# ROTATING LEADERSHIP AND SYMBIOTIC ORGANIZATION: RELATIONSHIP PROCESSES IN THE CONTEXT OF COLLABORATIVE INNOVATION

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**Rotating Leadership and Symbiotic Organization:**
**Relationship Processes in the Context of Collaborative Innovation**


## ABSTRACT

Relationships between firms are at the heart of how industries are organized, and are central to industry innovation. Despite significant attention focusing on the exchange and endorsement value of these relationships, and how they are formed, very little attention has been given to their capacity to generate innovations. Using a multi-case, inductive study of eight technology collaborations between ten firms in the computing and communications industries, this paper examines how inter-organizational relationships engender innovation and adaptation in unpredictable and interdependent environments. Comparisons of successful and unsuccessful collaborations show that generating collaborative innovations depends not only on appropriate design conditions (e.g., governance form, social embeddedness) as suggested by prior literature, but also on using appropriate organizational processes that lead relationships over time. While less successful collaborations are associated with domineering leadership or consensus leadership processes, successful collaborations use a rotating leadership process that creates transient unilateral leadership opportunities for each partner. Rotating leadership involves *revolving decision control* between partners to engender high-quality contributions of technologies and IP, *fluctuating cascades of network activation* which dynamically modify innovative team composition, and *zig-zagging relationship trajectories* that effectively search the broader space of potential innovations. A broader contribution is to reframe inter-organizational relationships as *organizational symbiosis,* a state of organization that engenders mutually reinforcing adaptive changes to partner's strategies and structures. In contrast to other images of relationships as engines of efficient exchange and endorsement, symbiotic relationships focus on engendering technology innovation, organizational adaptation, and industry transformation.

*"Most of the problems in our technology collaborations are not really engineering problems. It's like that radio program 'CarTalk'. When people call in they think they have a technical problem. But really their problems are about the relationship. It's the same with us." (Alliance Manager, Cleopatra Corporation.)*

Relationships between firms are at the heart of how industries are organized. While much research focuses on the benefits of efficient exchange and endorsement that derive from these relationships (Uzzi, 1996; Dyer, 1997; Stuart, et al., 1999) or how they are formed (Gulati, 1995b; Eisenhardt and Schoonhoven, 1996; Stuart, 1998), less research has focused on their capacity to generate innovations (Ahuja, 2000; Baum, et al., 2000). Product development and acquisition are critical sources of innovation for firms (Brown and Eisenhardt, 1997; Ahuja and Katila, 2001). Yet, when markets are interdependent and unpredictable, it is unlikely that single firms can consistently develop or acquire the best innovations. Instead, technology collaborations become a pivotal innovation strategy (Powell, et al., 1996; Ahuja, 2000; Baum, et al., 2000). For instance, Google and Apple have used their relationship to generate a number of new technologies (Rosmarin, 2007). Recently, the firms developed a battery-saving mobile player for viewing videos, bringing Google's fast-playing YouTube videos to Apple's high profile iPhone product. As a result, Apple CEO Steve Jobs was able to claim that the "iPhone delivers the best YouTube mobile experience by far" (Apple, 2007), leading analysts to speculate about whether "Goopple" would "tie the knot" and continue their innovative relationship (Rosmarin, 2007).

Technology collaborations are attractive to these firms because this collaborative mode of innovating seems to balance some of the benefits of open and closed innovation systems (Chesbrough, 2003), bringing in new knowledge from outside the boundaries of the firm but preserving some degree of proprietary protection. Furthermore, technology collaborations can accelerate development by virtue of production efficiencies (Katila and Mang, 2003; Rothaermel and Deeds, 2004), generate more original innovations by recombining complementary knowledge (Nohria and Garcia-Pont, 1991; Gawer and Henderson, 2007), and enjoy more powerful positioning due to the combined market-power of partners (Brandenburger and Nalebuff, 1996; Adner and Kapoor, 2006). In fact, many other high performing products such as Apple's iPod, Microsoft's Xbox, and Motorola's RAZR rely on collaborative innovations (Kahney, 2004; Schoenborn, 2006; Takahashi, 2006), suggesting that this mode of

innovating may be the norm in interdependent industries.

Yet despite their importance, the intense "symbiotic" relationships that generate collaborative innovations can be fraught with difficulties. For instance, even Intel and Microsoft's famous relationship involved repeated confusion and conflict about the development of new technologies, placing future innovations in doubt (Casadesus-Masanell and Yoffie, 2007). Yet, in spite of these challenges, the two firms collaborated effectively, producing a number of complementary technologies underlying the dominant "Wintel" platform (Bresnahan and Greenstein, 1999; Casadesus-Masanell and Yoffie, 2007). As Intel CEO Andy Grove once described, the firms became "joined at the hip" with highly intertwined strategic trajectories as a result of these collaborations (Burgelman, 2002: 341). The mystery is how these and other firms sustain their strong and innovative relationships over many years. How do firms develop collaborative innovations and effective relationships?

The broader literature on alliance performance provides some insight into the determinants of collaborative innovation. A striking feature of this research, though, is that it rarely examines the collaboration process. Instead, it relies primarily on archival data to link various antecedent factors such as governance form (Parkhe, 1993; Dyer, 1997; Park and Ungson, 2001), collaborative experience (Anand and Khanna, 2000; Kale, et al., 2002), and social embeddedness (Gulati, 1995a; Uzzi, 1996) to the performance of inter-organizational relationships. In addition, archival studies of technology collaborations suggest that the success in this context depends on other antecedent factors like possessing related technologies (Ahuja, 2000), R&D capabilities (Stuart, 2000), and absorptive capacity (Lane and Lubatkin, 1998). Taken together, these studies of exchange alliances and technology collaborations provide significant insight into effective choices surrounding the initial design of collaborations, but lack focus on how the dynamics of relationships effect innovative development. The resulting image is one of relationships as engines of efficient exchanges and routine R&D whose success is highly constrained by their initial conditions.

In contrast, a few process studies have sought to open the "black box" of inter-organizational relationships by examining collaboration mechanisms directly (Larson, 1992; Doz, 1996; Arino and de la

Torre, 1998; Reuer, et al., 2002). Adding considerable nuance to the antecedents literature, these studies suggest important lessons such as the importance of competitive learning races between partners (Hamel, 1991; Doz, 1996; Khanna, et al., 1998) and positive feedback cycles of commitment and trust (Larson, 1992; Doz, 1996; Helper, et al., 1999). Collectively, these studies suggest that fundamental changes in the underlying relationship (i.e., fluctuating objectives, commitment, and trust) can have dramatic implications for collaborative performance (Ring and Van de Ven, 1994; Gulati, 1998).

Although these process studies considerably enhance our understanding of alliance performance, they suggest further research opportunities. First, very few process studies exist, and extant studies often use indirect performance measures such as collaboration dissolution as a proxy for failure (Ring and Van de Ven, 1994; Gulati, 1998). More robust and varied measures of collaborative performance could enhance the linkages between process and performance, and improve generalizability. Second, these studies often assume a uni-dimensional perspective emphasizing, for instance, either an overly cooperative view that effective collaboration is simply a matter of learning and trust, or an overly competitive view that effective collaboration is about extracting value at the partner's expense. This neglects the challenging mix of cooperative intentions and competitive pressures that are a hallmark of relationships in dynamic environments. Finally, the literature sometimes points to the importance of collaborative capabilities and processes (Larson, 1992; Kale, et al., 2002), but rarely details the specific mechanisms underlying these capabilities and processes. In other cases, the literature provides extensive detail about some processes – as in the case of inter-organizational learning (Hamel, 1991; Doz, 1996; Arino and de la Torre, 1998; Lane and Lubatkin, 1998) – but the links to innovation remain unclear.

These issues are critical in the collaborative innovation context because the ambiguous and unpredictable nature of joint R&D make relationship dynamics particularly salient (Hansen, 1999; Chesbrough, 2003; Ancona and Bresman, 2007). For instance, how do partners share strategic decision-making when incentives are misaligned? How do firms utilize network ties between executives, managers, engineers that cross organizational boundaries? More broadly, how do these intense relationships shape the strategic trajectories of each partner organization? That is, a focus on the

collaborative innovation context could bring organizational processes underlying joint decision making, boundary spanning networks, and intertwined trajectories into the foreground. These gaps in the literature are important to address because prior evidence suggests that, while challenging, technology collaborations are an important technology strategy and source of industry innovations (Ahuja, 2000; Baum, et al., 2000; Stuart, 2000).

The purpose of this paper is to explore how firms manage effective inter-organizational relationships. Specifically, we ask: what are the organizational processes that enable some technology collaborations to generate innovations while others do not? Given the lack of prior research on the organization of collaborative innovation, we use grounded, inductive methods (Glaser and Strauss, 1967; Eisenhardt, 1989) to examine eight technology collaborations between ten firms in the highly dynamic and interdependent computing and communications industries. This organizational field is an attractive setting for this study because the growing convergence of computing and communications technologies in products such as smartphones, laptops, and web software create multiple attractive opportunities for inter-firm collaboration (Mowery, et al., 1996; Bresnahan and Greenstein, 1999).

The major findings center on the leadership processes that firms use to organize collaborative innovation and sustain their broader symbiotic relationships. We find that rather than use either *domineering leadership* or *consensus leadership* processes associated with less innovative collaborations, more innovative collaborations *rotate leadership* between the partners over time. Rotating leadership involves, first, *revolving decision control* between partner organizations across phases of the collaboration. Rather than demotivate weaker partners through domineering processes or engender ambiguity with consensus seeking, rotating leadership combines clear roles and responsibilities with discrete opportunities for both firms to shape the collaborative relationship. These transient phases of control increase commitment and generate a sense of urgency that can be used to acquire critical resources inside partner organizations. Second, rather than rely on a single, fixed pattern of cross-firm participation over time, rotating leadership involves *fluctuating cascades of network activation* across phases. Controlling firms typically involve their own members of the collaboration network before

others, leading to shifting cascades of participation across phases that promote a more comprehensive approach to innovation. Third, rotating leadership generates *zig-zagging relationship trajectories* that combine the direct and forceful actions of unilateral objectives (in each phase) with dramatic changes of direction (across phases) that reflect the differing interests and perspectives of two collaborating organizations. In contrast to the unswervingly forceful trajectories of domineering leadership which generates little novelty, and the weaker trajectories of consensus leadership which make little progress towards objectives, the zig-zagging trajectories of rotating leadership effectively search the broader space of potential innovations.

The primary contribution of this paper is a growing understanding of the organizational processes underlying effective inter-organizational relationships. While antecedent factors such as prior experience and social embeddedness are likely to remain important, effective collaboration depends on organizing processes that strengthen inter-firm relationships. Furthermore, not all processes are created equal: critical differences in processes generate widely varying performance outcomes. Indeed, this suggests an emerging view that strategy, organization, and innovation are embedded not only in the prevailing incentives and complex social structures, which are difficult to change, but also in the use of subtle organizational processes that managers can influence. Overall, this perspective points to a multi-dimensional perspective that differs substantially from exchange and endorsement images of inter-organizational relationships.

A broader contribution is an emergent perspective that reframes inter-firm relationships as organizational symbiosis. Symbiotic organization relies on processes such as rotating leadership that generate mutually reinforcing adaptive changes to partner's strategies and structures, creating ambiguous demarcating boundaries between organizations and unpredictable outcomes in the process. This perspective contrasts with many views of inter-organizational relationships that emphasize gradually increasing trust and efficient exchange, but do not account for the highly adaptive relationships and collaborative innovations that at the heart of how dynamic and interdependent industries are organized and evolve. Beyond inter-firm relationships, the symbiotic perspective suggests that effective strategy

and organization in industries, organizations, and groups depend critically on three essential characteristics: (1) promoting commitment by broadening decision control, (2) varying participation through fluctuating network activation, and (3) generating strategic trajectories that explore the broader space of innovations. Overall, this research complements existing research on antecedents of alliance performance with a multi-dimensional view of relationships emphasizing organizational processes.

**METHODS**

The research design is a multiple-case, inductive study of inter-organizational collaborations. Case studies are particularly appropriate for studying how collaborative processes impact performance because they enable detailed tracking of complex collaboration processes which cannot be controlled in the lab and are difficult to find in archival data (Yin, 1994). Multiple cases permit a replication logic in which the cases are treated as a series of experiments that confirm or disconfirm emerging conceptual insights (Eisenhardt, 1989; Yin, 1994). The results of multiple-case research are typically more generalizable and better grounded than those of single-case studies, making them more amenable to exploration with other methods (Davis, et al., 2007). The research also uses an embedded design involving analysis at multiple levels including collaboration, firms, business units and labs, teams, projects, and individual participants. Although complex, embedded designs permit induction of richer, more reliable models (Yin, 1994).

This research focuses on how firms engage in effective inter-organizational collaboration with a focus on generating technology innovations. We chose technology collaborations between established firms as the research context because technology collaborations are particularly intense and unpredictable and, thus, fertile ground in which to explore collaborative processes. Sometimes called R&D or innovation alliances, these technology collaborations are specific, innovation-focused projects with common technology and product development goals. Technology collaborations are attractive because they have discrete start and end times, making it possible to track the entire collaboration from inception which enables more accurate observation of the collaboration process and performance measurement. In addition, technology collaborations are attractive because they are highly strategic – often requiring

significant resources and risk-taking – yet unpredictable by nature, in contrast to more routine alliance types. We chose technology collaborations between large established firms for several reasons. From a research standpoint, these firms typically share antecedent characteristics associated with collaboration performance (e.g., extensive experience with collaborations), so they allow a focus on the collaboration process without the complication of varied antecedent factors. From a pragmatic standpoint, these firms have enough resources to engage in significant R&D. Finally, their size is likely to preclude their acquisition of each other, putting M&A in the background, and making collaboration necessary and important.

The research setting is the computing and communication industries. We define these industries broadly as the set of firms who produce computer and communications related products such as processors, laptops, cellphones, and internet software. This organizational field is a particularly appropriate setting because the convergence of communications, computing, and internet services created multiple opportunities that required collaboration between firms across semiconductor, hardware, and software sector boundaries (Mowery and Rosenberg, 1998; Bresnahan and Greenstein, 1999). We used a stratified sampling strategy whose intent is to include a broad range of technology projects and firms that are relevant in the computing and communication industries.

Table 1 describes the eight cases between ten firms used in this study. Firms are disguised with pseudonyms drawn from Shakespearean characters (e.g., Macbeth, Ariel), while cases are named for the broad technological area of the collaboration project (e.g., Security, VOIP). These technologies span many relevant technology categories including security circuits and firmware (Security); platform middleware (Middlware); virtual private network hardware and software (VPN); mobile email applications and operating systems (Mobile Email); internet application software (XML); wireless communications circuits, devices, and firmware (WLAN); web services software (Web Services); and voice-over-internet-protocol software and hardware (VOIP). The collaborations lasted from 1-3 years, all occurring within the period from 2001 to 2006.

The firms participating in these collaborations do business in the relevant sectors of the

computing and communication industries, including semiconductors (Macbeth), network equipment (Falstaff), systems hardware (Ariel), operating systems (Lear, Rosalind), software applications (Cleopatra, Prospero, Lear, Ariel), mobile devices (Rosalind, Portia), and internet services (Mercutio, Ophelia). Most pairs of collaborating firms had extensive prior relationships with each other as complementors, buyer/suppliers, joint sales and marketers, and even direct competitors. Finally, the sample includes six firms headquartered in the US and four headquartered internationally, reflecting the global nature of high-technology industries. Such industry and geographic variety should enhance the representativeness of the sample and generalizability of the results.

