

# INNOVATION ORCHESTRATION

## MATCHING NETWORK TYPES AND ORCHESTRATION PROFILES

### **Abstract**

*Various forms of innovation networks and coalitions are becoming central in constructing new technologies and business fields. Yet only scant knowledge exists of the deliberate orchestration of these networks. We identify four innovation network types – science networks, innovation coalitions, dominant design networks, and application and commercialization networks – and argue that they differ in terms of how they are orchestrated. Proposing six orchestration dimensions, we construct detailed orchestration profiles for each type of innovation network. The resulting contingency model for orchestrating innovation networks contributes significantly to the theory of network management and suggests several managerial implications.*

**Keywords:** Innovation networks, Innovation coalitions, Network orchestration, Innovation orchestration, Network management, Innovation management, Orchestration profiles

## INTRODUCTION

This paper examines the nature and characteristics of innovation networks and the ways companies and other organizations try to orchestrate them. Focusing on innovation networks is highly relevant for several reasons. Prior research has suggested that network forms are becoming central to the efforts to create radical innovations in such fields as energy, wellness services, and in harnessing the potential of biotechnology, nanotechnology, and Web, 2.0. Indeed, it can be argued that all systemic innovations involve a network of firms and other types of actors (de Man 2008; Powell & Grodal 2006; Powell et al. 2010). We are moving from closed toward open innovation, embracing not only organizational actors but various user and innovation communities and intermediaries (Chesbrough et al. 2006; Fichter 2009; von Hippel 2007; Howells 2006).

Despite their recognized significance, relatively little knowledge exists about how innovation networks form or are managed. The network literature has focused mainly on networks that emerge, often incidentally, from dyadic interactions (Raab & Kenis 2009). Goal-directed, consciously formed networks have received much less attention (Provan et al. 2007). A key question is to what extent actors—firms, government agencies, and other organizations—can purposefully create and orchestrate innovation networks (Dhanaraj & Parkhe 2006; Möller & Svahn 2006; Rampersad et al. 2010). Understanding innovation orchestration and the capabilities involved is therefore a core issue for companies and government agencies (Hagedoorn et al. 2006; Lundvall 2010; Malerba et al. 2004; Powell et al. 1996).

Another limitation of extant studies is their tendency to regard innovation networks as relatively generic. Very few authors (for exceptions see Möller & Rajala 2007; Powell & Grodal 2006) distinguish theoretically between networks relating to, for example, scientific discoveries, creation of new breakthrough technologies, establishing designs and standards, or developing first generation applications that can be commercialized. This is a major issue as we are going to demonstrate that different innovation networks pose diverse challenges for network orchestration.

We address this knowledge gap from two perspectives. First, we argue that network forms are used to pursue many different types of innovations. These range from relatively well identifiable product and service innovations such as the iPod, to complex systemic innovations such as creating the electric car and related infrastructure, to using scientific research or invention networks to generate innovation in fields such as biotechnology (de Man 2008; Powell & Grodal 2006; Powell et al. 2010; Pyka & Koppers 2002). Second, we argue that this variety in the relative complexity and uncertainty in innovation networks influences their orchestration potential, as well as the organizational forms and capabilities involved in orchestration. Based on this reasoning, this study aims to:

- Discuss different types of innovation networks and how the extant literature has categorized them.
- Develop an organizing system for innovation networks.

- Analyze the organizational forms and management capabilities exhibited in different types of innovation networks and construct a contingency framework for orchestrating innovation networks.
- Develop proposals for future research and suggest managerial implications for orchestrating innovation networks.

Innovation networks have been studied in several disciplines and from several approaches, including evolutionary economics (Lundvall 2010); economic geography and regional studies (Saxenian 1996 2001); economic sociology (Powell & Grodal 2006); social network theory and social capital (Inkpen & Tsang 2005; McFadyen et al. 2009); organizational theory and innovation management literature (Ahuja 2000; Dhanaraj & Parkhe 2006); and industrial network theory (Håkansson & Waluszewski 2002). This variety is understandable considering the relevance and complexity of innovation amidst increasingly knowledge-based, global competition. To cope with this multiplicity of research perspectives, however, we have to impose certain limitations on this study.

We do not seek to provide a comprehensive review of the innovation literature, but will focus instead on studies that address the evolution and formation of innovation networks from a management perspective. Questions such as “How do firms try to influence and coordinate emerging innovation networks?” “What kinds of processes and organizational forms are being used and what kinds of capabilities are involved?” are pertinent to this study. The second constraint concerns the qualities of the innovations networks. Attention will be focused primarily on innovation networks that enable radical systemic change rather than incremental innovation. The reason for this focus is the knowledge we have about potentially orchestrating the emergence of new technologies and business fields is more limited compared to the narrower incremental innovation that the research and development (R&D) literature and new product development (NPD) research have addressed (de Man 2008). While this paper is principally conceptual, case material and secondary sources covering innovation networks will be used for illustrative purposes.

In the following section, we first discuss the research on innovation generating networks, examining their characteristics and the typologies the extant literature describes. Based on this review, we propose an organizing system for classifying different types of innovation networks. Section three addresses the extant knowledge on developing, organizing, and orchestrating innovation networks. We advance a set of orchestration activities that, we argue, are manifested in all innovation networks. In section four, we construct a contingency theory of innovation network orchestration by combining the innovation continuum and the example networks with the set of orchestration activities. We contend that particular networks require specific orchestration profiles. We conclude the paper by discussing the theoretical and managerial implications and suggesting direction for future research.

