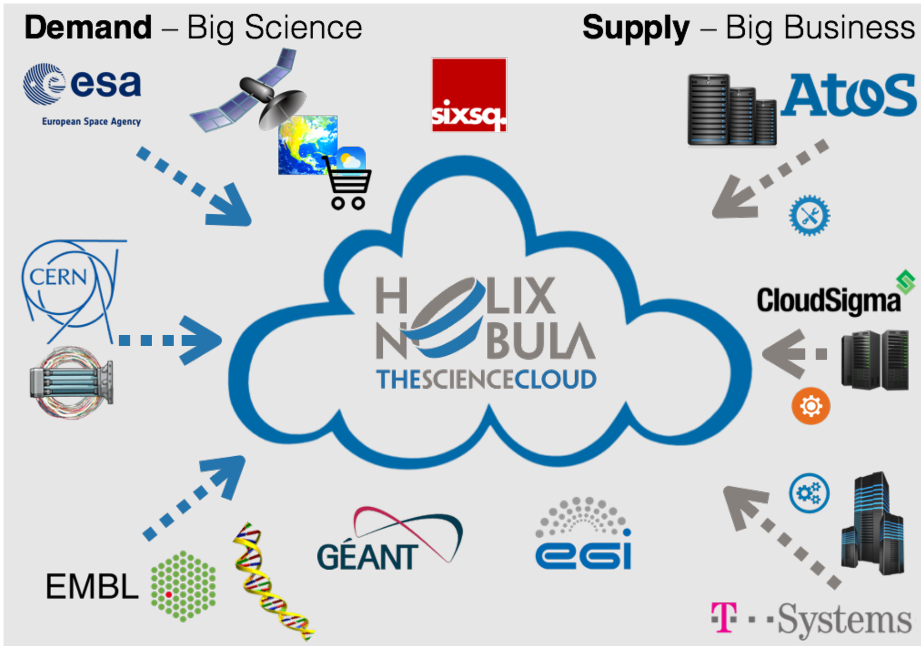


TABLE 1
Conditions of reconfiguration episodes

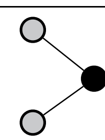
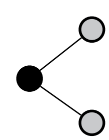
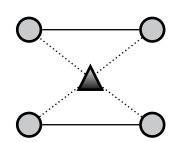
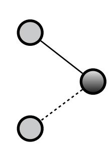
Reconfiguration pattern	**Trigger and conditions**	**Members actions in meta-organization**	**Outcomes**	**Depiction**
Merging *Merging of two or more development options*	Surfacing of dependencies	Making differences ambiguous Creating intermediate alternatives Finding legitimacy of outcome	Legitimacy of outcome	
Forking *Forking of development options*	Surfacing of differences	Disambiguation of development options Disputing development options Accepting legitimacy of process	Legitimacy of process	
Altering *Altering of development options*	Surfacing of differences	Changing development options decision-making parameters Creating linkages between common resources	Lacking legitimacy of process	
Annexing *Annexing of development options*	Surfacing of dependencies	Integrating development options without consensus Enforcing legitimacy of outcome	Lacking legitimacy of outcome	

FIGURE 2
Overview of the emerging Blue Box development options

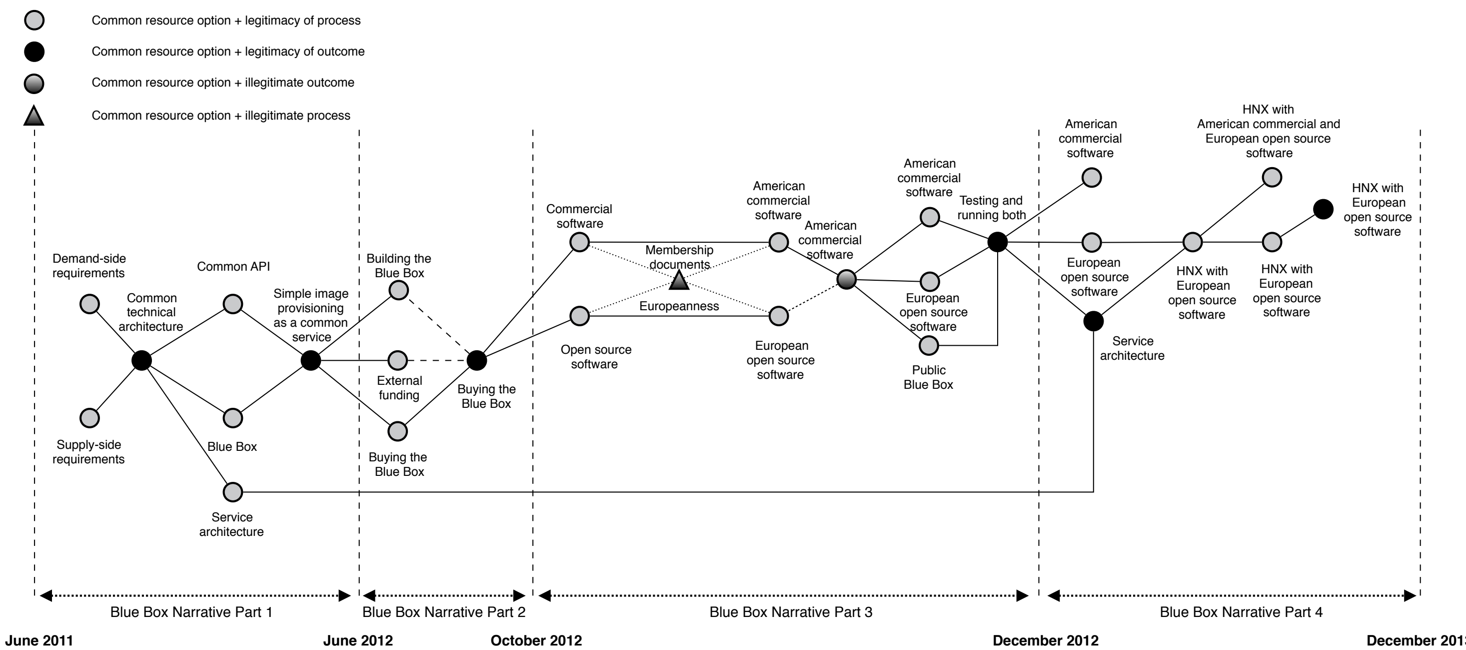


FIGURE 3
Process model of organizing the development of common resources in meta-organizations