**Dyadic Sample**

We took pains to mitigate bias, improve generalizability, and enhance the reliability of the sample of collaboration cases. For example, we focused on important antecedents of superior collaboration performance already in the academic literature. Broadly, the literature suggests that prior experience with collaborations may improve future collaborations (Anand and Khanna, 2000; Kale, et al., 2002), and specific R&D related skills and technical leadership can increase the likelihood of collaborative innovation (Lane and Lubatkin, 1998; Ahuja, 2000; Stuart, 2000). In addition, the literature predicts that strategically interdependent firms will have complementary skills and interests (Marsden, 1983; Gulati, 1995b), and social embeddedness can facilitate the coordination of complex problem solving (Uzzi, 1997; Gulati and Singh, 1998). Finally, the literature also focuses on governance form, suggesting that contracts should involve equity participation to mitigate opportunism when outcomes are uncertain (Pisano, 1989; Gulati, 1995a; Dyer, 1997). Finally, in the special case of R&D alliances or technology collaborations, firms that operate in technically related areas should benefit from ease of communication and common technical understandings (Dougherty, 1992; Lane and Lubatkin, 1998; Ahuja, 2000).

In fact, what this study will show is that these antecedent factors are not constraining enough – i.e., they do not ensure high innovation performance. As Table 1 illustrates, all the relationships in this study share the literature's recommended antecedents. The established firms in this study all had extensive experience collaborating, possessing dedicated alliance functions (Kale, et al., 2002). In

addition, each pair of firms is strategically interdependent with their core businesses in complementary sectors (e.g., hardware/software, circuits/systems) (Gulati, 1995b). Both partners dedicate significant resources to joint development and govern these collaborations with loose "memorandums of understanding" (MoUs) that are signed at the beginning of the collaboration. However, these MoUs are incomplete contracts which specify only "broad areas of technology exploration" that do not legally bind the firms (Williamson, 1975; Grossman and Hart, 1986). Instead, multiple participants joked that these collaborations operated by the principle of "Mutual Assured Destruction" – that is, the implied threat that opportunism would result in costly retaliation (e.g., legal battles and direct competition). In addition, these relationships all conformed to standard descriptions of social embeddedness (Gulati, 1995a; Uzzi, 1997) – that is, these relationships are characterized by previous inter-organizational interactions which generated multiple boundary-spanning ties between individuals and workgroups. Finally, these firms were all technical and market leaders in their respective domains (i.e., either 1st or 2nd in market share). These domains are highly related technical areas (e.g., circuits, chipsets, systems, applications) that facilitated discourse in the common language of the computing and communications industry.

Yet, despite sharing these relevant antecedents, the collaborations in this study generate a wide variance of innovation performance. As the next section details, even properly designed collaborations can fail, suggesting that these antecedent factors alone do not sufficiently solve the organizational problems in these relationships. Ultimately, effective collaboratoin must build upon but, ultimately, transcend these antecedents and utilize more complex organizational processes that effectively manage these collaborations over time.

Finally, we also constructed the sample to control for relevant relational issues suggested by prior literature on collaboration antecedents. For example, the sample includes three collaborations between the same partner firms (Security, WLAN, and VOIP) because the literature suggests that prior experiences between pairs of partners are important determinants of collaboration effectiveness (Gulati, 1995a; Uzzi, 1997). Also, the sample includes two pairs of collaborations involving the same partner in order to compare collaborations that share a single partner organization (VPN & Mobile Email; XML &

Web Services) because the literature suggests that collaborative capabilities and alliance functions in single partners are important determinants of collaboration effectiveness (Gulati, 1995a; Kale, et al., 2002). These attributes of the sample enable exploration of these key issues, and increased the efficiency of data collection as conversations with some informants could be split into multiple case interviews.

**Data Sources**

This study uses several data sources: 1) qualitative and quantitative data from semi-structured interviews, 2) emails and phone calls to follow-up interviews and track collaborations in real-time, and 3) both publicly available and internally private archival data from websites, corporate intranets, business publications, and materials provided by informants. We began research with 15 pilot interviews to explore the feasibility of studying inter-organizational collaborations. These interviews indicated that rich data about collaboration life histories could be collected, which moved the study quickly into the formal design stage. Formal data collection took approximately two years and is described below.

We conducted 72 case interviews over 24 months. We interviewed collaboration participants at three levels of authority in both partner organizations for each case. Specifically, we aimed to interview at least one representative participant from the executive, manager, and engineer levels of both partner organizations, which we achieved in all but one case where the collaboration's team structure made this impossible. Multiple informants at multiple levels mitigate subject biases and lead to a richer more elaborated model (Eisenhardt, 1989; Miller, et al., 1997). We used a "snowball sampling" method that began by targeting a CEO or CTO, or other executive representative in a single firm. The first executive we contacted typically began by contacting an executive at the partner firm. Then, often in parallel, executives contacted project managers involved in the collaboration's day-to-day management, who assisted in identifying relevant functional mangers, technical leads, and engineers. The informants typically included at least two executive leads (typically CTO, EVP, or SVP) who oversaw the collaboration although larger executive teams were possible; multiple strategic alliance directors, product-line general managers, or laboratory heads; and technical leads, scientists, and engineers.

Throughout data collection, an important goal was to mitigate sources of bias. The semi-

structured interviews were 60-90 minutes, following an interview guide directing the informant to tell the known facts of the case while leaving room for relevant asides and increasing focus on interesting issues. The guide focuses on the goals of each project, how they were initiated and negotiated, how the work progressed and evolved, the different roles and activities of participants, and how progress was assessed. Each interview used a "courtroom" procedure that concentrated on facts and events rather than respondent's interpretations, especially of others' actions (Eisenhardt, 1989). Interviews began with an open-ended chronology of the collaboration, including relevant events occurring before the collaboration's start date. Open-ended questioning leads to higher accuracy in retrospective reports (Golden, 1992; Miller, et al., 1997). For the research of which this study is part, the second phase of these interviews included questions asking respondents to give numerically scaled responses to characterize their projects.

Finally, we took specific steps to minimize informant biases. First, we gathered secondary data both on-site and from the media about these collaborations. Most interviews were tape-recorded and transcribed, with a total source material of 1643 double-spaced pages from interviews. In most cases, we collected data as the collaboration progressed, returning to conduct multiple site-visits. This enabled the collection of both real-time and retrospective data that improved the depth of understanding of how events evolved (Leonard-Barton, 1990). Including multiple informants at different levels increased the number of distinct perspectives to search for inaccuracies and, thus, mitigated retrospective bias. Also, focusing on facts in the interviews mitigates some cognitive biases and impression management (Golden, 1992; Miller, et al., 1997). Finally, care was taken to motivate informants to provide accurate data by promising confidentiality (Eisenhardt, 1989; Miller, et al., 1997).

**Data Analysis**

As is typical in inductive research, we analyzed the data by first building individual case histories synthesizing interviews and archival data (Eisenhardt, 1989). Triangulation promotes a richer, more reliable account (Jick, 1979). Case histories were 40 to 90 pages long and took four months to write. They focused on the prior history of the inter-organizational relationship, detailed chronologies of the

collaboration project, and a conclusion describing the collaboration's impact on each firm for one year after the collaboration's end.

The case histories were used for two analyses: within-case and cross-case. Within-case analysis focused on developing constructs that describe each case. Following an inductive approach, these emerged from each case independently. When within-case analysis concluded, cross-case analysis progressed following methods suggested by Miles and Huberman (1994) and Eisenhardt (1989) to develop conceptual insights. We began with no a priori hypotheses, and used comparisons between cases to develop tentative propositions. Relationships were refined with repeated use of replication logic, often revisiting the data and constructing new charts in an attempt to find patterns that fit all the data. We often took breaks to refresh our thinking, and talked with other experienced researchers about the data. As the analysis evolved, we often raised the level of abstraction, but returned to interviews to ensure that these new ideas fit with the detailed data. From this process a framework emerged which explains how firms engage in effective inter-organizational collaboration.

## ROTATING LEADERSHIP AND COLLABORATIVE INNOVATION

The firms in this study compete in the highly dynamic and interdependent computing and communications industries where collaborative innovation is the norm (Bresnahan and Greenstein, 1999; Adner and Kapoor, 2006; Yoffie and Kwak, 2006), and informants were well aware that many breakthrough products such as the iPod, Xbox, and RAZR rely on collaborative innovations. The importance of working together to develop new technologies, products, and platforms comes through in many statements such as, *"This better help us build a new platform!"* and *"New products are the only worthy objective."* As a result, these technology collaborations occupy a central role in the innovation strategies and organizational change efforts of these firms. This is best summarized up by these comments from a CTO of a major computing firm in this study:

> *"If you want to study innovation in my industry, you need to study collaborations. … In fact, you'd be hard pressed to find a single innovative product that isn't the result of specific, strategic technology collaborations. Honestly, I spend 80% of my time doing collaborations. That's how important it is."*

That is, far from the view of alliances as a way to reduce costs and gain status, the established firms in

this study risk considerable resources in the hope of developing collaborative innovations that will transform their organizations and strengthen their strategic positions.

Yet conducting technology collaborations creates unique organizational challenges that must be met for innovation to progress. For instance, both firms possess well developed organizing structures and R&D processes, but when and how should each be utilized? *"We both have certification processes…we needed to chose between them."* How are critical choices about the collaboration content such as technological features made? *"Do we negotiate? Do we just do what they want?"* If they chose to integrate structures and processes from both firms, how do they avoid confusion and conflict that may emerge from misaligned incentives or simple misunderstandings? *"They open source everything…we honestly can't understand how they make money."* Equally important, how do firms motivate their partners to make valuable contributions of critical resources, especially technologies and expertise in the broader parent organizations? *"There is a certain poker-element to <disclosure>. What cards are we putting on table? But at least having all the executives there was…like having a big group hug."* At a broader level, effective collaboration involves managing who controls decision making, how resources are allocated, and how the relationship evolves over time. How do partners balance their immediate objectives with the broader relationship?

This is particularly challenging in the context of collaborative innovation where ambiguous activities and unpredictable outcomes are the norm. During technology collaborations, executives may be called upon to manage the day-to-day activities of the project, exploitation objectives may be replaced by exploration objectives, and the direct reporting structure may cross organizational boundaries. As one collaboration manager put it, *"I really don't know who I'm working for now. Most of my time is spent in their headquarters trying to implement their strategy with my firm's resources. It's confusing."* Moreover, it is extremely difficult to predict the outcomes of collaborative innovation and, thus, incorporate these outputs into strategic plans. To some extent, this is a natural bi-product of innovative technology development which can produce surprising competitive implications for firms (Henderson and Clark, 1990). Yet, firms engaged in intense collaborations have the additional challenge of predicting how their partner's preferences and actions will affect the relationship. For instance, firms in this study took multiple actions

such as product releases, acquisitions, and patenting that genuinely surprised their partners and had a direct impact on the course of collaborative development. *"We filed <the patent> and they accused us of IP exploitation! I told them they must be confusing us with IBM!"* Given these considerable challenges, how do pairs of firms develop innovations and effective relationships?

Prior theory emphasizes the importance of cooperation (Gulati, 1995a; Uzzi, 1997; Zaheer, et al., 1998), prior experience (Anand and Khanna, 2000; Kale, et al., 2002), and governance form (Pisano, 1990; Parkhe, 1993; Dyer, 1996) in inter-organizational relationships. That is, experienced partners are more likely to conduct effective collaborations when they work closely together and ensure that commitments are carried out. Yet this literature offers little guidance on the specific processes that partners use to manage effective collaborations when, like the firms in this study, they already possess the relevant antecedent conditions suggested by the literature. Organizational processes are especially relevant in the context of collaborative innovation where a focus on the joint production of new technologies and IP places a premium on effective relationship management.

What emerged from the data were insights that linked differences in innovation performance with the use of different organizational processes for leading inter-organizational collaborations. For instance, some collaborations used a *domineering leadership* process where dominant firms control decision making and monitor their partners to mitigate opportunism. Other collaborations used a *consensus leadership* process where firms seek agreement in joint decision making, relying on social norms like reciprocity and generosity to ensure that commitments are fulfilled. Yet, as we found, these processes are associated with lower innovation outcomes than a third process, *rotating leadership*, where firms take turns leading the collaboration in discrete phases over time. Each of these processes involves distinct approaches to controlling decision making, utilizing network resources, and directing the trajectory of the relationship.

We begin by describing the innovation performance of the collaborations in this study. We then describe the three relationship processes that emerged from the data, using the lenses of decision control, network activation, and relationship trajectories to understand their differential impact on innovation

performance.

**Innovation Performance**

As a result of the multi-case analysis of the data, a broad view of innovation performance emerged. Consistent with both the informants in this study and the prior literature, we define *innovation performance* as the degree to which collaborations generated new technologies and intellectual property that had positive impact on product lines and firm performance. This definition synthesizes various aspects of innovation in the literature including new technologies and codified intellectual property (IP) such as patents created in the process (Griliches, 1990; Grant, 1996a; Ahuja, 2000), the impact these technologies have on the firms' product lines including new product releases and improved product platforms (Comanor and Scherer, 1969; Henderson and Clark, 1990; Katila and Ahuja, 2002), and the organizational consequences of innovation including organizational and strategic change (Cohen and Levinthal, 1989; Kogut and Zander, 1992; Grant, 1996b). Therefore, we assessed all these factors. The result is a particularly robust multi-factor measure of innovation performance.

Specifically, we measure collaborative innovation using six performance measures: the (1) number of new technologies generated by the collaboration; (2) codified IP including patents and written trade secrets; (3) immediate product line impact (e.g., changes to an existing product platform or new product releases); (4) market acceptance of the new technologies including qualitative evaluations by analysts, and immediate financial performance of the products; (5) significant changes to partners' strategies, organizational structures, and overall performance that can be directly traced to these new technologies; and (6) participant's perceptions of the overall innovation performance. Since new technology generation is the immediate goal of these collaborations, we describe each new technology generated and United States patent applications submitted as a result of each collaboration case. While accepted patents are not yet available, the established firms in our sample use experienced IP lawyers and tend to have high patent acceptance rates compared to their peers (Comanor and Scherer, 1969; Trajtenberg, 1990). Therefore, patent applications are a useful proxy measure.

Moreover, for each case, we assessed the collaboration's impact on each partner for at least one

year of time post-collaboration. Thus, we captured data on technology exploitation and evaluated product line impact, defined as product or platform enhancements and new products released as a result of these new technologies (Comanor and Scherer, 1969; Katila and Ahuja, 2002). To construct a conservative measure of organizational outcomes, we only recorded strategy and organization changes that are direct results of technology innovation, such as opening a new business unit to exploit a new technology or product. Similarly, changes in overall firm performance in these large organizations were often difficult to attribute directly to these new technologies (Levin, et al., 1987; Narin, et al., 1988). Therefore, we recorded only a few clear instances of performance changes generated as a direct result of the new technologies generated by the collaborations. These measures were constructed from publicly available data or data supplied by informants.

We supplemented this data with subjective assessments in which informants were asked to rate the innovation performance of the collaboration using a 10-point Likert scale. These ratings were averaged across all informants. We calculated ranges as well (averages appear in Table 2 below), finding strong uniformity of ratings across levels of hierarchy – i.e., executives, managers, and engineers – and between partners when asked about the overall collaboration innovation performance. The focus here is the overall innovation performance of inter-organizational collaborations. The innovation performance of all eight cases is detailed in Table 2.

An example of a case with high innovation performance is the Middleware collaboration between Ariel and Cleopatra. Cleopatra, an enterprise software applications firm, began a collaboration with Ariel, a prominent systems firm supplying hardware and internet software tools, to redesign their core software platform and associated middleware using Ariel's development tools. Extensive joint development between Ariel and Cleopatra over three years resulted in a variety of new internet-based technological features and interfaces, 18 patent applications, and new software interfaces (APIs) for use by the many small firms in Cleopatra's Independent Software Vendor (ISV) ecosystem. The collaboration had immediate product impact on Ariel's software development toolset by improving its robustness for large enterprise customers.