## VARIETY AMONG INNOVATION NETWORKS - GROUND FOR ORCHESTRATION

The challenge of studying innovation creating networks is their layered and multidimensional character. Innovation activities have been studied on a national basis (so-called national inno-

vation systems; Lundvall 2010) exemplified by approaches taken by countries such as Denmark, Singapore, and Taiwan, and on a regional basis such as in Saxenian's (1996) comparison of the Silicon Valley and Boston's Route 128 in terms of their innovative characteristics. Various industry and cross-industry networks have also been addressed in terms of the structure and changes within their inter-organizational relationships (Powell et al. 1996, 2006; Rosenkoph & Schilling 2007). Finally, research has been conducted on the role of firm-specific (Maurer & Ebers 2006) and individual or entrepreneur level networks (Larson 1992; Rost 2011) on innovation. The foci of these different levels of studies have involved the emergence of new science and technological fields, as well as business fields (e.g., biotechnology and its applications), new product and service categories and their complementary products, systems and services (e.g., mobile telephony and mobile services), and major product innovations (e.g., flat screen televisions, MP3 players, and DVD systems).

To navigate within this accumulated material, we try to identify the characteristics of various innovation networks that influence their potential to be governed or orchestrated. Dharanaj and Parkhe (2006, 659) defined network orchestration as "the set of deliberate, purposeful actions undertaken by the hub firm as it seeks to create value (expand the pie) and extract value (gain a larger slice of the pie) from the network" We agree with their proposition, but extend it by suggesting that in addition to the hub organization, orchestration can be carried out by a group of organizations or by an intentionally established orchestration organization. This extension matches the view of Provan and Kenis (2008), who differentiated between three forms of network governance: participant governed networks, the lead-organization-governed networks, and network administrative organizations (NAOs) in which a separate administrative entity is wholly responsible for governing the network and its activities.

### Categorizing innovation networks

We start this enquiry into the premises of orchestrating innovation networks by examining the available characterizations and typologies of inter-organizational networks. The goal is to identify network attributes that influence the relative ability of networks to be orchestrated. Several authors have offered classifications of business or inter-organizational networks. de Man (2004), for example, distinguished among supply/distribution oriented and primarily vertical networks; quasi-integration networks having primarily horizontal members such as airline alliances; and multidimensional technology development networks. Inkpen and Tsang (2005), examining a space formed by vertical versus horizontal dimensions and structured versus unstructured dimensions, identified intracorporate networks, franchising chains, strategic alliances, R&D consortiums, trade associations, and industrial districts.

Powell and Grodal (2006) proposed that the degree of network member embeddedness, varying from fluid to relatively closed, and whether the network was more informal or contractual could be used as classifying dimensions. The resulting space includes supply chains; primordial networks (dense, primarily social networks such as that found in the diamond trade and film industry); invisible college networks (relatively fluid, discovery oriented, informal networks such as research collaborations); and strategic networks (fluid and contractual firm alliances typical in high-technology industries).

Möller and his colleagues (Möller, Rajala, & Svahn 2005; Möller & Rajala 2007) argued that categorization should focus on the network's primary goal(s) and on its underlying value-system, ranging from a high level to a low level of determination. Using this continuum, they distinguished relatively stable current business networks (vertical and horizontal networks focused on efficiency and new offerings); business renewal networks (characterized by incremental innovation typical in multiparty NPD projects, in business process renewal projects, and in businesses offering customized solutions such as construction and system solutions); and emerging business networks, which focus on radical innovation and new technology and business development. In this domain, Möller and Rajala (2007) positioned application nets, dominant design nets, and innovation networks. In addition to these classifications, Newman et al., 2006 distinguished among social, technological, biological, and information networks, whereas de Man, 2008 addressed networks using social capital, structural holes, and modular structures.

A striking feature in these network classifications is the relatively scant attention to networks focused on innovation. A definite need thus exists for a more profound understanding of networks and their role in radical and systemic innovation eminent in the emergence of new technologies and business fields (Geels 2002; Murtha et al. 2001; Möller & Svahn 2009). The studies by Möller and Rajala (2007) and Powell and Grodal (2006) offer useful starting points.

Powell and Grodal (2006, p. 64) used the extent of network membership embeddedness, the level of formality, and the degree of purposiveness in the network as the bases for their categorization. They suggested that fluid and informal "invisible colleges", typical in science and research networks, emerge from shared interests by the potential network members. These are characterized by low level of purposiveness and highly fluid structure. According to Powell and Grodal this kind of network can evolve in two directions: either into a more closed "primordial network" characterized by stronger and more stable social ties, identity, and with higher purposefulness (such as found in the film industry network); or toward more formal, generally contract-based strategic business networks aiming at R&D breakthroughs, technological standards, and market commercialization (typical in biotechnology and in the ICT field).

It is useful to link Powell and Grodal's (2006) suggestions with the propositions by Möller and his colleagues. The invisible colleges concept represent the "fuzzy end" of Möller's and Rajala's (2007) innovation networks, which are populated by "science networks" in their terminology. They proposed these are guided more by academic interests and the ethos of discovery compared to more commercially oriented innovation networks. The dominant design networks and the application networks Möller & Rajala (2007) examined come close to the description of the relatively broad strategic networks Powell and Grodal (2006) discussed. Both are characterized by a clear goal-orientation and formal contractual structure guiding the network members' activities and roles. Dominant Design Nets represent mobilizing a target-oriented coalition or network of actors that aim to establish a dominant technological design within an emerging business field. This concept is exemplified by the Android and Bluetooth coalitions within the field of wireless and mobile communications (Srinivasan et al. 2006). Application Nets refer to the networked development and launch of early commercial applications within an emerging business field. Early mobile phones and Internet portals provide a

few examples. Application Nets may overlap with Dominant Design Nets, but are driven generally by a hub company and involve a web of complementary component, software, and other technology producers as well as pilot customers. Thus, Application Nets do not generally contain clear market competitors that are relatively typical in Dominant Design Nets (Möller & Rajala 2007).

#### Types of innovation networks: An orchestration continuum

The above discussion shows that the generic term “innovation network” covers widely different networks and multi-actor coalitions, which we argue differ essentially in terms of their network orchestration. By extending the level of determination Möller and his colleagues we suggest that innovation networks can be positioned on a continuum reflecting their potential for network orchestration. The resulting innovation network orchestration framework is depicted in Figure 1. As we will show, this framework can be anchored to several fundamental dimensions in management research including Weick’s (1976) loose-tight coupling notion; Polanyi’s (1966) tacit-codified knowledge distinction; and March’s (1991) explorative versus exploitative learning.