Participants at multiple levels in both firms gave the Middleware collaboration very high innovation performance ratings, with an average of 8.5 out of 10. As one Ariel manager put it, *"This collaboration really made a significant difference: I think that probably no one at Ariel could imagine anymore doing this [technological] evolution without Cleopatra."* However, the collaboration had an even greater impact on Cleopatra's product line which they completely rewrote using Ariel's new internet tools. As one Cleopatra manager said, *"It was absolutely successful. Actually, it drove a completely new product architecture. I mean, [our middleware] wouldn't exist without [their technology], and that drove their whole new value proposition for their customers and their future destiny."*

The longer-term strategic impact of the collaboration was to increase Ariel's commitment to internet and open source technologies and create a specialized group inside Ariel Corporation to support Cleopatra's internet needs. As a result of the improvements, Ariel's tools would become the de facto industry standard in the tools market, and Cleopatra would become the dominant force in their markets, considerably increasing their revenue growth, profitability, and stock price. One manager said: *"It sure has had an impact! We had huge competitors like Caliban and Hamlet, and look where they are now! Cleopatra is number one in every segment, in every country…"*

By contrast, Falstaff and Macbeth's VOIP collaboration produced no significant new technological assets, although Falstaff filed four "conceptual" patent applications based on their conversations. As a result of this contentious collaboration, Macbeth would forbid Falstaff from using its current Radio Frequency (RF) technologies in Falstaff's (VOIP) product line. While Falstaff's VOIP product line sold reasonably well, it would lag behind other competitors with more advanced technologies in the VOIP device space. More dramatically, Macbeth would suffer the harsh judgments of technical analysts for another failed RF project, and ultimately be forced to exit the wireless communications market and sell their business unit. Participants on both sides viewed the collaboration as unsuccessful with an average rating of 2 out of 10. As one manager described, *"We ultimately failed to get to an agreement. If we had figured that out earlier, we could have saved a lot of wasted time,"* and *"I would say we did very poorly."*

What explains these dramatic differences in innovation outcomes (see Table 2)? The analysis

reveals that successful collaborations were managed by partners using a rotating leadership process that involved revolving decision control, fluctuating cascades of network activation, and zig-zagging relationship trajectories. In the next sections, we elaborate on these insights and describe their grounding in the data.

**Revolving Decision Control**

When beginning technology collaborations, some firms explicitly discuss collaboration leadership including how decisions will be made, how resources will be allocated, and where they hope to take the relationship. In other cases, discussions are vague and participants prefer to "dive-into" the technical content. Yet, in all cases, partners are forced to confront issues related to the management of the relationship when the "design phase" begins in earnest. In this phase, partners must choose which technical areas to target and formulate tentative plans for how to work together. This may include making decisions about whether to pursue open-source or proprietary technologies, which markets to target with the potential innovations, and whether to focus these discussions into sub-phases based on differences in content (hardware vs. software design phase).

To explore strategic decision making, we examined the major decisions made in each phase of development, noting when partners made either a majority of decisions, a minority of decisions, or seemed to share decision making in each phase. In most cases, there were only a few major decisions made per phase, and informants gave highly consistent accounts of who controlled decision making, *"Cleopatra's team made that decision"* or *"We let Mercutio control the marketing deadlines."* Based on the number of decisions made by each partner, we tracked how decision control changed over time based on whether partners possessed "minority," "majority," or "shared" control from phase to phase[i]. The evidence of changing decision control is presented in Table 3. For ease of exposition, we define a "leadership rotation" as a case when a partner with "minority control" in one phase gained "majority control" in the next phase, as depicted in Figure 1. Viewed from the perspective of the broader collaboration, *domineering leadership* involves a single partner in control of decision making across most phases, while *consensus leadership* involves sharing control across most phases. By contrast, *rotating leadership* is

unique in its pattern of revolving decision control – that is, the process involves multiple leadership rotations between partners over time. We describe these processes below.

A good example of revolving decision control is the VPN collaboration between Rosalind and Prospero that rotated leadership three times over the course of development. In the beginning, both partners agreed that Prospero should lead the initial design phase. The objective of the collaboration – building a new virtual private network (VPN) system – required both application expertise from Prospero, a leading software vendor, and operating system (OS) expertise from Rosalind, a prominent hardware systems vendor. Yet Prospero effectively argued that since the software applications would drive customer adoption that they should lead the critical first design phase. As one Prospero manager described, *"Rosalind stands on the quality of its platform…while our claim to fame from day 1 has been enterprise wide security management applications. I don't think there is a close second."* In fact, Prospero had a highly profitable line-of-business in an area closely related to VPN software, which convinced Rosalind's managers to let Prospero take the lead.

Yet as design progressed, it became clear that the application's features depended critically on the structure of the operating system, which Rosalind controlled. *"The way it works is they don't have our source code, and <we don't have theirs>. That's the way it is."* Prospero could "work around" the current operating system if necessary, but if they could convince Rosalind's managers to rewrite the operating system using Linux software it would significantly enhance the applications they could develop. This represented a real dilemma for Propsero's managers. While ceding control of the next "platform development" phase to Rosalind meant they'd gain a new Linux-based operating system, it would be difficult for Prospero to control other critical development decisions that occurred in real-time. A Prospero manager explained why they ultimately decided to cede control to Rosalind:

> *"We've been trying to pitch Linux to them for years and years but their messaging in the marketplace was that their legacy OS was special. We don't believe that. From the Prospero perspective, we really need them to switch to Linux before we start the <software application> innovation per se, and only they could do that. Usually Prospero just makes all the decisions, and pushes Rosalind to take it or leave it, but we really needed them to do this first."*

As the platform development phase ended, Prospero and Rosalind conducted a joint progress review to

assess the new security platform. Both partners agreed that Rosalind's engineers had developed a new platform that was more robust and facile than their previous operating system. The same Prospero manager admitted,

> *"The platform works. <Moving to Linux> should help us reduce costs and enhance the distinctiveness of the Rosalind/Prospero product. This way, Rosalind can take pieces of Prospero's software and find areas to fit it in. That should produce new features."*

As the platform development phase ended, Rosalind returned control of the collaboration to Prospero, who went on to make critical decisions about the customer-facing aspects of application development, such as the graphical user interface (GUI), which made the underlying VPN features easier to access. A Rosalind manager reflected on the collaboration so far, *"This relationship has been successful for a long time. … We found that somebody really had to take the lead."* Informants in the VPN case repeatedly emphasized that the pattern of revolving decision control seemed to accelerate and clarify the decision-making process.

With the basic security applications completed, the VPN collaboration moved to the "feature extension" phase where much of the innovation would occur. Prospero retained control in this software-intensive phase and, in parallel, they were pursuing an important acquisition to complete their security technology portfolio. As one executive described,

> *"We are a bit late in this <other nascent market>… With this acquisition, we get the product offering and brand. They are perfectly aligned with our vision and are an ideal complement to our products."*

After two months, though, a crisis emerged that threatened Prospero's ability to participate in the collaboration: Prospero failed to make the acquisition, and their reputation suffered in the marketplace. As a result, their senior management were forced to turn their attention away from the VPN collaboration (and innovation efforts, more generally) to begin crafting new marketing messages for their firm.

After weeks of unanswered questions and requests, Rosalind's managers directed the joint engineering team to begin application development without the benefit of Prospero's executives. *"We took over."* Consequently, Rosalind's executives made unilateral decisions about the technical scope of the product that benefited their own firm. For instance, they directed the team to prioritize mobile VPN functionality over other features since Rosalind had deeper expertise and more product tie-in opportunities related to mobile security technologies. Thus, collaboration leadership rotated to Rosalind,

unbeknownst to Prospero's executives.

Sometime later, Prospero's marketing crisis was resolved and their senior management returned to find an on-schedule collaboration that was already nearing key product milestones. The modified product fit Prospero's requirements, although with Rosalind's stronger emphasis on mobile VPN features. On reflection, Prospero's management considered this new emphasis a small price to pay for a finished product,

> *"I think frankly--My honest impression of this is we've under-performed as a partner. I think we've done ourselves a disservice because we didn't dedicate ourselves to it. … But, you know, they really saved us."*

The pattern of revolving control ensured that decisions were made even when one partner was occupied. But, more importantly, it increased commitment to the collaboration because partners knew they'd be able to influence decision making during their turns at decision control.

The impact of rotating leadership on innovation was striking. Revolving decision control allowed Prospero and Rosalind to capitalize on each other's complementary expertise and expand the scope of technological alternatives over time. More importantly, revolving control increased the likelihood that the firms would make unexpected technological recombinations, a hallmark of innovation. Specifically, the dawning of each new phase provided an occasion for each firm to change its plans to incorporate their partner's contributions from prior phases. The result was often some unexpected solution to current problems that brought development down unpredictable paths. For instance, Prospero's technical director described how designing a new GUI (graphical user interface) on Rosalind's new Linux-based OS forced them to improve their GUI prototyping methods in real-time, an important process innovation. *"A lot of the value resides in this software."* Even more surprising, it was Rosalind's unexpected focus on mobile VPN features that formed the basis for what industry analysts would call the product's "most distinctive" features:

> *"These features allow mobile users to access information … when a VPN is created in accordance with security policies. All data is secured… As a result, the users benefit from an experience that is intuitive and easy to use."*

These mobile VPN features built directly upon Prospero's basic VPN applications, illustrating the valuable technology recombinations that rotating leadership can facilitate.

Like all organizational processes, rotating leadership can be planned or emerge in real-time. In some cases, control rotates because partners agree that one firm's competencies seemed better matched than another. In other cases, control can be seized (or given), often triggered by exogenous events (e.g., a failed acquisition). Like the VPN case, Ariel and Cleopatra's successful Middleware collaboration involved both intended and unintended leadership rotations. The Middleware collaboration focused on improving Ariel's software development tools, and then using these tools to write new internet-enabled middleware platform underlying Cleopatra's enterprise software applications. Ariel's R&D manager described the motivation to collaborate,

> *"We wanted to improve the robustness of our tools, and help Cleopatra quickly adopt them. Cleopatra needs to change their platform so they can compete against the best-of-breed players. Having them involved speeds things up. You can't do everything <alone>."*

As a result of extensive negotiations, Ariel and Cleopatra agreed to rotate leadership of the collaboration first to Ariel to generate specific project proposals that utilized their distinctive development tools, and then to Cleopatra to make middleware integration choices based on customer-specific expertise that they possessed. Cleopatra's collaboration manager summarized,

> *"It's really simple. We just divided it into client and server technologies. After the <discussions>, the relationship really matured because we got more realistic. Now we're confident we can create real value … because we have trust that the other corporation <can complete the work>."*

That is, these leadership rotations were made on the basis of differences in domain expertise – i.e., Ariel's deep knowledge of "server-side" tools and Cleopatra's "client-side" software.

Like VPN, leadership rotations in the Middleware collaboration were triggered by external factors such as unintended changes in market power. For instance, the internet bust caused Ariel's performance in their core server business to decline severely. In response, their SVP of Marketing *"turned into a pumpkin"* in order focus his efforts on Ariel's restructuring initiative. In his absence, Cleopatra's executive team took responsibility for marketing the high-profile collaboration. As their PR manager described, *"We rarely do co-announcements… so we were careful <about this joint PR>. … it's pre-defined, and we'll drive the messages."* In fact, Cleopatra's executive team used their control of the product roll-out and marketing phase to achieve their own marketing objectives. For example, the press release focused on

Cleopatra's new competence in Ariel's internet tools, leaving discussion of improving these tools for another day. More significantly, Cleopatra dropped efforts to co-release early "beta" versions of the platform and tools jointly to their lead-users, an initiative that Ariel's SVP of Marketing had spearheaded. While unintended, the temporary absence of Ariel's SVP placed decision making under Cleopatra's control, which they used to their advantage.

Leadership rotated back to Ariel during the "ecosystem development" phase which focused on gaining feedback from Ariel's community of open source developers and independent software vendor firms (ISVs) on the new technologies. As the phase began, Cleopatra hoped to maintain control in order to focus the community on testing their own new middleware. Yet, Cleopatra's efforts were frustrated when they realized that Ariel's open source community was hesitant to fulfill their requests; instead, the community preferred to work with Ariel. One Cleopatra manager complained, *"It's not like we don't know how to manage developer communities! We have thousands of developers."* But because of these difficulties, a leadership rotation emerged: Cleopatra was forced to cede control of the "ecosystem development" phase to Ariel, who went on to effectively manage the ecosystem feedback process. Yet, the unintended impact on the relationship was positive: rotating leadership to Ariel ensured that important bugs in the new tools were found by their open source community. More importantly, Ariel's executives remain satisfied that, while they lacked influence over regular marketing in the prior phase, they were having substantial marketing influence with the software ecosystem.

The key point is that revolving control ensures that, eventually, both partners can influence the collaboration as partners take turns leading the relationship. Like VPN and Middleware, the successful Security and Mobile Email collaborations rotated leadership, generating a pattern a revolving control that allowed both partners to make critical decisions about technologies, markets, and how to complete the work. In turn, this kept both partners highly committed to the collaboration. A Security manager described, *"We don't just want an enabling program. We want them as a co-creator of <technologies> and that means making them heavily involved. … We tried to stay out of their hair. If we give them time, they'll devour it."* Sometimes, these transitions were planned – that is, partners use complementary differences in expertise as the basis

for allocating leadership between partners – while in other cases these transitions emerged without planning. Whether intended or unintended, these rotations ensured that partners were able to make forceful decisions that achieved their own strategic objectives. Another manager summarized, *"Does it really matter how we get there…as long as we get our shot?"*

In contrast, other collaborations (XML; WLAN; Web Services; VOIP) used either *domineering leadership* or *consensus leadership* processes that did not produce revolving decision control. These processes diminished innovation performance, but for differing reasons: while domineering leadership demotivated partners and caused them to withhold their most relevant knowledge, consensus leadership caused confusion about who was in charge at any given time. Both processes made the innovative recombination of resources more difficult. Consider Lear's Web Services collaboration with Ophelia. Lear, a leading developer of software applications, used its market power and *domineering leadership* style to control decision making in every phase of the collaboration. During the planning phase, the collaboration seemed to offer value for both partners. By adding features in Lear's software product that allowed users to utilize Ophelia's internet technologies, Lear's applications would become more "web enabled" and Ophelia would develop a new channel for their web services. As Lear's technical lead described, *"This marries the two together: rich <internet> document creation and the ability to pull that content into the application. We had products looking for a solution … it was a natural win."*

Ophelia's managers agreed to these objectives, but as the collaboration evolved Ophelia was unable to influence any decision making. In fact, Lear seemed to not prefer Ophelia's involvement, as demonstrated by their "take it or leave it" offer to fund and develop the tool that accessed Ophelia's customer database. Ophelia's sole contributions under this scheme were to grant Lear access to their database and provide minor input into the design of the internet infrastructure. In spite of some suspicion, Ophelia's executives agreed to Lear's proposal, hoping they could informally influence Lear's design process. One Ophelia manager was optimistic:

> *"Some say 'we don't want that 800 pound gorilla in our space.' …but a lot of what happens at Lear is through personal relationships. If you can use personal relationships then you don't have to go in with official approval to get things done. Things can happen very quickly."*

Yet, as the collaboration evolved, Lear's managers continued to make all decisions without Ophelia's involvement. As a result, Ophelia's managers began losing motivation for the collaboration, and second-guessing their partner. The same Ophelia manager noticed that his colleagues were becoming *"afraid of working with Lear"* and thought that *"bad things might happen."*

Seeking to live up their commitments, Ophelia delivered specific technologies (e.g., APIs, database scripts) requested by Lear but took little initiative to search broadly across their divisions for the "best" technologies. For example, a more elegant technical solution was known to exist in Ophelia's "search engine" division, although it was not used in the collaboration because Ophelia's managers did not seek it out. *"Their <application> group really didn't make it very easy to build integrated solutions with it, or even use it…"* Ophelia's managers questioned whether it was worth spending the political capital to obtain these high-profile technologies if they would have little control over how to develop them.

In retrospect, using Ophelia's search technology may have substantially improved the applicability of Lear's product. Lear's technical leaders regretted not finding the "missing link" that might have improved their products. *"We wanted to…demonstrate <the product> as a smart client application. One of the things was that … it needed to be able to consume web services"* and *"We needed to make <our applications> more internet-friendly!"* In fact, had it been shared, Ophelia's search technologies may have led to many novel recombinations with Lear's leading productivity applications. Ophelia's managers later reflected on why they didn't procure the search technologies, *"I didn't want to stick my neck out [for the project],"* and *"I didn't really know if they needed it."* As it happened, the Web Services collaboration produced a working prototype with narrow utility for users. One manager described, *"So, Lear created a solution that looked pretty basic and rudimentary compared to what some of their developer communities [could] come up with"* but *"I guess it did show that we could work together."*

Falstaff and Macbeth used a *consensus leadership* process in their WLAN collaboration. The goal of the collaboration was to use technologies from Falstaff's wireless business unit and Macbeth's communication labs to build better wireless communications equipment that worked on existing "Wireless LAN" networks. *"We haven't deluded ourselves into thinking we have an agreement yet…but <the main*

*idea> is to use Macbeth's fast <silicon> and Falstaff's Ethernet IP on these new <wireless standards>."* Rather than use a pattern of revolving control, consensus leadership involved sharing control in every phase with joint strategic decision-making, consensus-building, and agreements sealed "on a handshake" as opposed to formal contracts. In fact, the collaboration's management explicitly committed to use this style of leadership, which they had used in a successful marketing collaboration where decision-making was simple and fluid. *"We really leveraged the smooth processes in the marketing collaboration."*

However, an important misunderstanding emerged around the complex issue of whether and how to use Falstaff's certification process during WLAN development: Falstaff understood that Macbeth was fully committed to their certification requirements, while Macbeth understood that they would only "follow the spirit" of Falstaff's certification process. Certification was a "deal breaker" for Falstaff, who needed to ensure that all their partner's products used the same networking standards, *"For <our relationship> with Macbeth, we start by engaging through our certification program. This must be our narrow focus for now…and later on we can expand beyond that."* By contrast, Macbeth's managers thought that, *"Their certification program is just for extensions to wireless standards. <It is mainly> for client vendors to support to help Falstaff differentiate against their competitors."* That is, despite extensive discussion, Macbeth and Falstaff had widely differing views of the importance of this process.

After many months of work, it became clear that the technical output did not fulfill Falstaff's certification requirements and needed to be repeated. This led to substantial deceleration of the collaboration. One Macbeth manager lamented, *"It pains me to no end… Now Falstaff is saying, 'we can't do this in time…'"* That is, Falstaff suggested scaling back the collaboration in order to complete certification, and made significant changes to their management team involved in the relationship. Members of the WLAN collaboration seemed to never understand why their collaboration was characterized by indecisive management and unclear roles. As one Falstaff manager reflected, "*With the wireless collaboration, we really missed that strategic focus. …asking what we are really trying to do, and what would we cut…these are the real problems to solve [now].*" Consensus leadership involved seeking agreement in every phase of WLAN development, requiring extensive communication that created occasions for misunderstanding

and confusion about how decisions would be made.

**Fluctuating Cascades of Network Activation**

While much of the substance of collaborative leadership focuses on strategic decision making, the ways that resources are used can have an equally important impact on organizational performance (Allison, 1971). As the preceding finding illustrates, revolving control can focus strategic decision making on procuring complementary technological resources from both partners. Equally important, though, is how collaborations utilize the "network resources" that constitute an inter-organizational relationship (Gulati, 2007). Prior research finds that social networks are an important source of innovations for organizations (Hansen, 2002; Obstfeld, 2005), although substantial debate exists about how these networks are actually utilized once they are in place (Burt, 2004; Uzzi and Spiro, 2005; Fleming and Waguespack, 2006). For instance, a boundary-spanning network of ties between engineers, managers, and executives is formed in the early phases of these collaborations (Davis, 2007). How is this collaborative network used during development? What role do leadership processes play in ensuring that actors in the network are actively involved in collaborative work?

What emerged from the data were important differences in the patterns of participation by members of the collaborative network, a phenomenon we call *network activation*. While relationships using domineering and consensus leadership process rely on stable patterns of network activation across phases, rotating leadership involved a unique pattern of *fluctuating cascades of network activation* that actively changes who participates in the collaboration over time (depicted in Figure 2). This pattern ensures that expertise is varied across the phases of development. Typically, the leading organization in one phase begins by involving their executive team who work down their chain-of-command by enlisting various collaboration managers to coordinate development. Then, collaboration managers involve various project and functional managers in *both* firms (crossing organizational boundaries as necessary) to manage the various teams involved in joint development. The result is a cascade down the hierarchy of one firm into another (see Figure 2). Similarly, when leadership rotates, the controlling firm in the next phase begins network activation with its own executives, then managers, and, ultimately, teams with

participants from both firms. Like a waterfall whose source shifts over time, the overall pattern is a series of fluctuating cascades of participation where *different actors are involved in different phases* of development. The impact is to vary team composition and, thus, the manner in which innovation activities are conducted over time. The evidence is summarized in Table 4 and below.

For example, the pattern of participation in Falstaff and Macbeth's Security collaboration changed predictably as they rotated leadership across phases. After some initial discussions, development began in earnest when Macbeth's CTO directed an engineering Vice President to prepare a design proposal for Falstaff's executives to review. As informants described, Falstaff and Macbeth's executives already had strong ties, having collaborated in the past:

> *"Our <executives> already know each other. They meet periodically…. Macbeth always had this internal plan about how to use <Security circuit> technologies, and we started talking a lot about how we could use it on communications equipment. We were looking at each of our places in the ecosystem and thought, 'Gosh, wouldn't it be great if our products could … have some kind of trustworthy association to improve security? … Adam [the VP] was put in charge of making this happen."*

Macbeth's VP turned to his trusted subordinates, two technical project managers, to help formulate the technical details of this "advanced Security" proposal for Falstaff. The team of three worked on the proposal for months, until they found the "right language" for joint development:

> *"Then we had this breakthrough meeting where we finally figured out how to pitch this to Falstaff. It became very clear…we would focus on getting a collaboration agreement figured out and, if we're going to get embarrassed, we'll just get embarrassed together."*

As a result, these meetings activated Falstaff's executives in the collaboration who, in turn, called upon their security product managers to assess Macbeth's proposals. *"We had Peter and Maria in the room as Falstaff's executive sponsors,"* and *"in the next series of meetings they brought in their lower level people to go into the bits and bytes."* Thus, a common pattern emerged where cascades of participation flowed down the lines of authority from one organization into another. These cascades flowed down existing network connections, ensuring that the appropriate participants were involved in these discussions.

In a similar manner, network activation in the next phase began when Falstaff's CTO called on a trusted alliance manager who, in turn, enlisted an experienced engineering director to ready Falstaff's security engineering team. Activating the engineering director was a critical step, since he had deep

connections into Falstaff's product groups and knew some of the security experts at Macbeth. Before the engineering director was involved, Falstaff's alliance manager admitted to *"just sort of making it up, assuming this is what we're going to need."* In fact, even Macbeth's managers recognized a noticeable difference: *"The beginning of Falstaff's waterfall seems slow. It seems slow for the water to fall into their product groups. I mean, they're really apologetic."* Things changed dramatically with access to the product groups: *"People told us Falstaff was really product oriented. Now we're having that mindshift – they want to expand on the basic themes and show how they fit into a broader picture."* That is, activating Falstaff's engineering director facilitated deep access to Falstaff's engineering talent during the critical design phase.

This cascading pattern of network activation repeated itself as leadership rotated a final time during the marketing phase. With Macbeth in control, the phase began in earnest when Macbeth's CTO called upon a marketing director, who in turn involved mid-level marketing managers at Macbeth and Falstaff, to begin the critical technology PR phase. *"Falstaff wants access to our technology marketing dollars. …our <developer conference> is where we define our technology vision for <the industry>."* Macbeth used control of marketing to promote the collaboration at their high-profile developer conference, using ties to Falstaff's mid-level marketing managers to ensure that Falstaff's messages were included in the PR when appropriate. *"The product groups got comfortable enough to say, 'Hey, let's make a big announcement about this work.'"* By now, the pattern of cascading involvement was a well understood practice that was reinforced with each passing phase. *"I mean, <at the beginning of each phase> everyone always looks to <our executives>, asking 'what would Peter do?' or 'what will Maria do?'"* These cascades created unambiguous lines of authority that reached from the executive-level to the engineering-level and fluctuated predictably over time.

Similarly, the successful VPN and Mobile Email collaborations, like Security, used fluctuating cascades of network activation that flowed down the chain of command and varied participation over time. *"Well, first it was Patty (Vice President), then myself (Alliance Director) … and then the <joint> handset and software teams. Then <our partner> changed it in <the next phase>."* Moreover, the successful Middleware collaboration even switched the locus of each cascade from executives to middle managers across phases, producing a highly differentiated pattern of network activation that gave their middle-managers

opportunities to gain "leadership" experience in a "strategic" setting. They key point is that the rotating leadership process produces a pattern of highly varied involvement that provides an occasion for using the most appropriate participants in each phase and increases the flexibility with which collaborative work is performed. As a result, the newly formed teams in each phase can "start fresh" and try to imagine new possibilities for development.

By contrast, domineering and consensus leadership processes involve more uniform modes of network activation with rare variations in participation. For instance, domineering leadership involves a similar cascade of activation down the chain-of-command of the controlling firm. Yet because this firm never relinquishes control, this pattern of participation is repeated across phases of development. Consensus leadership may involve cascading patterns of network activation that begin from any locus (executives, mangers, or teams) but nonetheless ensure that participants from both firms are involved in nearly every phase. Typically, this same pattern of "maximum involvement" is replicated across phases in order to maintain consensus over time. Both patterns produce highly uniform development methods from the same over-involved participants.

For example, Lear and Ophelia's used a highly uniform mode of network activation in the Web Services collaboration due to Lear's domineering leadership. Phases always began with a Lear executive calling upon two project managers to initiate disclosures (Phase 1), organize the team and begin work (Phase 2), and assess the work and plan PR (Phase 3). Lear's co-leads would call upon Ophelia's project manager, as necessary, and direct the lower level Lear employees to conduct the work. *"It took very little effort to <develop> the idea for this one. We just talked to <Ophelia's project manager>."* A final step always involved Ophelia's project manager calling upon his boss, an executive in charge of Ophelia's technology platforms, to sign off on important issues. Ophelia's project manager described, "*Getting signoff from my boss wasn't hard. He's a Harvard MBA and asks lots of questions, which is good. He just looked at it and said, 'That looks pretty good. I guess it will further our goals. Let's do it.'"* However, the late involvement of Ophelia's executives in each phase had a large impact: when it became clear that this domineering pattern of network activation had generated few valuable technologies, Ophelia's executive

representative proclaimed the collaboration "dead on arrival." As a result, the collaboration team had difficulty gaining support from the platform group that he led.

By contrast, the VOIP and WLAN collaborations used consensus leadership processes involving a highly uniform network activation that always emanated from mid-level managers. For instance, a pair of mid-level managers from both partners in the VOIP collaboration always called upon the same executives and, then, the same team members in each phase of development. *"This is just taking so long. We're just waiting…"* That is, consensus leadership ensured maximum involvement, but also involved high coordination costs and seemed to tire participants. Similarly, the WLAN collaboration produced maximum involvement with the same pattern of activation that generated ambiguity about authority and decelerated workflow. *"This <joint> wireless team has been working for awhile, so they had the experience… But the execution isn't working."* Overall, the pattern of uniform participation ensured that the central participants always had a voice in development, but generated precious little new perspective on the difficult problems of VOIP and WLAN development.

**Zig-Zagging Relationship Trajectories**

Partners make decisions and use collaborative networks to produce coordinated organizational behaviors that advance the innovation objectives of the relationship. Prior research focuses on how partner's objectives can change, bringing collaborations down unpredictable paths (Ring and Van de Ven, 1994; Doz, 1996). For example, collaborations can change as partners learn from each other (Hamel, 1991; Doz, 1996; Arino and de la Torre, 1998), or reshape their commitments in response to occasional exogenous shocks (Larson, 1992; Doz, et al., 2000). That is, relationships have distinct trajectories with their own direction and magnitude. *"Where are we going together? This is the real question now…"*

Relationship trajectories are a focus of collaborative leadership because changing trajectories can have a dramatic impact on innovative development. For example, the paths that collaborations take can fulfill one firm's objectives at the expense of their partner's objectives, potentially derailing collaborative development (Doz, 1988; Hamel, 1991). By contrast, relationship trajectories can converge too quickly

to local maxima and fail to find the most innovative solutions to technical problems (Stuart and Podolny, 1996; Gavetti and Levinthal, 2000). Despite their relevance, we know little about how relationship trajectories actually evolve (Ring and Van de Ven, 1994). What role do leadership processes play in shaping relationship trajectories? How do partners effectively explore the innovation space together?

We examined relationship trajectories by analyzing how the actions in each phase fulfilled each organization's objectives on a variety of strategic dimensions. For instance, critical issues on which partners had differing objectives included whether to pursue an open-source or proprietary strategy, to use old or new technologies, or to target existing or nascent markets with new products. In some cases, partners are aligned and trajectories pursue direct paths. In other cases, the direction and magnitude of trajectories changed substantially over time.

For example, Ariel and Cleopatra had differing views about the relevance of proprietary and open-source IP strategies. Cleopatra's managers described their partner: *"Ariel just wants to come up with new features…they reward fast evolution. They open source everything…we honestly can't understand how they make money."* By contrast, managers in Ariel viewed Cleopatra as, *"Very conservative. IP management is very important <to them>…their business model is all about site licensing <to> new users."* During the Middleware collaboration, the OS design phase made great progress along an open source trajectory – e.g., the firms released their source code, and used external developers to perform testing. Later, the GUI design phase made modest progress towards a propriety strategy – e.g., the firms filed a few patents, and codified a few trade secrets. While trajectories in the OS and GUI phases differed substantially, the broader collaboration was not balanced on this issue. *"We always had this problem of shifting platform importance… We favored <this system>, but that was proprietary, so we moved towards…platform independence."* That is, the magnitude of the open source trajectory greatly outweighed the magnitude of the proprietary trajectory, leading the pair to pursue an increasingly "open" IP strategy over time. In fact, we found substantial variations in the relationship trajectories across phases of the collaborations in this study. Viewed across multiple cases, these patterns seem to be associated with differences in leadership processes, as we describe below (see also Figure 3). The evidence of differing relationship trajectories is presented in Table 5.

*Domineering leadership* involves forceful relationship trajectories that are efficient and direct. As dominant firms control decision making and resource allocation, they drive their collaborations along purposefully narrow and forceful trajectories that fulfill their objectives. However, domineering leadership is more susceptible to unforeseen roadblocks because dominant firms have difficultly soliciting trajectory-changing assistance from their partners. Equally important, these narrow trajectories explore precious little of the innovation space, generating more routine technologies. *Consensus leadership* produces trajectories that are less narrow but of weaker magnitude. Compared to domineering leadership, partners using consensus leadership have difficulty advancing along their intended trajectories due to confusion and high coordination costs. This reduces the magnitude of progress towards critical innovation objectives. By contrast, *rotating leadership* involves *zig-zagging relationship trajectories*. Within each phase, these trajectories resemble strong, domineering paths. Yet as partners rotate leadership they radically shift the direction of the relationship as they correct perceived "mistakes" of their partners and move development more in line with their own objectives. The overall impact of zig-zagging trajectories is to explore more of the innovation space than narrow domineering trajectories or less forceful consensus trajectories (see Figure 3).