Figure 1. Innovation network orchestration framework

As illustrated in Figure 1, the left end of the continuum is the domain of science and basic research-oriented networks that involve mainly university academics, but increasingly more applied-oriented researchers in various institutions and research organizations of major corporations. Science networks are predominantly professional networks, guided primarily by the ethos of scientific discovery. As such, no single company or institution alone can manage them. Large corporations, however, are participating in these networks to a growing extent through their own researchers and by sponsoring university laboratories and other research institutions. Furthermore, governments and regional bodies are increasingly trying to guide the goals and direction of science networks through selective financing and specific science programs (Gambardella & Malerba 1999; Lundvall 2010; Powell et al. 2010).

A key managerial challenge in the early phase of emergence is identifying and making sense of widely dispersed and inherently local nature of new scientific knowledge. The knowledge may be relatively well codified and understandable for researchers in the specific disciplines, but very ambiguous in terms of its potential to generate innovation. Early application ideas—offered, for example, by early genetic research and nanotechnology—are often fuzzy; that is, ambiguity is inherent to the possible cause and effect relationships between existing knowledge and emerging knowledge. Fuzzy ideas do not yet contain a clear heuristic of how to pursue the potential innovation idea (Scharmer 2000). This is understandable because the commercial considerations are not the primary incentive of science networks. High levels of exploration, tacitness of knowledge, and looseness of organization, while advancing the potential of breakthrough inventions, tend to hinder more systematic sharing and co-development of knowledge required for systemic innovation. Here we propose that innovation communities and coalitions bridge the gap between the invisible college (Powell & Grodal 2006) type science networks and Dominant Design Networks (Möller & Rajala 2007). These are purposive networks of actors which, while bringing their special knowledge and resources to the network, share and use a joint knowledge base and a vision of how the innovation activities

should proceed. They may be orchestrated by a hub firm such as Genentech in developing genetics and genetechnology driven diagnostic solutions and developing new medicines or formed by a more loose coalition of actors that share an interest in developing the technological basis for innovation commercialization. Coalition communities often take the form of multiparty collaborative research projects with universities and research institutions and have more specific and application-oriented goals than do pure science networks (Doz et al. 2001; Murtha et al. 2001).

Dominant Design Networks represent a type of clearly organized innovation network that has several specific characteristics (Axelrod et al. 1995; Möller & Rajala 2007). Compared to innovation coalitions, DDNs mobilize a target-oriented coalition, or network of actors, that aims to establish a dominant technological design in an emerging business field. Examples include the Android, Symbian, and Bluetooth coalitions within the field of wireless and mobile communications. The Bluetooth coalition is a good example of a technological innovation where partially competing and partially complementing wireless technology and service companies joined forces to develop a technological solution. This solution became a dominant design for future commercial applications and services (<http://www.bluetooth.com>). Dominant Design Networks purport to reduce the very uncertainty and ambiguity inherent in radical emergence by creating a credible platform for new service offerings. If successful, this leads to a path formation that involves lock-in that benefits the whole coalition. For example, competition among the alternative high definition television video modes, the BluRay coalition led by Sony and the HD DVD group headed by Toshiba illustrates this logic (Christ & Slovak 2009). Strategic management of the coalition generally involves establishing a formal organization in which at least the major coalition members are represented. Generally, actual development work is carried out through working groups, and the members aim to arrive at shared, unidirectional decisions.

Finally, application/commercialization networks (ANs) refer to the networked development and launch of early commercial applications within an emerging business field (Möller & Rajala 2007). ANs may often overlap with dominant design networks, but are generally driven by a hub company and involve a web of complementary component, software, and other technology producers as well as pilot customers. Thus, as Möller and Rajala (2007) pointed out, ANs do not generally contain clear market competitors, which are relatively typical in dominant design coalitions. In terms of management, ANs are argued to exhibit a hybrid character. The application development work is carried out through multiparty projects similar to dominant design networks. It contains analogous issues in terms of collaborative, project-based learning, enhancing the importance of boundary persons, the trust-based sharing of knowledge, and efficient project management (Möller & Svahn 2006). Parallel to solving the technological aspects of an application, the network must create an efficient marketing, distribution, and production system for the application. The need for these kinds of competences and resources may involve inviting new members to the network to make it truly multidimensional.

Clearly, the proposed framework is a highly abstract theoretical construct. We contend, however, that it synthesizes the fundamental differences of various innovation networks in terms of their orchestration potential and solutions. When moving from the scientific knowledge-based foundation of a radical and systemic innovation to its actual commercialization, the

share of tacit knowledge tends to decrease in favour of codified knowledge; the share of explorative behaviours and learning gives way to higher share of exploitation; and the organization of networks changes from informal, personal, and fluid to more highly coupled, directed and contract-based. Although we suggest these generalizations, we do not assume clear-cut distinctions between the proposed networks types. As Orton and Weick (1990) noted, there is no pure form of loose or tightly coupled systems; instead, there are hybrid or mixed forms along a continuum. This is indicated by the overlapping ellipses in Figure 1. Moreover, the identified networks are dynamic and fluid, and able to transform. For example, science networks can morph into innovation coalitions and dominant design networks into application networks. However, being able to identify the primary characteristics and goals of an innovation network is highly relevant for understanding and designing orchestration.

## DIMENSIONS OF NETWORK ORCHESTRATION

Scholars and practitioners debate to what extent business and innovation networks can be managed. Studies drawing on economic sociology and the tradition of social networks (see review by Brass et al. 2004) as well as key authors who advocate the industrial network approach tend to emphasize the historical, evolutionary, and embedded character of networks (Håkansson & Ford 2002; Håkansson & Snehota 1995). Networks are seen as complex adaptive systems, comprised of interacting sets of organizational and social relationships in which each entity pursues its own goals (Stacey 1996). From this perspective, networks are only weakly manageable, and no single “hub firm” can provide direction or control to the entire network (Ritter et al. 2004). On the other hand, scholars representing strategic research, the resource-based view, and those that focus on network organizations with intentionally created structures, negotiated roles and goals argue that networks can, and indeed must, be managed in order to be efficient (Dhanaraj & Parkhe 2006; Dyer 1996; Dyer & Nobeoka 2000; Järvensivu & Möller 2009; Kale et al. 2002; Möller & Svahn 2003).

Both of these network views are relevant to understanding innovation networks and how organizations behave and trying to manage within network contexts (Capaldo 2007; Doz et al. 2000). The key issue, as Möller and Rajala (2007) emphasized, is not whether networks can or cannot be managed, but what kind of governance or managerial solutions are most suitable for different types of networks. To distinguish management in the network context from the situation of the single organization, we use the orchestration concept. In this section, the primary activities or dimensions of network orchestration are described.

Orchestration (Dhanaraj & Parkhe 2006) refers to activities that enable mobilization and coordination of the innovation network through discreet direction and influence. Orchestration is essential for co-creation of innovation outcomes, whether they are new technological platforms or service systems. In line with this, orchestration profiles consist of a set of purposeful, deliberate, and interrelated activities and mechanisms that facilitate collaboration that targets innovation. We suggest that through a carefully constructed orchestration profile the innovation activities, the knowledge resources they require and actors in the innovation network can be coordinated in a way that does not jeopardize creativity and flexibility, but provides direction and structure to achieve network goals.

Drawing on an extensive literature review (Capaldo 2007; Cohen & Levinthal 1990; Dhanaraj & Parkhe 2006; Dyer & Nobeoka 2000; Hurmelinna-Laukkanen & Puumalainen 2007; Järvensivu & Möller 2009; Kale et al. 2000; Leonard-Barton 2007; Kenis & Provan 2006; Luo 2008; McAdam et al. 2008; McGuire 2002, 2006; Möller & Rajala 2007; Möller 2010; Provan & Kenis 2008; Zahra & George 2002) we suggest that network orchestration can be captured with the following six action sets:

1. Agenda setting involves creating and communicating a credible development agenda that underlies the innovation. This influences how various actors frame the innovation and its potential and provides direction and goal-orientation. Agenda setting also impacts the relative attractiveness of those who hold the early innovation ideas and is deeply enmeshed with network mobilization.
2. Mobilization refers to attracting and selecting partners to the innovation network and includes their motivations and early goal-setting.
3. Network stabilization involves co-creating the network's identity and its basic shared values and beliefs. Depending on the life-span of the network, network stabilization represents the underlying elements of the network culture.
4. Knowledge creation and transfer involve the activities and structures through which the network members share and combine specialized knowledge and co-create new knowledge. These processes are essential for constructing innovation and are deeply interrelated with network stabilization and innovation appropriation.
5. Innovation appropriation refers to the activities and structures through which the network members control their knowledge creation vis-à-vis outsiders and among themselves.
6. Coordination—while embedded to a certain extent in the other orchestration dimensions—involves establishing operative goals and schedules underlying the innovation targets, distributing responsibilities and work processes between the members, and monitoring network members' abilities to meet goals and schedules.

Each of the proposed orchestration dimensions has attracted intensive research attention and is supported by extensive literatures, especially knowledge transfer, innovation appropriation, and coordination. Our intent here is not to review all of this material, however. Our key contribution is recognizing that these dimensions in general have been addressed on an individual basis, as individual activities in and of themselves. To our knowledge, they have never been related to a spectrum of innovation networks as this paper identifies. The next section explains how this study fills this gap.

## INNOVATION NETWORK ORCHESTRATION – AN ORCHESTRATION PROFILE APPROACH

Two premises guide this section. First, we contend that various types of innovation networks, due to their underlying differences in goals and network characteristics, require different orchestration profiles. That is, the orchestration profile must match the requirements of the network and its context. In brief, we propose a contingency view for innovation network orchestration. Second, we suggest that all six identified orchestration dimensions are relevant for each innovation network type, but that their content and emphases differ significantly across networks.

### From scientific inventions to founding commercial innovations

#### *Science networks*

Science networks, as noted, are primarily academic networks designed to pursue new scientific, research-based knowledge. This kind of research is carried out mainly by professional university academics, but increasingly by more application-oriented researchers in various institutions and research organizations of major corporations. With advancements in technology and the evolving knowledge-based economy, science networks have become extremely significant in providing the seeds for emerging technologies, new business fields, and social change (Lundvall 2010; Möller & Svahn 2009; Powell et al. 2010).

Innovators—entrepreneurs, specialized science and technology based firms, chief technology officers, and business development managers of incumbent firms—face special challenges in trying to harness new scientific breakthroughs. How do these firms identify and assess the commercial innovation potential of new knowledge? How do they influence researchers driven by the ethos of discovery and working in dispersed research groups within university institutions? A core task in the early orchestration of such networks is agenda development. An innovator faces, however, a paradoxical situation: how can he or she influence professionals who are experts in their own fields?

We see two major ways agendas can be constructed. If the basic research involves several potential pathways and application domains, such as found in the fields of nanotechnology and genetechnology, it is advisable to sensitize the science experts to look for application potential themselves. An innovator with a strong reputation and market position can use these resources to persuade the relevant scientific communities to advance from the basic research perspective to developing technologies and platforms that enable application development (Möller 2010). Such network mobilization may involve directly funding selected research groups and programs and establishing joint research teams if the innovator has its own researchers or even centers. Good examples are the legendary Xerox Park, the corporate research center in Palo Alto (<http://www.parc.com>) and IBM's active involvement in establishing computer science as a new discipline in major universities in the 1950 and 60s. Typical agenda communication and network mobilization channels include participating in scientific conferences and research forums and seminars. Personal relationships are essential, but corporate researchers or other representatives must also master “research-speak” and be able to make sense of relevant papers and journal articles.