Portia and Rosalind rotated leadership three times during their successful Mobile Email collaboration, following zig-zagging relationship trajectories that generated multiple new technologies. The collaboration began with leadership by Portia, who worked quickly to port their mobile email software to Rosalind's leading mobile devices. A Portia manager explained his firm's objectives:

> *"This is about propagating software such that those devices could work with us… GSM, CDMA, GPS…we need to regularly support all these standards with all the carriers including the Cingulars, T-Mobiles, and Verizons of the world. We are connected to so many different things in the system... We need to <learn how to> license our technology to other handset manufacturers."*

That is, while Portia was interested in learning how to work with the handset manufacturers, they expected to easily port their software and quickly gain a market presence on Rosalind's handsets.

Leadership rotated to Rosalind in order to integrate Portia's email into the user interface. As Rosalind took over, though, they demanded important changes to Portia's software to improve the end user's emailing experience. Rosalind argued that these time-consuming changes were *"necessary to ensure*

*high-quality service"* from the major US telecommunication carriers for the new mobile email services. Portia's executives protested the extra time it took to develop these features, but ultimately yielded to Rosalind's changes. The same Portia manager described their reluctance to change directions:

> *"We want to learn … but at the beginning, it took a really long time <to make> the first basic and limited client. Some friction came from that. It was lots of development work, but not a lot of ... results or revenues."*

Ultimately, this abrupt turn would prove useful since fulfilling the US carriers demands saved them from rewriting new follow-on features.

Leadership then rotated back to Portia, who used an older version of their underlying software platform to save integration time, producing a surprisingly valuable combination of "new" user interface and an "old" software platform that was both novel and more robust than competitor's products.

> *"We provided features <that worked on the old> protocols. It sounds easy, but … this is a robust solution. The competition is already in the application layer, but now we stretch down into the deepest ISO layer to a really low level where you handle the radio signal on the network. This is the reason it works so well."*

Such deep integration made it difficult for competitors to copy their solution. Upon regaining control in the marketing phase, Rosalind directed their PR department to emphasize the new features and bug-free platform as an ideal combination for email-intensive enterprise users.

The impact of rotating leadership in the Mobile Email case was striking: in fits and starts, the collaboration moved down zig-zagging development paths that were impossible to predict. These zig-zagging trajectories effectively explored the innovation space in ways that single partners could not do alone, but enabled each firm to achieve their strategic objectives when they gained leadership of the collaboration. Specifically, Portia ported their basic software and platform to Rosalind's handsets, and Rosalind ensured that the carrier's requirements were incorporated into the design. *"It's been a hard road to hoe, but … now that we're on the other side we have ironed out the kinks. <The impact> is including their footprint in the market and our attractive brand …it is very positive."* That is, the unexpected combination of "old" and "new" technologies that emerged from rotating leadership seemed to fill a genuine market need.

Similarly, the rotating leadership process in the Security, Middleware, and VPN collaborations generated zig-zagging relationship trajectories that explored the broader innovation space. For example, the Middleware example described above produced a unique combination of open source and proprietary

technologies that complemented each firm's IP strategy and was difficult for other middleware vendors to imitate. Moreover, the impact on the relationship was positive. One manager reflected on the zig-zagging path the relationship followed:

> *"We learned a lot about the idiosyncracies of their firm including <how to work with> their sites in the West and East Coast. We want these benefits… otherwise without < these dramatic changes> the collaboration happens in a silo and you wouldn't get that learning and knowledge."*

That is, each dramatic turn allowed leading firms to achieve their strategic objectives, and non-leading firms to better understand these objectives.

By contrast, domineering leadership in Lear and Ophelia's Web Services collaboration generated forceful trajectories in the direction of Lear's unilateral plans. For instance, Lear planned to incorporate Ophelia's web services technologies in their software applications. Ophelia's managers pushed the Lear team to see the larger possibilities of Web2.0 technologies outside of traditional "client-side" software applications, but to no avail. An Ophelia manager recalled:

> *"We tried to convince them of the potential of these technologies… We even looked at NASDAQ, which is the best example. They basically used a financial version of XML… We invested a lot of money in showing Lear that <Lear's product> was like a productivity version that consumed a lot of data. ...but this evangelization is hard."*

In spite of Ophelia's efforts, the resulting trajectory moved steadily towards Lear's lower aspiration of integrating Ophelia's database with their application, thereby missing critical opportunities to innovate in the fast-growing Web2.0 space.

Alternatively, Falstaff and Macbeth's use of consensus leadership in their less successful WLAN collaboration generated weaker relationship trajectories that made little progress towards innovation goals. For instance, over the first four phases, the scope of the WLAN collaboration expanded from one to four major projects that required sign-off from managers in multiple business units before action could be taken. *"This seems slow… We're just waiting <for Falstaff> to find the right manager. They need to bless the meetings."* Slow planning led to even slower engineering as these stakeholders questioned the value of the collaboration and tried to impose multiple competing requirements. As a result, disappointing progress reviews led to new executive leadership at Falstaff who imposed a new vision for the future using resources from other business units, all in hope of salvaging the collaborative relationship. That is, they

significantly lowered their aspirations:

> *"Now we just want to have one successful in-depth relationship in the wireless space… We want to make sure there are three features that get adopted into Falstaff's wireless product line, and then into Macbeth's product line."*

The collaboration ended after two frustrating years of development and few valuable outcomes, highlighting the importance of these processes on relationship trajectories and organizational outcomes.

## DISCUSSION

We began by notating that while much research has focused on the exchange and endorsement value of inter-firm relationships (Uzzi, 1996; Dyer, 1997; Stuart, et al., 1999) or how they are formed (Gulati, 1995b; Eisenhardt and Schoonhoven, 1996; Stuart, 1998), some research has focused on their capacity to generate innovations (Powell, et al., 1996; Ahuja, 2000; Baum, et al., 2000). While some studies suggest that the determinants of collaborative innovation and effective relationships reside in antecedent design factors such as prior experience (Anand and Khanna, 2000; Kale, et al., 2002), governance form (Pisano, 1991; Parkhe, 1993; Dyer, 1996), and social embeddedness (Gulati, 1995a; Uzzi, 1996), this study finds that successful collaborations rely on organizational processes like rotating leadership. Rotating leadership involves revolving decision control between partners, fluctuating cascades of network activation, and zig-zagging relationship trajectories. Together, these three aspects of rotating leadership promote organizational commitment by broadening decision control, vary participation through fluctuating network activation, and use changing trajectories to explore the broader space of innovations. These mechanisms work across multiple levels – individual, group, and organization – to promote innovation and strengthen the inter-organizational relationship.

**Multi-Level Mechanisms.** One reason that rotating leadership is associated with high innovation performance is that it clarifies roles, responsibilities, and priorities for collaboration participants. Managers of leading organizations can clearly define these structures because their span of control extends across organizational boundaries throughout the collaboration group, even as the demarcation between organization is becoming less clear. By contrast, the ambiguity of roles, responsibilities, and priorities is a difficult problem with consensus leadership since many have a voice in decision-making.

Even routine decision-making entails high coordination costs when groups are sufficiently large (March, 1994). Moreover, this decision making often involves finding the "lowest common denominator" (points upon which all participants agree) so that actions tend to be incremental. Instead, rotating leadership, like domineering leadership, allows managers to make unilateral decisions that have clear consequences for other participants.

Further, different individuals are working at different times during rotating leadership. The group's objectives can change dramatically from phase to phase as different patterns of network activation unfold. For example, participants may occupy an active role during the "design phase" when their focal firm is in charge, but only a passive consultation role during the "manufacturing phase" when the partner organization leads development. As a result, participants have flexibility across phases to gain needed rest or temporarily return to their busy "day jobs." By contrast, domineering leadership asks participants to perform similar roles (either domineering or subservient) across phases. Consensus leadership also uses the same participants across phases. Thus, both processes can produce similar, routine behaviors from participants. Rotating leadership is unique in involving participants in different ways at different times. Varying team composition over time increases the likelihood that groups will use diverse knowledge and take novel actions necessary for innovation (Lau and Murnighan, 1998; Beckman, 2006; Ancona and Bresman, 2007).

At the organizational level, rotating leadership involves the participation of both firms. Each organization is guaranteed a series of "turns" during which they can temporarily influence development and fulfill their organization's objectives. This creates a sense of urgency and commitment in both organizations which motivates both partners to make high-quality contributions when they are in control. The sense of urgency can be used by collaboration managers to marshal resources in a timely fashion from other business units in their firms. These managers can honestly claim that they have a limited "window of opportunity" to shape the collaboration, so that technical or human resources are urgently needed. The commitment mechanism is highly related to literature on "procedural justice" which emphasizes the importance of participation in contexts where there can be no guarantee of a fair outcome

(Rawls, 1971; Donald and Preston, 1995), like collaborative innovation. If participants have some influence over the process, then the likelihood of commitment increases (Rawls, 1971). By contrast, domineering leadership demotivates dominated partners since they have little influence over development. Consensus leadership dilutes the degree of influence that single organizations can have over development in any given phase and, thus, diffuses the sense of urgency that can be created.

At the level of the relationship, rotating leadership produces zig-zagging paths that push collaboration evolution in unexpected directions, and breaks the inward-focus of central planning by single partners. Specifically, each subsequent rotation of leadership involves dealing with the unexpected decisions and contributions engendered by partners in the previous phase. Partners maintain enough independence to learn about each other's contributions and act upon this learning (Gibson and Vermeulen, 2003). This increases the likelihood that partners will create novel recombinations of technologies in ways that were difficult to plan during in the beginning of the collaboration. By contrast, shared leadership produces less forceful trajectories that make less progress towards innovation objectives. Domineering leadership proceeds according to one partner's plan which produces a path-dependent evolution of the collaboration that deepens the collaboration's trajectory in the direction of the domineering partner's momentum.

Rotating leadership makes collaborations less predictable, but increases the likelihood of truly path-breaking innovations and organizational changes. While this uncertainty can produce anxiety (Bourgeois and Eisenhardt, 1988) and sometimes even derail previously efficient relationships (Arino and de la Torre, 1998; Doz, et al., 2000), observing some innovative outcomes generates confidence in rotating leadership and mitigates the temptation of some firms to meddle during their partner's phase of control. In fact, we observed that as organizational members link these innovative outcomes with rotating leadership in their own minds, they increase their commitment to the process. As one informant described, *"we'll get there, eventually…"* and another echoed, *"We just found that someone had to take the lead."* This reinforces the process by more sharply demarcating the lines between "turns" which, consequently, improves rotating leadership in a beneficial feedback loop. Ultimately, these process improvements

strengthen the broader inter-organizational relationship.

**Alternative Explanations, Bundles of Mechanisms, and Concurrent Processes**

If correct, the view that relationships depend on organizational processes like rotating leadership would significantly advance our science about how organizations collaborate, and how they mutually constitute an evolving and innovative industry. Therefore, before we move to a fuller exploration of the theoretical implications, it is important to examine the major alternative explanations.

As we describe in the methods, it is difficult to explain the variance in innovation performance of these collaborations through simple design choices or the fixed features of these firms. For example, all pairs of firms in this study are socially embedded, with long relationships based on past collaborations and trust in each other not to engage in rank opportunism (Gulati, 1995a; Uzzi, 1997). Related, all firms used the MoU governance form because they realize that only incomplete contracts are appropriate for uncertain R&D (Grossman and Hart, 1986; Pisano, 1991). Importantly, all pairs of firms shared important related technologies (Ahuja, 2000; Stuart, 2000) and came to the table with complementary resources (Tripsas, 1997). In fact, this interdependence likely motivated them to collaborate in the first place (Gulati, 1995b; Ozcan and Eisenhardt, 2007). Also, all firms had extensive experience collaborating and dedicated alliance functions (Anand and Khanna, 2000; Kale, et al., 2002). Despite sharing these and other antecedents (see Table 1), effective collaboration remains difficult, and the collaborations in our sample had a wide variance in innovation performance (see Table 2).

A related issue is whether single firms themselves are the true locus of these relationship processes. For example, Lear's two collaborations in our sample used domineering leadership, a relationship process that some of Lear's managers seemed to prefer. Yet, single partners are not always associated with one relationship process. Macbeth and Falstaff conducted three collaborations: two used consensus leadership, but their Security collaboration used rotating leadership and thrived. This suggests that relationships are at least as dependent on the *processes that partners actually use* in their collaborations as on the preferred processes of intractable partners or processes used in the relationship's distant past. Rather than rest on the capabilities of only one partner, effective collaboration depends

critically on the use of specific behavioral mechanisms by *both* partners involved the relationship.

**Bundles of Mechanisms.** We found a bundle of three mechanisms that constitute the rotating leadership process (see Tables 3, 4, 5). Another line of inquiry asks whether any one of these mechanisms is the "fundamental" cause of the others since they appear to work in tandem. To wit, is it "obvious" to managers that if they are revolving decision control (Figure 1) that they should also activate their networks in a fluctuating cascade pattern (Figure 2) and push their relationships in zig-zagging trajectories (Figure 3)? While these mechanisms are certainly complementary, they are also separable: relationships can and do use "incomplete" rotating leadership processes with varying outcomes. For example, some less successful collaborations used only a single rotating leadership mechanism or understood that they needed to do so but couldn't figure out how (XML; WLAN). In addition, the moderately successful Mobile Email collaboration seemed to only partially activate its networks through fluctuating cascades, suggesting that relationships can gain some benefit from less effective implementation of relationship processes. In fact, it may be possible that some mechanisms are more or less appropriate in certain contexts. We return to scope conditions and generalizability below.

**Concurrent Processes.** Finally, it is important to ask: is rotating leadership the only process at work? Our focus has been on the ways that organizations lead their relationships, so that observable behaviors related to decision-making, network activation, and relationship trajectories emerged as the salient issues. However, we did observe some other behaviors which suggest that other "concurrent" processes have important contributions to collaborative evolution. For example, we observed fluctuations in commitment to the relationship. Some studies link de-commitment to a decline in relationship quality or trust (Uzzi, 1996; Arino and de la Torre, 1998; Zaheer, et al., 1998). Others link it to a decline in learning, such as Doz's (1996) seminal study. Yet these transient moments of low commitment were rarely associated with a lack of learning or trust in our cases, but rather by frustrations related to either lack of participation (XML; Web Services) or confusion about roles and responsibilities (WLAN; VOIP). This doesn't mean that relational trust and learning processes are not important. Partners that do not have high-quality relationships as the firms in this sample do would likely need to

develop trusting relationships where they learn from each other. A future study could explore these and other relationship processes in the context of innovation.

**Theoretical Contributions**

**Predestination and Alliance Processes.** Using technology collaborations as a context, this study contributes to the broader strategic alliance literature. Specifically, the findings relate to a debate among alliance scholars about whether collaborations are constrained by initial design choices (e.g., governance form) (Pisano, 1989; Dyer, 1996), partner characteristics (e.g., differential bargaining power) (Doz, 1988; Casciaro and Piskorski, 2005), and relational qualities (e.g., social embeddedness) (Gulati, 1995b; Uzzi, 1996) or whether post-formation dynamics are susceptible to managerial interventions such as contract alterations or board changes (Doz, 1996; Arino and de la Torre, 1998; Reuer, et al., 2002). That is, this debate has centered on whether alliance paths are "predestined" or amenable to managerial intervention.

This study contributes by revealing how specific organizational processes like rotating leadership can influence the paths that relationships follow (Ring and Van de Ven, 1994). These processes operate not by changing alliance design choices (e.g., contracts, equity-participation) that may be difficult to alter, but by influencing the real-time control of decision making, the use of professional relationships, and how managers look for innovative solutions to technical problems. Prior literature suggests that these collaborations can engender long-term adaptive changes to the strategy and organization of each firm (Powell, et al., 1996; Dussauge, et al., 2000). This study provides evidence for this perspective (see Table 2), suggesting that effective leadership processes may be the missing link between simply forming relationships (which many firms do) and realizing the strategic value that can be obtained from relationships (which is significantly more difficult).