In the sketched situation, the research network—or at least its targeted representatives—are forming application ideas through self-construction. Interaction with the research community allows the potential innovator to co-create more specific development ideas of the science or technology in focus. This enables an articulation of the innovation agenda and more narrowly targeted in terms of key research groups and persons, network mobilization.

The previous description presumed a relatively large incumbent company or organization. Where does this leave smaller firms and potential individual entrepreneurs? The second typical route to early agenda construction and network mobilization involves small science or technology-based entrepreneurial firms, which are often university spinoffs (Maurer & Ebers 2006). They are highly focused on their specific science/technology domains and led by persons who are experts in the field. Genentech is a good example. Its cofounder was a top expert in recombinant DNA technology, forming an early platform for therapeutic genetechnology applications (<http://www.gene.com>). This situation enables the network to create an articulated and focused innovation agenda immediately. Network mobilization is facilitated by the readily available personal research networks of these micro firms and their leaders.

We believe that the agenda construction activity cannot be overemphasized in early innovation emergence. An interesting and credible agenda provides a cognitive frame through which interested actors make sense and construct relevant meanings of potential future innovations. It provides focus, reduces perceived uncertainty, and creates meanings (Möller 2010). Henry Ford's vision of mass production systems in the early car industry is a simple example of the power of framing. In essence, a frame focuses attention, activates network members, and may lead to a new technology trajectory (Geels 2002).

Mobilization of science networks is highly enmeshed with orchestrating innovation coalitions. As such, and to avoid repetition, we discuss the remaining orchestration dimensions—network stability, knowledge transfer, innovation appropriability, and coordination—in the context of innovation coalitions.

#### *Innovation coalitions*

Innovation coalitions are purposive networks of actors working to develop a breakthrough innovation or technological platform for innovation. They bridge science-oriented networks and commercialization networks. Generally, they are mobilized either by a powerful incumbent or a specialized start-up company as discussed above. Again, the orchestrator must have an attractive development agenda, which allows it to mobilize the actors that have the competences and resources required to realize innovation. An articulated and credible agenda provides the orchestrator with what Hardy (1996) and Swan and Scarborough (2005) called “meaning power” and what Perrow (1986) termed “premise control”. In a situation where competing innovators and innovation paths exist, an attractive agenda plays a key role in getting the best partners to join the coalition.

The next challenge is to motivate the network members to collaborate in solving the problems at hand and creating the technologies and systems involved in the innovation. In high-tech and high-science fields, this may involve considerable a priori investments with relative uncertain commercialization dates and payback periods. Competition between various flat screen technologies provides a good example. It took several decades to develop a flat screen

television set that was ready for the mass market, and several early developers dropped from this race (Murtha et al. 2006). Facing this kind of risk scenario, an orchestrator should try to ensure equitable principles for collaboration. This involves discussing the appropriation rules openly among the key network members, taking into consideration their roles and investment shares. Any major orchestrator candidate with a track record of capturing the lion's share of the future profits will find it difficult to mobilize top network partners. A variety of means are available, however, to ensure appropriation ranging from formal contracts to establishing jointly created ground rules for cooperation (Heiman & Nickerson 2004; Hurmelinna-Laukkanen & Puumalainen 2007).

Equity also influences knowledge sharing and joint problem solving. Establishing effective collaborative processes requires laying down ground rules and the network's identity, basic shared values, and beliefs. In essence, this is what we call the network stability dimension of orchestration. This involves agreeing on the governance structure of the innovation coalition. In general, three alternatives are available (Provan & Kenis 2007): governance dominated by the lead-organization, shared governance by key coalition members, and establishing a new organization for governance. Selecting among these is guided by aspects such as the relative importance of the coalition members; the need to co-create new solutions involving the members' core competences; and the size of investment and business risk and how these are distributed among the partners. High equality, collaboration intensity, and high investments favor the second and third governance modes.

Finally, solutions concerning coordinating and directing the network's work processes play a critical role in achieving innovation goals. Complex innovations, such as creating a first-generation smart phone or a working flat screen television, generally involve solving a set of interrelated technical and systems problems. Recognizing and understanding the causal knowledge and technological links involved requires architectural understanding of the targeted innovation (Sanchez & Mahoney 1996). Some of these problems can be solved by specific coalition members through their autonomous self-organizing (Nishiguchi & Beaudet 2000), whereas some require joint collaboration. Generally, co-problem solving is organized into multiparty projects, to which each member brings his or her specific competences.

The sticky, tacit, and social character of specialized knowledge emphasizes the capabilities of bridging the borders of both the involved firms and their communities of practice (Mowery et al. 1996; Nonaka & Takeuchi 1995; Simonin 1999). The critical issue is to facilitate crossing these disciplinary boundaries. One solution is to select and educate boundary-spanning professionals who are able to lead projects. The coalition should aim to create a collaborative project culture following the ideas of communities in practice (Brown & Duguid 2001; Dyer & Nobeoka 2000; Möller & Svahn 2006). A more technical issue is establishing a project management platform that includes enabling tools for work process design and monitoring. Finally, partner-specific experience, general alliance experience, and relational governance structures and processes support creating such community-specific coordination routines that facilitate creating joint knowledge and problem solving (Kale et al. 2002; Lambe et al. 2002; Möller & Svahn 2006; Zollo et al. 2002).

## Dominant design coalitions

Dominant design networks (DDNs) are strategic, multiparty coalitions that aim to establish a dominant technological design, often involving several standards and patents, to an emerging business field (Leiponen 2008; Möller & Rajala 2007; Srinivasan et al. 2006). They are often initiated by proactive orchestrator firms in the so-called pre-market competition phase in order to favor their technology choices and positions in the field and to accelerate market construction (Abernathy & Utterback 1978; Anderson & Tushman 1990; Tushman & Rosenkopf 1992). The Bluetooth, Symbian, and Android alliances represent well-known dominant design coalitions within the field of wireless and mobile communications. Because dominant design networks share many features with the discussed innovation coalitions, we will focus on their distinguishing orchestration characteristics only.