**Contrasting Images of Inter-Organizational Relationships.** This study also ties in closely to organization theory and the broader study of inter-organizational relationships (composed of multiple alliances and interactions). There are many images of inter-organizational relationships (IORs) in the literature including the distinction between legitimizing an de-legitimizing relationships (Galaskiewicz, 1985), the distinction between symmetric and asymmetric dependence relations (Oliver, 1990), and the

distinction between arms-length and embedded relationships (Uzzi, 1997). These distinctions have tended to focus on how these relationships influence partners' capacity to conduct efficient exchanges to procure needed resources, legitimacy, or status (see Table 6).

While this study began as an exploration of collaborative innovation, it also generates important insights about IORs in highly dynamic and interdependent environments. The context was established firms in the computing and communications industry where innovation-generation is an important source of organizational transformation and competitive advantage (Brown and Eisenhardt, 1997; Bresnahan and Greenstein, 1999). Thus, the activities in these collaborations were oriented less towards status seeking and resource procurement than *creating* new technological resources. The established firms in this study all had sufficient status, adequate resources and power to maintain symmetric dependence relations, and a moderate degree of social embeddedness as suggested by prior research (Uzzi, 1997; Stuart, et al., 1999; Casciaro and Piskorski, 2005), yet none of these features seemed essential to their innovative capacity. Thus, we realized that it was possible that these relationships were of a substantially different type that emphasized innovation and adaptation over exchange or endorsement.

**Describing Symbiotic Relationships.** Therefore, a broader contribution of this study is the theoretical development of an ideal type of relationship that better fits the reality of the collaborations in this study. We define a *symbiotic relationship* as a set of mutually reinforcing interactions between two different organizations with the potential to generate innovations and adaptive changes to each partner's strategies and structures. Organizational symbiosis shares many properties in common with biological symbiosis, including the ambiguity about demarcating boundaries between partners, the unpredictable character of their complex interactions, and the way that symbiotic partners sometime act "as one" in their environments (Margulis and Fester, 1991). The defining feature of these relationships, though, is their capacity to generate adaptive changes to strategy and structure. Symbiotic organizations often use specific technology collaborations as the platform for these changes. For example, as a result of the successful collaborations in our study, partners entered new markets (Security; Middleware; Mobile Email), strengthened positions in relation to competitors (Security; Middleware; VPN), shifted to more

open IP regimes (Middleware; VPN), formalized linkages and created new business units (Security, Middleware, VPN), while failed collaborations led firms to exit existing businesses (WLAN), cede new markets to competitors (XML; VOIP), and revise organization structures (WLAN; Web Services) (see Table 2). While difficult to control or predict, symbiotic relationships may be a primary way that firms innovate and change in dynamic and interdependent industries (Adner and Kapoor, 2006).

In contrast to existing images of inter-organizational relationships emphasizing exchange and endorsement, the defining feature of symbiotic relationships is their generative capacity. Table 6 summarizes the symbiotic view and contrasts it with three powerful models of relationships in the literature, namely arms-length, embedded, and endorsement relationships (Podolny, 1994; Dyer, 1996; Uzzi, 1996; Stuart, et al., 1999). The exercise of comparing these relationships helps to clarify their characteristics and find scope conditions for the emerging concept. Symbiotic relationships involve *ambiguous activities with unpredictable outcomes* such as knowledge generation and technology innovation (as opposed to routine economic exchanges or the transfer of status); rely on social mechanisms such as knowledge recombination with significant risk in collaborative innovation projects (as opposed to single or repeated exchanges or strategic signaling); and *transformational economic and organizational objectives* of industry leadership and organizational adaptation (as opposed to exchange efficiency and affiliation).

It is perhaps no accident that many of the most famous examples of symbiotic relationships are in highly dynamic and interdependent environments such as the computer industry where innovation and adaptation are central to competitive advantage. For example, Burgelman's (2002: 341) study describes a particularly famous example, the symbiotic relationship between Intel and Microsoft:

> *"Andy Grove described the relationship…as 'two companies joined at the hip.' While constantly vying for perceived leadership of the PC industry and jealously guarding their own spheres of influence (software for Microsoft and hardware for Intel) most of the time the two companies were able to maintain their symbiotic relationship…"*

This suggests an important boundary condition of rotating leadership and symbiotic relationships. Given their focus on innovation and change, it is likely that relationship processes such as rotating leadership are most applicable to symbiotic relationships which are central in highly dynamic and interdependent

environments. In fact, it is possible that domineering and consensus leadership processes may function effectively in relationships where innovation is not central. In particular, domineering leadership appears to map well to the atomistic transactions of arms-length relationships, and more routine exchanges between trusted embedded partners create conditions where consensus leadership may work effectively. Developing these contingencies is outside the bounds of this study, but could be explored in future work.

## CONCLUSION

Building upon extensive prior work on inter-organizational relationships emphasizing exchange and endorsement, this paper outlines a different symbiotic view of inter-organizational relationships that focuses on relationship processes such as rotating leadership. Pairs of firms utilize these processes to effectively coordinate joint decision making, activate network resources, and traverse unique relationship trajectories. Just as relationship processes increase the dynamism of symbiotic inter-organizational relationships, symbiotic organization holds lessons for managers in single industries, organizations, and groups, suggesting that effective strategy and organization involves three essential characteristics: (1) promoting commitment by broadening decision control, (2) varying participation through fluctuating network activation, and (3) generating strategic trajectories that explore the broader space of innovations. In contrast to some perspectives which view these relationships as incidental or mere conduits for exchange, this viewpoint identifies symbiotic relationships as the central organizational phenomena at the heart of how highly dynamic and interdependent industries are organized. The implication of this perspective is an emerging theory of the firm as a collection of processes for making, breaking, and sustaining organizational relationships. Rotating leadership is part of the puzzle, explaining how organizations together lead symbiotic relationships, but further work is needed to account for unexplored characteristics of symbiotic relationships. If validated empirically, future exploration of symbiotic relationships could contribute to strategy by emphasizing the dynamic balance of cooperation and competition that is necessary in highly dynamic and interdependent industries, and to organizational studies where a more realistic view of innovation and adaptation focuses less on the core and more on the periphery.