Mobilizing a DDN generally presumes an attractive and credible technological or business agenda that favors larger incumbent firms as mobilizers. Ericsson, for example, mobilized the Bluetooth coalition; Nokia mobilized the Symbian coalition; and Google mobilized the Android Open Handset Alliance. Android is an interesting hybrid network that hosts an open source based systems development community and an applications selling platform, the Android Market, that represents a commercialization network. As these examples indicate, network organization has been used to initiate a variety of dominant design coalitions. Here we use Symbian and Bluetooth as examples.

Symbian, established by June 1998 as a partnership between [Ericsson](#), [Nokia](#), [Motorola](#), [Psion](#), and joined somewhat later by Panasonic/Matsushita, exploits the mobile operating system originated by the small Psion Corporation. It is an example of early platform cooperation between major handset rivals Ericsson, Nokia, and Motorola. The underlying motive was to collaborate in creating one dominant design in order to reduce investor risk and promote mobile service and application development. Nokia was the major partner because it was leading the smart phone development during that period. The coalition established Symbian, Ltd. as the network governing organization and had a relatively clear agenda of sharing innovation tasks. Psion and Nokia lead the operation system development, which the partners used through licensing and Symbian, Ltd. marketed the platform for the service developers. In effect, the Symbian coalition was a market construction and development alliance.

Somewhat similar logic underlies the Bluetooth coalition. The technology development—allowing short distance wireless communication between all kinds of digital devices such as cell phones, personal computers, personal data devices, among others—was initiated in the mid-1990s by Ericsson, a Swedish company with strong early market share in the market for mobile handsets and telecom network equipment. The company realized, however, that in order to make Bluetooth a truly dominant technology, it had to collaborate with other major players. In 1998, the Bluetooth Special Interest Group (SIG) was founded by five major companies (Ericsson, IBM, Intel, Nokia, and Toshiba); soon Microsoft, Lucent, 3Com, and Motorola joined the SIG as promoters.

How was Ericsson able to mobilize such core competitors as Nokia and Motorola? The application potential underlying the Bluetooth technology provided a huge incentive. The development costs were considerable and had to be shared. All players realized that by joining forces they could advance the continuous development of the technology and secure the application market development. The non-profit governance form, SIG, was chosen as an operating platform; it provided flexibility and was attractive for recruiting new members and promoting rapid growth. Each member was responsible for promoting applications within his or her own field.

With hindsight, one can see that Ericsson made the right strategic move. The early production costs of Bluetooth technology were so high that the technology never reached expected application volumes in mobile phones until the current smart phones hit the mass market. Through the alliance, however, the investment was shared and the technology promoted to cover a huge variety of products and applications ranging from USB sticks to health care and auto devices. Current Bluetooth membership, over 14,000 organizations (<http://www.bluetooth.com>), suggests that the coalition succeeded in their marketing activities and in creating a clear identity for the network and the technology it promotes.

In terms of the orchestration competencies, the early Bluetooth coalition was characterized by establishing the technological collaboration, clearly coordinated by Ericsson, which initiated the specific R&D program. This was followed by well-developed marketing activities that were carried out through the SIG platform, but used the funding, experience, and expertise of the core members. The resulting visibility of the Bluetooth brand clearly resembles the “Intel inside” branding phenomenon.

In general, one can distinguish two to three primary levels of orchestration in the dominant design networks. First is the agenda setting and mobilization, which also involves establishing the network stability phase. This is characterized by a mix of informal top-level negotiations between the targeted core parties followed by creating a formal network governance organization in which the key organizations are represented. The direction, goals, value appropriation, and other principle ground rules are constructed through this process. Rotating leadership provides one way to foster network stability (Davis & Eisenhardt 2007). Second, technological development is carried out through collaborative projects, characterized by issues of management similar to those discussed in relation to innovation coalitions involving agreement on knowledge sharing, co-development, and the project and process coordination. Third, the established coalition government, with its tasks groups or committees, is used to develop the network identity and to promote its agenda and further development (de Man 2004).

### Application and commercializing networks

Application Networks (ANs) refer to the networked development and launch of early commercial applications within an emerging business field (Möller & Rajala 2007). Early mobile phones, DVD video players, flat screen televisions, and blade technology based servers in computers provide some examples. Application networks may evolve from innovation coalitions or dominant design networks, or be established independently. They differ from innovation networks in that they emphasize market entry and commercialization. This generally requires recruiting new members who can provide the necessary resources and competences as

well as a change in the agenda. Compared to dominant design coalitions, ANs are generally driven by a hub company and involve a web of complementary component, software, and other technology producers as well as pilot customers. Thus, ANs do not generally contain clear market competitors, which are relatively typical in DDNs. In all cases, application networks have a strong marketing agenda that calls for a cultural shift from the primarily technology and R&D oriented innovation networks and dominant design coalitions.

The BluRay coalition, led by Sony, presents a recent example. The emergence of high-definition (HD) players followed the entry of HD televisions into the mainstream market in the mid-2000s. Consumer-grade HD players required an inexpensive storage medium capable of holding the larger amount of data needed for HD video, first produced by the major film studios and distributed by satellite and cable television operators and video chains. The technological breakthrough came with Shuji Nakamura's invention of the blue laser diode in late 1990s. Two competing coalitions were established to develop this technology into workable HD video formats: one led by Sony and the other by Toshiba (Christ & Slowak 2009; Daijd et al. 2010; Spark 2010).