**Figure 1. Decision Control**

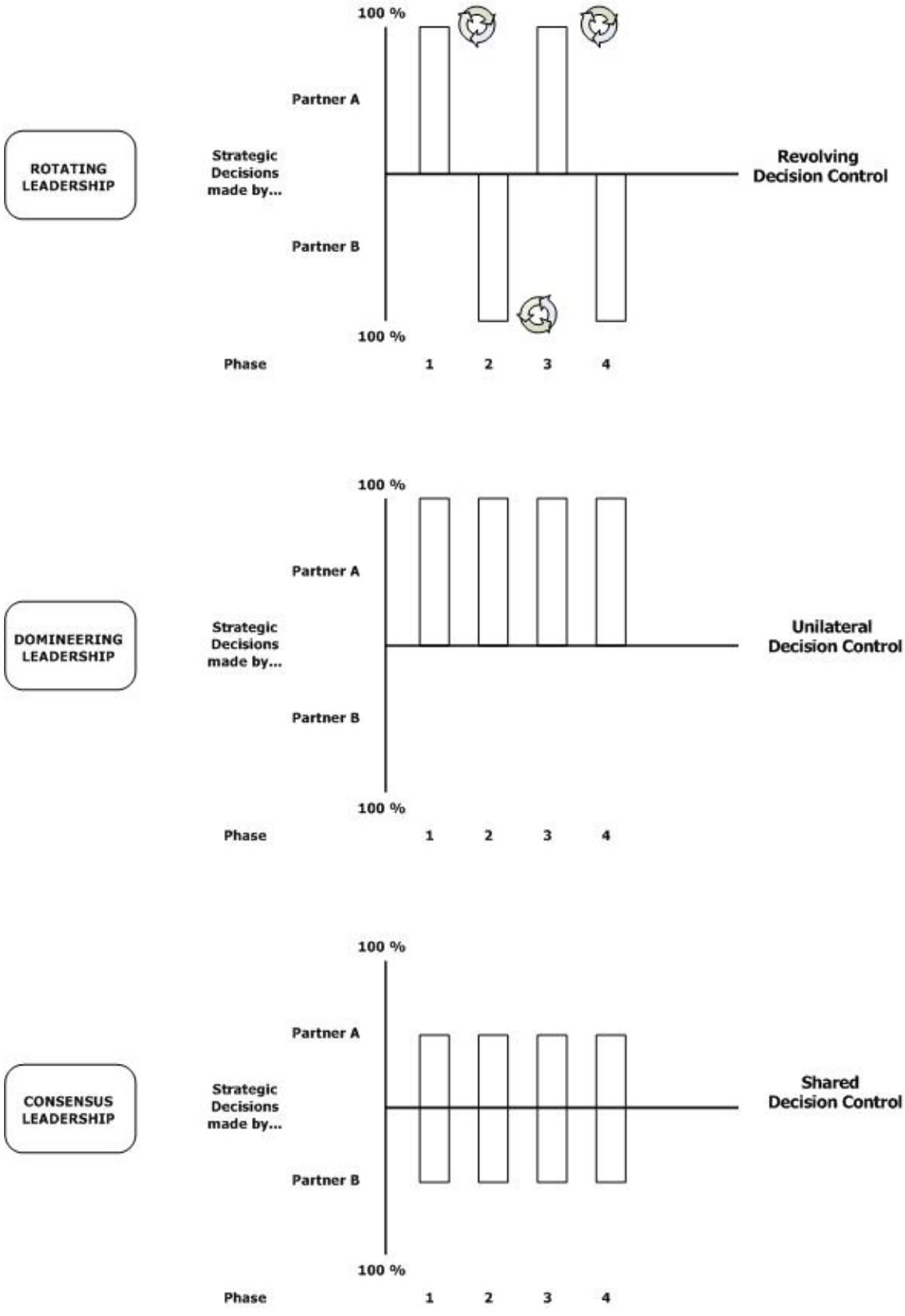

Figure 2. Network Activation

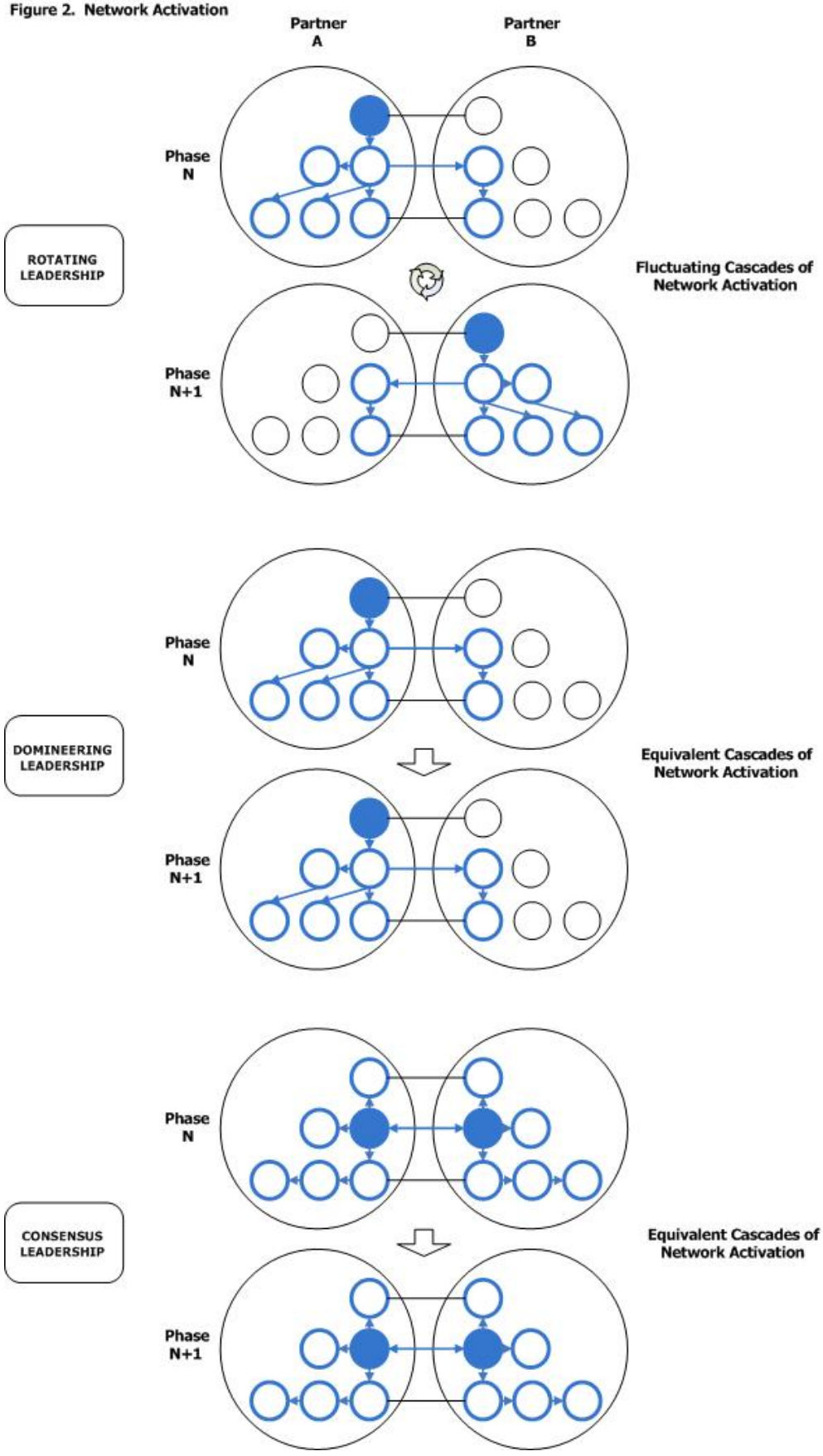

**Figure 3. Relationship Trajectories**

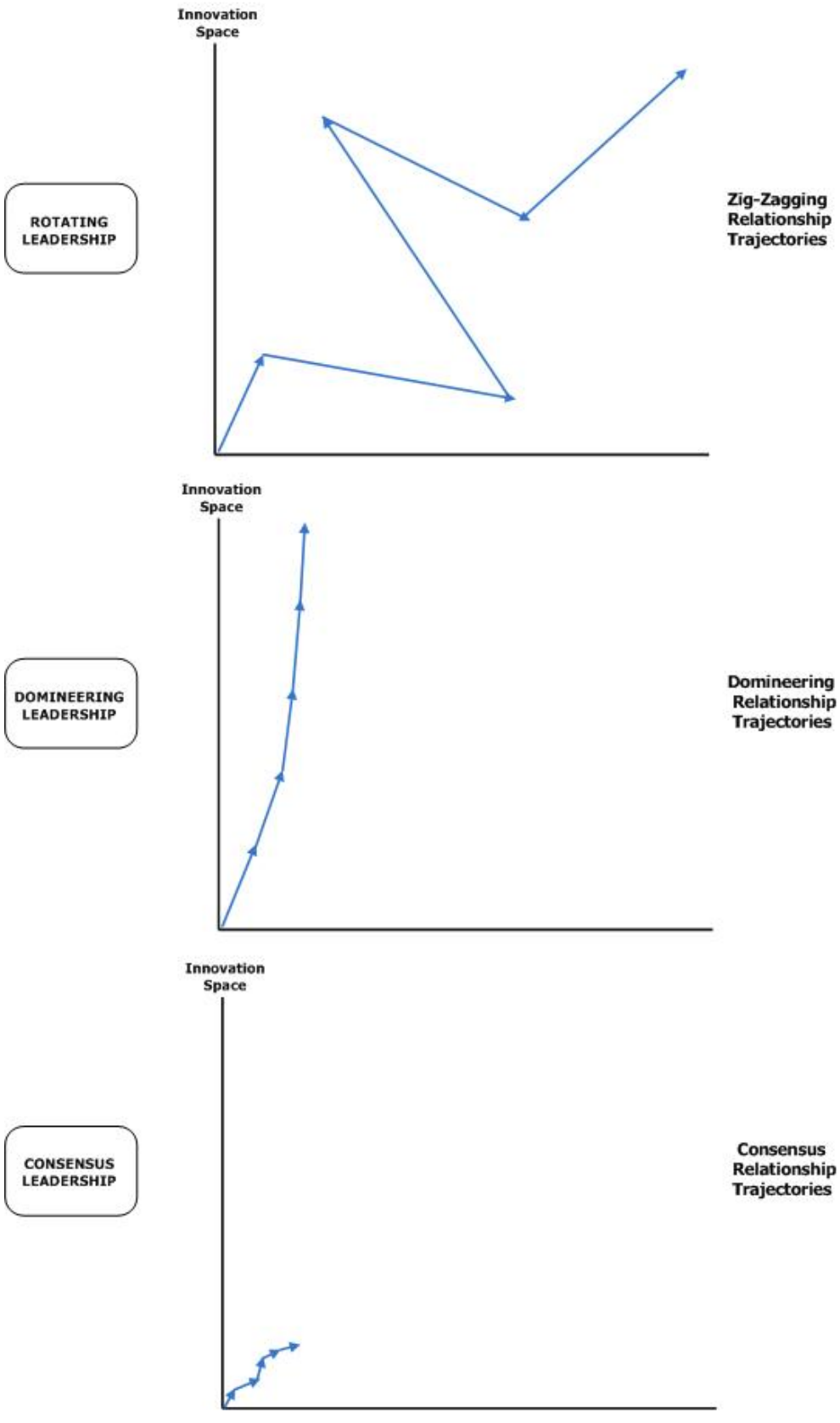

**Table 1: Description of Collaboration Cases**

| | Case Name | Case #1<br>Security | Case #2<br>Middleware | Case #3<br>VPN | Case #4<br>Mobile Email | Case #5<br>XML | Case #6<br>WLAN | Case #7<br>Web Services | Case #8<br>VOIP |
|---|---|---|---|---|---|---|---|---|---|
| Organizations | Partner A Sector | **Macbeth**<br>Semiconductors | **Ariel**<br>Systems | **Rosalind**<br>Mobile Devices / OS | **Rosalind**<br>Mobile Devices / OS | **Lear**<br>OS / Software Apps | **Macbeth**<br>Semiconductors | **Lear**<br>OS / Software Apps | **Macbeth**<br>Semiconductors |
| | Partner B Sector | **Falstaff**<br>Network Equipment | **Cleopatra**<br>Software Apps | **Prospero**<br>Software | **Portia**<br>Mobile Devices / Software | **Mercutio**<br>Online Marketplace | **Falstaff**<br>Network Equipment | **Ophelia**<br>E-Commerce | **Falstaff**<br>Network Equipment |
| | Firms' Prior Collaboration Experience | Extensive; Dedicated Alliance Functions | Extensive; Dedicated Alliance Functions | Extensive; Dedicated Alliance Functions | Extensive; Dedicated Alliance Functions | Extensive; Dedicated Alliance Functions | Extensive; Dedicated Alliance Functions | Extensive; Dedicated Alliance Functions | Extensive; Dedicated Alliance Functions |
| Relationship | Prior Relationship between Partners | Embedded & Interdependent | Embedded & Interdependent | Embedded & Interdependent | Embedded & Interdependent | Embedded & Interdependent | Embedded & Interdependent | Embedded & Interdependent | Embedded & Interdependent |
| | Prior Interactions between Partners | Tech and Product Development, Joint Sales & Marketing, Buyer/Supplier, Standards, R&D consortia, Direct Competition | Joint Sales & Marketing, Buyer/Supplier, Technology Standards | Product Development, Joint Sales & Marketing, Standards, R&D consortia | Technology Standards, R&D consortia, Direct Competition | R&D consortia, Buyer/Supplier | Tech and Product Development, Joint Sales & Marketing, Buyer/Supplier, Standards, R&D consortia, Direct Competition | Joint Marketing, Buyer/Supplier, Standards, R&D consortia | Tech and Product Development, Joint Sales & Marketing, Buyer/Supplier, Standards, R&D consortia, Direct Competition |
| Technology Collaboration | Innovation Objective | Security and Manageability Silicon and Software | Internet-enabled Enterprise Middleware and Applications | Secure Mobile Devices and Robust Firewalls | Mobile Email Application | Application-Embedded Online Tools | RF Silicon Components | Web Services Application Integration | VOIP Phone and Infrastructure |
| | Collaboration Duration | 2002-2005 | 2001-2004 | 2003-2006 | 2004-2006 | 2003-2004 | 2003-2006 | 2004-2005 | 2002-2003 |
| | Basis of Complementarity | Circuits / Systems | Systems / Software | Devices / Software | Devices / Software | Applications / Internet | Circuits / Systems | Applications / Internet | Circuits / Systems |
| | Related Technologies Possessed by Partners | Security Firmware | Communications Protocols | Security Systems | Mobile Data Infrastructure | Database Software | RF Algorithms | Software-design Tools | TCP/IP Components |
| | Governance Form | Memorandum of Understanding | Memorandum of Understanding | MoU + Existing Joint-Sales Contract | Memorandum of Understanding | Memorandum of Understanding | Memorandum of Understanding | Memorandum of Understanding | Memorandum of Understanding |
| | Innovation Outcome | Successful | Successful | Successful | Successful | Not Successful | Not Successful | Not Successful | Not Successful |
| Data | Internal / External Archival Data (pages) | 1300 / 1600 | 1100 / 1500 | 1500 / 1200 | 1400 / 1100 | 700 / 1100 | 1200 / 1700 | 1100 / 1200 | 1000 / 1500 |
| | Case Interviews | 15 | 7 | 7 | 7 | 7 | 13 | 6 | 10 |

## Table 2: Innovation Performance Outcomes

| Case / Partners | New Technologies Generated | Intellectual Property (Patents, Trade Secrets, Papers) | New Products and Improved Platforms | Market Acceptance and Product Performance | Impact on Partner Strategy, Structure, and Performance | Subjective (Average) Evaluation of Innovation Performance | Overall Rating / Rank |
|---|---|---|---|---|---|---|---|
| **Security: Macbeth - Falstaff** | Chipset improvements that allow Falstaff's SecTech to access clients pre-BIOS using Macbeth's T201 technology. New security/management technologies that link Macbeth's ManTech and Falstaff's SecTech which span the silicon and firmware levels and impact 6 different product-markets. | 19 patent applications, 10 white papers, and extensive product documentation | Macbeth's Song processor is delayed a few months, but includes new security and Manageability technologies so that ISVs can start exploiting them. Macbeth's next ClientPlat and LiveCircuit processors and products feature these technologies prominently in their high-end products. Falstaff bases a new line of client-based security and Manageability software around these new technologies. | Othello, a prominent OEM, commits to specified volume and to be a reference customer for the Macbeth-Falstaff combined solution. Industry experts and analysts rate the new technologies highly and foresee industry structure changes based on their use. Both Macbeth and Falstaff see significant revenue growth this year in these markets. Technologies diffuse data centers first, and then server market. | New Manageability technologies become core features in Macbeth's new 'SKU-based' product strategy, making the high-end products more distinctive. Security and Manageability becomes a key charter for the Desktop Division as the new re-organization takes effect inside Macbeth. Higher prices for Macbeth's new high-end chips allows them to start a price war with Coriolanus on the low-end. Falstaff enters client-security software market strongly. Security and Manageability becomes an EVP level role at Falstaff. | **Average = 8.5** "Macbeth's numbers are so big that if I moved the cycles by one percent, you know, we get an additional billion dollars or something like that. So, the bar is high, but this collaboration was important enough to have that sort of impact: if we can get the major OEMs signed up to support these technologies next year then they'll want to buy [an additional] ten percent year-over-year contribution while the market grows. So, I really do feel strongly that this was a success" "[Falstaff] really had no strong position in the security area, and we wanted a lever against Lear. Now we [have that], and are able to deliver value to customers in new ways." | **Successful: 1** |

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| **Middleware: Ariel - Cleopatra** | Ariel gains a more robust 'enterprise-ready' Emulator101 programming environment. Cleopatra gains new internet-based middleware that supports virtualization, portals, network identity and authentication. More broadly, Cleopatra gains directory servers and application server technology. | 18 patent applications, multiple white papers, and extensive middleware and product documentation | Ariel's J101 and J102 improve technically as a result of the collaboration. Cleopatra's adoption of NewLanguage gives Ariel supporting products a large marketing boost. More broadly, Ariel Emulator101 middleware engine is now usable in large scale enterprise applications, which opens up a large new product-market. Cleopatra's complete shift to NewLanguage and internet-based middleware and applications makes their product technologically distinctive and easier to support. | Ariel's J101 and J201 become dominant tool sets for developing internet applications. Cleopatra's new internet-based middleware and applications are rated as excellent by industry analysts and produce excitement inside their installed base of customers. Cleopatra's products will solidify or gain leadership in every important segment in the next 3 years. | Collaboration forces Ariel to more fully develop a NewLanguage and open-source innovation strategy. They will shift significantly focus to these software products, although their hardware business will continue to suffer. Cleopatra will dominate the Enterprise Application space, enjoying easier development and participation in open-source community innovation. Cleopatra will make its middleware and platform engineering groups permanent, and the NewLanguage Technology Factory staffed with Ariel engineers at Cleopatra headquarters will remain a strong tie between the organizations. | **Average = 8.5** "It was absolutely successful. Actually, it drove a completely new product architecture. I mean, [our middleware] wouldn't exist without [their technology], and that drove their whole new value proposition for their customers and their future destiny. I think that probably no one at Ariel could imagine anymore doing this [technological] evolution without Cleopatra." "I think [the collaboration] has really changed many of our internal activities. It has sure has had an impact. I'd probably give it an 8. We had huge competitors like Caliban, Hamlet, and look where they are now! Cleopatra is number one in every segment, in every country…" | **Successful: 2** |

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| **VPN: Rosalind - Prospero** | New Linux-based security OS with increased robustness and supportability. Secure mobile-IP/LAN VPN and firewall integration components. Increased appliance hardware performance including speed, memory, and multi-threading enhancements. Finally, some intrusion detection technologies were developed, and mesh architecture and re-routing functionalities were ported to Linux. | 18 patent applications, multiple white papers, and extensive product documentation and marketing | Rosalind and Prospero base new integrated firewall / VPN appliance product around new Linux OS as planned, and emphasize new integration with mobility features as distinctive product advantage. However, the new VPN and firewall appliance is lacking new intrusion detection and prevention technologies. | Robustness and supportability are appreciated in feedback from customers, although the analyst communities focus strongly on new mobile security enhancements. Product performance increases steadily, although cost improvements are not passed along to customers immediately. | Rosalind significantly increases profitability from reduced cost structure thanks to new Linux-based OS, which allows them to restructure and reduce engineering staff by 100 FTEs. Rosalind exploits synergies from mobile IP integration, which is viewed as distinctive. Prospero fails to innovate on intrusion detection and prevention, but the new product release allows them to project a public image that de-emphasizes failed acquisition and technology shortcomings. | **Average = 6.5** "Well, this new project has been reasonably successful." "I think frankly--My honest impression of this is we've under-performed as a partner. I think we've done ourselves a disservice because we didn't dedicate ourselves to it. We found that somebody really has to take the lead. Now we're working a little on catch-up." "Basically, certain places we compete, other places we cooperate. The irony is that this is a very successful partnership in terms of revenue, market visibility and market penetration. But, luckily, there is a lot of value coming, the market is looking for a specialized [product like our] offering, and I think we definitely bring value to the table." | **Successful: 3** |
| **Mobile Email: Rosalind - Portia** | MobileProduct push email solution successfully ported to Rosalind's JoinTech OS. New synergistic technologies such as 3rd party vendor non-mobile client-email application-integration, conference calling / speakerphone operability, and security locking methods. | 13 patent applications, multiple white papers, and product documentation | Portia's basic MobileProduct push-email product rolled into Rosalind's HandsetProduct 1a series, and next generation MobileProduct push email and mobile data services available on Rosalind's HandsetProduct 2a and 2b phones. | MobileProduct on HandsetProduct 1a develops small 'beta test' user base before larger subscriber growth of MobileProduct on HandsetProduct 2a and 2b. Portia improves their one phone voice quality of service, and Rosalind improves their Rosalind-branded email program offerings. | Portia's MobileProduct Connector Licensing Program delivers significant high-profitability revenue growth, allowing them to expand the program and business unit. Rosalind reduces churn and gains loyalty through full mobile data application portfolio. Collaboration motivates Rosalind's management to continue portfolio growth in mobile data services, including prominent competing push-email acquisition | **Average = 6.5** "There's nothing wrong with the collaboration at the moment, although it's a little bit slow on new technological development compared to what is available if you go to the nearest email vendors ... But I think that Portia's footprint in the market, combined with our attractive brand and devices then--I think the performance is positive." "It was a hard row to hoe, but now that we're at the other side of it, we have what we wanted to get out of it. I think we've ironed out a lot of kinks." "In the second phase it's more [about] generating revenue and such. We are working with them, but it's not a totally smooth road..." | **Successful: 4** |

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| **XML: Lear - Mercutio** | Two new technologies enable XML-based management of Mercutio's e-commerce transactions through Lear's AppSuiteSpread spreadsheet program and AppSuiteEmail email program, and AppSuiteWeb web design applications. | 7 patent applications, a few white papers, and extensive product marketing | XML based add-ons available by download from Lear.com, but not pre-packaged. Mercutio sees steady growth of automated transactions through Lear's applications, yet these are small improvements for both customer bases. | Prominent joint-marketing and demo events impress many industry analysts. Mercutio's high-end power user community adopts some developed features, demonstrating their desire for Mercutio-supported transaction-automation tools. | Mercutio copies AppSuiteSpread product to make their own spreadsheet-based program in the future. Lear continues to slowly explore XML and Web2.0 applications, yet the collaboration isn't credited with any new structural changes. | **Average = 6.5** · "On releasing AppSuite 11, people were saying Lear, you know, is not as hip as some of those web companies. But, now with Mercutio, we showed integration, and I think that resonated with a lot of people." "With Mercutio it seems like there were a lot of…cooks in the kitchen…and everybody was adding their own ingredient to the recipe…so coordination was pretty difficult. We were kind of struggling with…how many features we put into this solution." "We would have been successful without Lear." | **Not Successful: 5** |
| **WLAN: Macbeth - Falstaff** | Personal mobile router device technology built. Transceiver technologies with increased bandwidth, range, and memory. | 9 Patent applications, 5 white papers, and extensive product documentation and marketing of technology bundles | Personal Mobile Router device is delivered to the military, but has no impact on Macbeth or Falstaff's product lines. Next generation transceiver technology will appear in Macbeth's chips and Falstaff's wireless router product line. Bundling exclusivity agreement is dropped at the one year renewal point as there is little product impact. | Personal Mobile Router fails to see the light of day. Transceiver viewed as incremental 'next step' building block technologies and does not result in significant revenue growth for either firm beyond expectation. Bundled features get good ratings from analysts, but lacking next generation updates, Macbeth and Falstaff can deliver nothing new. | Another failed collaborative attempt to exploit UberComm architecture contributes to Macbeth's sale of the wireless business unit and technical assets to another firm. Wireless adoption of both Macbeth building blocks and Falstaff routers continues strongly, although it is difficult to tell if the new WLAN transceivers contribute to this resurgence. | **Average = 4.5** "Now, we are actually engaged with them and they are building stuff on our technology. But I honestly don't think that the value for [us] is really adequately defined. And, you know, I think that's ok because we are trying to build a relationship and are willing to sacrifice a little bit to get there." "Right now it seems [we] sort of we missed that real strategic focus -- like what are we trying to do, and what feature would we cut because of the lead-time involved. When we are starting to engage at a real problem solving level, then that'll be a marked change." | **Not Successful: 6** |