In the first phase, these were essentially innovation and design coalitions. Sony partnered with Pioneer and with several Japanese research companies and university labs. After presenting the first working prototypes in 2000, the project was turned into a combination of an application development alliance and a strategic commercialization coalition in 2002 by establishing the Blu-ray Disc Founders (BDF) group involving Sony, Panasonic, Pioneer, Philips, Thomson, LG Electronics, Hitachi, Sharp, Samsung, and MIT. After an intensive collaborative development phase, this core was opened up by forming the Blu-ray Disc Association in 2005. The target was to promote the format for content providers, especially the major movie studios. This was essential, because the competitive coalition—lead by Toshiba—the HD DVD format had a head-start in the high-definition video market. The first Blu-ray Disc player was perceived as expensive and buggy, and there were few titles available. The Blu-ray Disc Association was able, however, to even the situation by getting three major studios, including Columbia Pictures, Walt Disney Pictures, and 20<sup>th</sup> Century Fox to commit to the format. After Sony incorporated the Blu-ray Disc player as a standard feature of the PlayStation 3 video game console, Paramount and finally Warner Bros. switched to the Blu-Ray. This was the final tipping point in 2008.

The Blu-ray case describes the dual character of many application and commercialization networks. They involve both intensive application development collaboration and market making and commercialization processes. Generally, these networks are mobilized and orchestrated by a powerful lead company, which by articulating an agenda and its own market position, forms a strong strategic coalition. Application development is carried out through similar structures, which were discussed in the context of innovation networks and dominant design coalitions. The major difference here is that more carefully articulated technical specifications are available and a higher level of competitive pressure exists as the effort races to market (Christ & Slowak 2010; Möller & Rajala 2007). These characteristics call for fast technological solution development that requires collaborating through well-specified and scheduled sub-projects. In brief, it involves the distributed but coordinated work of multiparty projects led by experts (Adler et al. 1999). Integrating knowledge and solutions again presumes both a trusting culture and architectural vision of the complex system. Besides this

technological aspect, the coalition must be able to influence the market, content providers, distribution channels, and finally the end users that their offering is competitive. This involves mobilizing the top-level managers of the alliance to carry out missionary road tours within their customer and supplier firm networks, as well as constantly promoting the advantages of the offering through various trade forums and websites. In brief, orchestration should combine technological coordination with strategic making, and support an intense operational pace in the race to the market.

### Synthesis

The orchestration of the identified four innovation network types is summarized in Figure 2 which presents the synthesized orchestration profiles. These offer several significant points. As one can note, the manageability of networks increase, as postulated, when one moves from the science-oriented networks toward the application and commercialization networks. This relatively obvious pattern is based on the increased share of articulated knowledge that leads to reduced uncertainty and enables the development of more precise network agendas. More precise agendas contain more directive information for setting both network-wide and network-partner specific goals.

Figure 2 – Innovation Networks Orchestration Profiles

Reducing potential technological paths and solutions reduces the share of mutual exploration and development work. It also shifts the orchestration emphasis to exploiting each partner's specialized resources and expertise in a coordinate way. This is reflected in the orchestration profiles as a change from relatively loosely coupled networks toward more tightly coupled organizing and coordinating mechanisms. From a self-organizing system of scientific research networks, we move to jointly-agreed upon combinations of distributed and centralized organization and coordination. Although the innovation networks have hybrid orchestration profiles, the identified larger patterns are unmistakable and highly relevant for network orchestration.

### CONCLUSIONS

This paper makes several significant contributions to the emerging theory of network orchestration and to managing innovation networks. By drawing from the extant research that spans several disciplines and literatures and the available documentation and descriptions of innovation-oriented networks and alliances, we have constructed a framework of four innovation network types: science networks, innovation coalitions, dominant design networks, and application and commercialization networks. We postulated that these differ in terms of their orchestration. Using the established notions of tacit versus codified knowledge (Polanyi 1966), explorative versus exploitative learning (March 1991), and loose versus tight coupling (Weick 1976), we further propose that these innovation networks can be positioned in a continuum of orchestration and that they require specific orchestration profiles or mechanisms.

This new contingency model of innovation network orchestration was articulated further by proposing a set of network orchestration dimensions and mechanisms, including agenda setting, mobilization, network stability, knowledge transfer, and coordination. These were then

used to construct detailed orchestration profiles for the identified innovation network types. The resulting model for orchestrating innovation networks makes a major contribution to the current theory of network management.

The constructed framework and its propositions also have evident managerial relevance. They provide detailed suggestions on orchestrating various forms of innovation networks in terms of how they are established and mobilized; their organizational forms and governance principles; their mechanisms of knowledge transfer and co-creation; appropriation norms; and coordination forums and mechanisms. By offering an essentially comprehensive and systematic overview of the forms of innovation networks, coalitions, and alliances, the proposed framework provides a navigational tool for strategic managers. It can also be helpful for entrepreneurial start-ups and venture capitalists.

As primarily a conceptual paper, the current work has also limitations. First, it is based on relatively limited empirical material and may suffer from selection bias, although we have tried to avoid this tendency. We do hope the paper encourages more systematic research on orchestrating innovation networks. One alternative is to carry out comparative case studies on the orchestration of the postulated network types and assess the orchestration profiles and mechanisms and a broad range of performance indicators of the case networks. Another option is to gain a better understanding of the orchestration mechanisms through in-depth longitudinal case studies of specific innovation networks. A third direction is to develop proxy measures for orchestration and conduct quantitative analysis regarding the existence of different orchestration profiles and their performance associations with available databases.