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| **Web Services: Lear - Ophelia** | Web-services based access to Ophelia's e-commerce database inside Lear's AppSuiteDocs-processing application. | 5 patent applications, one white paper, but no product documentation | Lear's AppSuiteDocs-processing application can now include e-commerce applications in documents, although this application is limited and not promoted. | Collaboration team decided not to promote the functionality broadly, and it is hidden on a Lear.com download website with thousands of other downloads. Feature gains no acceptance with developers and no reviews by analysts. | Lear will not explore web services extensively, although Ophelia and Lear will collaborate on future search-related projects No real changes in strategy or structure for either firm. | **Average = 4.5** "Now, the application itself, was it the most compelling broad reach? No, no it wasn't." - "For [our other collaborations], we designed a [large] PR campaign. This level of [intense PR planning] didn't happen for Ophelia." "We walked away friends. Most collaborations you may walk away bad. We thought we made something good happen and got attention. Now, I'm not really metrics driven as I should be, so we didn't think about it from that perspective." | **Not Successful: 7** |
| **VOIP: Macbeth - Falstaff** | None | 4 patent applications, but no white papers or product documents since no new technologies were generated. | Falstaff's VOIP phone product line will not have the option to use Macbeth's UberComm architecture for the near future. | Falstaff's VOIP phone has a modest success. | Falstaff's VOIPBU enjoys modest revenue growth for their VOIP phone product. Macbeth searches for another outlet for UberComm architecture. After a few more quarters of bad results, Macbeth exists the wireless business by selling their business unit and assets. | **Average = 2** " I think I would say both sides did very poorly, right? I think there were miscommunications about expectations." "We ultimately failed to get to an agreement. If we had figured that out earlier, we could have saved a lot of wasted time." "The process wasn't working because when we got to the second phase it all fell apart." | **Not Successful: 8** |

## Table 3: Rotating Leadership (Revolving Decision Control)

| Evidence of Revolving Decision Control Across Collaboration Phases | | | | | |
|---|---|---|---|---|---|
| **Collaboration** | **Number of Phases** | **Number of Rotations** | **Intended Decision Control**<br><br>Partners agree to alternate control of decision making. | **Unintended Decision Control**<br><br>Control of decision making alternates without explicit agreement. | **Decision Control Pattern** |
| **Security** | **7** | **3** | Falstaff cedes control of decision-making about the marketing phase of the collaboration to Macbeth to exploit their expertise in technology marketing.<br><br>Falstaff retakes control over decision making about design changes to Macbeth's circuits that are necessary to meet Falstaff's customer-security commitments. | Falstaff makes important decisions about project scope as they wait to formally respond to Macbeth's project proposal until their relevant security executives are free to champion the risky collaboration. | Revolving Control |
| **Middleware** | **7** | **4** | Cleopatra gives control of project proposals phase to Ariel so they can effectively exploit their NewLanguage technologies.<br>Cleopatra makes product integration choices based on customer-specific expertise that Ariel lacks. | Ariel comes to control open-source process as community members refer inquiries to Ariel and not Cleopatra.<br><br>Cleopatra takes over marketing and product roll-outs as Ariel's lagging performance pulls their executives into other area. | Revolving Control |
| **VPN** | **6** | **3** | Prospero cedes temporary technology development leadership to Rosalind so they can rewrite their OS platform in Linux.<br><br>Rosalind cedes back customer-facing technology development leadership to applications-expert, Prospero. | Failed acquisition creates threat to reputation that distracts Prospero's managers, so Rosalind takes over application development in areas of Rosalind's choosing. | Revolving Control |
| **Mobile Email** | **6** | **3** | Portia modularizes their application before Rosalind integrates it into their JoinTech OS.<br><br>Rosalind takes over marketing and product roll-out so they can use their large product marketing organization. | Portia partner engineering group unintentionally takes over back-end integration decision making from Rosalind for HandsetProducts as it increasingly requires expertise from Portia's core R&D group. | Revolving Control |
| **XML** | **5** | **2** | | Lear is mostly dominant except when Mercutio's newly acquired leaders carve out their own e-commerce related "stealth" project which they control.<br><br>When Mercutio's e-commerce team returns with low quality work, Lear is forced to reassert control and re-write the core features and GUI. | Domineering/ Revolving Control |
| **WLAN** | **9** | **0** | Commitment to consensus leadership and jointly controlled development leads to confusion about growing project scope and overlapping responsibilities.<br>Falstaff's newly acquired wireless leaders make some decisions to salvage development in the final months of the collaboration, although control doesn't fully rotate. | | Shared Control |

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| **Web Services** | **5** | **0** | Dominance of project goals and development by Lear is agreed to by Ophelia's representatives so control never alternates. | | Domineering Control |
| **VOIP** | **4** | **0** | | Consensus leadership style that emerges makes it difficult to gain commitment on key decisions as partners struggle to understand and second guess each other's strategies. Falstaff surprises Macbeth midway by revealing that their long-term strategic plans don't require Macbeth's technologies, but this does not fully alternate control. | Shared Control |

## Table 4: Rotating Leadership (Fluctuating Cascades of Network Activation)

| **Evidence of Fluctuating Cascades of Network Activation Across Collaboration Phases** | | | | | |
|---|---|---|---|---|---|
| **Collaboration** | **Number of Phases** | **Number of Rotations** | **Sources of Activation**<br>**Cascade Direction**<br>**Boundary Spanning** | **Cascades of Participation in Collaboration Phases** | **Network Activation Pattern** |
| **Security** | **7** | **3** | Executive Leads<br>Top-Down<br>Spanning Boundaries | Design phase begins when Macbeth's CTO involves an engineering VP who brings in two project managers to organize boundary spanning design teams. Development phase begins with Falstaff's CTO who involves an alliance manager who involves an engineering director who activates Falstaff's security development team and Macbeth's security experts. During the marketing phase Macbeth's CTO calls upon a marketing director who involves mid-level marketing managers in both Macbeth and Falstaff. | Fluctuating Cascades |
| **Middleware** | **7** | **4** | Executive Leads or Middle Managers<br>Top-Down or Middle-Out<br>Spanning Boundaries | Ariel's VP calls upon two senior software directors to organize the software scoping team who bring in middle managers and platform engineers from Cleopatra. In later phases, Ariel and Cleopatra agreed to shift the locus of their cascades from executives to middle managers during the R&D phases to give them developmental opportunities in joint R&D strategy. For instance, Ariel and Cleopatra's middle managers will organize the applications and tools teams, bringing in executives as needed. | Fluctuating Cascades |
| **VPN** | **6** | **3** | Executive Leads<br>Top-Down<br>Spanning Boundaries | Rosalind's senior VP calls upon two trusted VPs and Prospero's CEO to begin negotiations about the software's features, and who then involve their various technical teams to evaluate proposals. During development, Prospero's Vice President involved the alliance director who assembled the joint handset and software teams. | Fluctuating Cascades |
| **Mobile Email** | **6** | **3** | Executive Leads<br>Top-Down | Portia's software executive calls upon a pair of technical directors from Rosalind and Portia to co- manage joint engineering teams to do the technical design. In an engineering phase, Rosalind's software executive | Fluctuating / Equivalent Cascades |

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| | | | Spanning Boundaries | leads this same pair of technical directors from Rosalind and Portia to co-manage the joint engineering teams to do the design. Overall, executive participation fluctuated but the teams did not. | |
| **XML** | **5** | **2** | Executive Leads | Lear's director of applications group calls upon an alliance manager who involves a technical lead to represent Lear in negotiations. Lear's technical lead works with a technical counterpart in Mercutio to write a project scope document. | Fluctuating / Equivalent Cascades |
| | | | Top Down | Lear's director of applications activates the same alliance manager and technical lead who organize a joint engineering team to do platform development. | |
| | | | Spanning Boundaries | During the e-commerce database phase Mercutio's newly acquired web-finance team also participates, leading to some unanticipated fluctuation. | |
| **WLAN** | **9** | **0** | Project Managers | Pair of strategic alliance managers from Falstaff and Macbeth pull in relevant executives, technical leads, and engineering teams from both firms to plan WLAN project scope. | Equivalent Cascades |
| | | | Middle-Out | Same pair of strategic alliance managers involve the same executives, technical lead, and engineering teams to conduct the various phases of research and development. | |
| | | | Spanning Boundaries | | |
| **Web Services** | **5** | **0** | Executive Leads | During the disclosure phase, Lear's Web executive would call upon two project managers to initiate disclosures with little involvement from Ophelia. | Equivalent Cascades |
| | | | Top Down | During the development phases, Lear's same Web executive called upon the same two project managers to organize the team and the follow of work, calling upon a few Ophelia database engineers when necessary. | |
| | | | Spanning Boundaries or Single Organization | During the PR phases, Lear's same executive called upon the same two project managers who brought in Lear's PR team without consulting Ophelia. | |
| **VOIP** | **4** | **0** | Project Managers | Pair of middle managers from Falstaff and Macbeth call upon, first, the same executives and, then, the same development teams in all phases. | Equivalent Cascades |
| | | | Middle-Out | | |
| | | | Spanning Boundaries | | |

## Table 5: Rotating Leadership (Zig-Zagging Relationship Trajectories)

| **Evidence of Zig-Zagging Relationship Trajectories Across Collaboration Phases** | | | | | |
|---|---|---|---|---|---|
| **Collaboration** | **Number of Phases** | **Number of Rotations** | **Changes in Direction / Magnitude of Progress** | **Varying Relationship Trajectories in Collaboration Phases** | **Relationship Trajectory Pattern** |
| **Security** | **7** | **3** | Changing | Productive debates eliminate two potential joint-marketing objectives and select three security R&D objectives on which they make quick progress during the planning phase. Falstaff pursues objectives to develop lower level technologies in the "quick wins" chipset development phase, while Macbeth deemphasizes these technologies to make significant progress in the more radical circuit development phase. | Zig-Zagging Trajectories |
| | | | Large | Macbeth VP pushes collaboration team to "think big" about the ecosystem and consider how to push these technologies to impact other big players beyond Falstaff. To wit, they start writing "hooks" for other software/systems vendors to utilize. Falstaff requests and, ultimately, receives big design changes in Macbeth's circuits to provide more access for Falstaff's firmware. | |

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| **Middleware** | **7** | **4** | Changing | OS design phase makes great progress towards along an open source trajectory, as Ariel prefers, by releasing source code and using external developers for testing. | Zig-Zagging Trajectories |
| | | | Large | GUI design makes some progress along a more proprietary trajectory by protecting trade secrets, as Cleopatra preferred, although the balance favored the open source direction.<br>To Ariel's surprise, Cleopatra carefully scripts marketing messages to emphasize "gradual migration path" of Cleopatra's ISV ecosystem to Ariel's tools. | |
| **VPN** | **6** | **3** | Changing | Prospero's push for a Linux-based VPN platform creates a more secure but less proprietary system that makes it easier for Prospero to support a broader VAR ecosystem than Rosalind intended. | Zig-Zagging Trajectories |
| | | | Large | Rosalind's decision to focus on mobile VPN features due to Prospero's absence opens up new wireless security markets for the VPN technologies.<br>Prospero changes the emphasis of the marketing to deemphasize the importance of technologies from their failed acquisition. | |
| **Mobile Email** | **6** | **3** | Changing | Portia prefers to quickly port their software to Rosalind's handsets and learn to work with device manufacturers, but Rosalind makes them fulfill many telecommunications requirements in the integration phase when Rosalind is in control. | Zig-Zagging Trajectories |
| | | | Large | To compensate for the slow speed of the porting phase, Portia uses an older version of their platform when they control the software platform phase. Rosalind emphasizes the new features and not the old platform when they regain control of the marketing phase. | |
| **XML** | **5** | **2** | Unchanging | Lear focuses intently on using XML to improve the reach of their projects into the e-commerce space to which Mecutio, passively, learns to improve their own product. | Narrow Trajectories |
| | | | Large | Mercutio holds back valuable knowledge about their own e-commerce tools, so that Lear and the collaboration will not benefit from them. | |
| **WLAN** | **9** | **0** | Changing | WLAN project scope grows dramatically as Macbeth and Falstaff seek consensus and seek to please all parties. As a result of high coordination costs and confusion about authority, the firms make slow progress in planning. | Weaker Trajectories |
| | | | Small | Consensus seeking in engineering development makes small progress on the many projects, but achieve very few objectives of either firm.<br>Falstaff and Macbeth lower expectations after years of inadequate progress towards strategic objectives and no real innovation. | |
| **Web Services** | **5** | **0** | Unchanging | Lear pursues technological trajectory using web services technologies in their applications. Ophelia argues strongly for broader Web2.0 focus and develops prototypes to convince Lear to collaborate in this broader technological space. | Narrow Trajectories |
| | | | Large | Lear resists this broader focus, preferring to stay focused on their lower aspiration which is ultimately achieved. | |
| **VOIP** | **4** | **0** | Changing | Confusion in the VOIP collaboration about basic objectives and authority translates into little progress. Multiple rounds of negotiation spend months of valuable time until partners finally agreed on areas of exploration in the VOIP space. | Weaker Trajectories |
| | | | Small | Vague project outlines means that basic R&D needs to be repeated multiple times until Falstaff and Macbeth finally agreed to give up on the project. | |

**Table 6: Contrasting Images of Inter-Organizational Relationships**

| Relationship | Arms-Length | Embedded | Endorsement | Symbiotic |
|---|---|---|---|---|
| **Definition** | Narrow focus on efficient economic exchange | Broader focus on social interaction and efficient exchange | Focus on prestige/status and transfer of legitimacy | Focus on innovation and organizational change |
| **Interaction Quality** | One-time or Few Exchanges | Many Exchanges, Social Interactions | Asymmetric Associations | Ambiguous, Unpredictable Projects |
| **Typical Collaboration** | Contractual Exchanges | Buyer/Supplier Alliances | CVC Investment or Licensing | Technology Collaboration |
| **Outcomes of Collaboration** | Minimizing Transaction Costs | Extensive Social Ties | Increased Status, Legitimacy | Technology Innovation, Organizational Change |
| **Social Mechanisms** | Contracts, Incentives | Reciprocity, Generosity | Status Seeking, Signaling | Knowledge Recombination |
| **Organizing Processes** | Domineering Leadership? | Consensus Leadership? | Low-touch? | Rotating Leadership |
| **Relational Properties** | Lack of Trust, Calculating Risk, Formal Agreements, Monitoring | Trust, Fine-Grained Info Transfer, Real-time Problem Solving | Legitimacy Transfer; Large/Small Firm Affiliations; Status Centrality | Revolving Decision Control, Fluctuating Network Activation, Zig-Zagging Trajectories |
| **Representative Research** | Grossman & Hart, 1986; Pisano, 1989; Parkhe, 1993; Gulati, 1995a; Dyer, 1996; Uzzi, 1996 | Gulati, 1995b; Uzzi, 1996; Arino & de la Torre, 1998; Zaheer et al 1998; Helper et al 1999 | Galaskiewicz, 1985; Oliver, 1990; Podolny, 1994; Stuart 1998; Stuart et al 1999; Chung et al 2000 | This Study; Burgelman, 2002; Casadesus-Masanell & Yoffie, 2007 |

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[i] To analyze decision control, we constructed a simple measure using the following procedure. First, we demarcated phases of collaborations as our informants did, defining a phase as an interval of time in which qualitatively different work activities occurred (e.g., prototyping vs. testing phases). Then, in each phase, we identified the number of important strategic work decisions, and noted which partner organization controlled decision making for each decision, of which informants gave highly consistent accounts. Then, we used simple cutoff points to construct the control metric: a partner in our study possesses "majority control" when they made at least 75% of the decisions in a phase, "minority control" when they made less than 25% of the decisions, or "shared control" when partners made between 25% and 75% of decisions. Thus, we define a leadership rotation as a phase transition where a "minority control" partner in one phase became a "majority control" partner in the next phase. Our results are not sensitive to the choice of 25% and 75% as cutoff points for this metric – e.g., the findings are robust to cutoffs as different as 10/90 and 40/60. Thus, this is a conservative measure of control that eases exposition and allows for the possibility of majority, minority, and shared control alternatives implied by the literature. Moreover, the range of strategic decisions per phase never exceeded ten, and most phases have only one strategic decision which makes determining control clearly evident.