## REFERENCES

- Abernathy, WJ & Utterback, JM 1978, 'Patterns of innovation in industry', *Technology Review*, vol. 80, no. 7, pp. 40-47.
- Adler, PS, Goldoftas, B & Levine, DI 1999. 'Flexibility versus efficiency? A case study of model changeovers in the Toyota production system', *Organization Science*, vol. 10, pp. 43-68.
- Ahuja, G 2000, 'Collaboration networks, structural holes, and innovation: A longitudinal study', *Administrative Science Quarterly*, vol. 45, pp. 425-455.
- Anderson, P & Tushman, ML 1990, 'Technological discontinuities and dominant designs: a cyclical model of technological change', *Administrative Science Quarterly*, vol. 35, pp. 604-633.
- Axelrod, R, Mitchell, W, Thomas, RE., Bennett, DS & Bruderer, E 1995, 'Coalition Formation in Standard-setting Alliances', *Management Science*, 41 (9), pp. 1493-1508.
- Brass, DJ, Galaskiewicz, J., Greve, H R., & Tsai, W 2004 'Taking stock of networks and organizations: A multilevel perspective', *Academy of Management Journal*, 47: 795-817.
- Brown & Duguid 2001, 'Knowledge and Organization: A Social-Practice Perspective', *Organization Science*, vol. 12, no. 2, pp. 198-213.
- Capaldo, A 2007, 'Network structure and innovation: The leveraging of a dual network as a distinctive relational capability', *Strategic Management Journal*, vol. 28, pp. 585-608.
- Chesbrough, H, Vanhaverbeke, W & West, J 2006, *Open innovation. Researching a new paradigm*, Oxford University Press, NY.
- Christ, JP & Slowak, AP 2009, 'Why Blu-Ray vs. HD-DVD is not VHS vs. BETA-MAX: The co-evolution of standard setting consortia', Discussion Paper 05-2009, Universität Hohenheim.
- Cohen, WM & Levinthal, DA 1990, 'Absorptive capacity: A new perspective on learning and innovation', *Administrative Science Quarterly*, vol. 35, no. 1, pp. 128-152.
- Daft, RL & Weick, KE 1984, 'Toward a model of organizations as interpretation systems', *Academy of Management Review*, vol. 9, no. 2, pp. 284-295.

Daijd, N, Grazia, C & Hammoudi, A 2010 'Introduction to the Non-Cooperative Approach to Coalition formation: The Case of Blu-Ray/HD-DVD Standards' War', *Journal of Media Economics*, vol. 23, pp. 192-215.

Davis, JP & Eisenhardt, K 2007, 'Rotating leadership and symbiotic organization: relationship processes in the context of collaborative innovation', *MIT Sloan School of Management Working Papers*.

Dhanaraj, C & Parkhe, A 2006, 'Orchestrating innovation networks', *Academy of Management Review*, vol. 31, no. 3, pp. 659-669.

de Man, A-P 2004, *The network economy. Strategy, structure and management*, Edward Elgar, Cheltenham, UK.

de Man, A-P 2008, 'Networks as the organization form of the knowledge economy', in A-P de Man (ed), *Knowledge management and innovation in networks*, Edgar Elgar, Cheltenham, UK, pp. 15-31.

Doz, Y, Santos, J & Williamson, P 2001, *From global to metanational. How companies win in the knowledge economy?*, Harvard Business School Press, USA.

Doz, Y, Olk, P & Ring, P 2000, 'Formation processes of R&D consortia: Which path to take? Where does it lead?', *Strategic Management Journal*, vol. 21, pp. 345-367.

Dyer, J 1996, 'Specialized supplier networks as a source of competitive advantage: Evidence from the auto industry', *Strategic Management Journal*, vol. 17, pp. 271-291.

Dyer, JH & Nobeoka, K 2000, 'Creating and managing a high-performance knowledge sharing network: The Toyota case', *Strategic Management Journal*, vol. 21, pp. 239-266.

Fichter, K 2009, 'Innovation communities: the role of networks of promoters in Open Innovation', *R&D Management*, vol. 39, no. 4, pp. 357-371.

Gambardella, A & Malerba, F (eds.) 1999, *The organization of economic innovation in Europe*, Cambridge University Press, UK.

Geels, F 2002, *Understanding the dynamics of technological transitions. A co-evolutionary and socio-technical analysis*. Twente University Press, Enschede.

Hagedoorn, J, Roijakkers, N & van Kranenburg, H 2006, 'Inter-firm R&D networks: The importance of strategic network capabilities for high-tech partnership formation', *British Journal of Management*, vol. 17, pp. 39-53.

Hardy, C 1996, 'Understanding power: Bringing about strategic change', *British Journal of Management*, vol. 7, no. 1, pp. 3-16.

Heiman, BA, Nickerson, JA 2004, 'Empirical Evidence Regarding the Tension Between Knowledge Sharing and Knowledge Expropriation in Collaborations', *Managerial and Decision Economics*, vol. 25, pp. 401-420.

Howells J 2006 'Intermediation and the role of intermediaries in innovation', *Research Policy* 35 (2006) 715-728.

Hurmelinna-Laukkanen, P & Puumalainen, K 2007, 'The nature and dynamics of appropriability – Strategies for appropriating returns on innovation', *R&D Management*, vol. 37, no. 2, pp. 95-112.

Håkansson, H & Ford, D 2002, 'How should companies interact in business networks?' *Journal of Business Research*, vol. 55, pp. 133-139.

Håkansson, H & Snehota, I 1995, *Developing relationships in business networks*, Routledge, London.

Håkansson, H & Waluszewski, A 2002, *Managing technological development, IKEA, the environment and technology*, Routledge. London.

Inkpen, AC & Tsang, EW 2005, 'Social capital, networks, and knowledge transfer', *Academy of Management Review*, vol. 30, no. 1, pp. 146-165.

Järvensivu, T & Möller, K 2009, 'Metatheory of network management: A contingency perspective', *Industrial Marketing Management*, vol. 38, pp. 654-661.

Kale, P, Dyer, JH & Singh, H 2002, 'Alliance capability, stock market response, and long-term alliance success: The role of the alliance function', *Strategic Management Journal*, vol. 23, no. 8, pp. 747-767.

Kenis, PN & Provan, KG 2006, 'The control of public networks', *International Public Management Journal*, vol. 9, no. 3, p. 227-247.

Lambe, C. J., R. E. Spekman, and S. D. Hunt. 2002. "Alliance Competence, Resources, and Alliance Success: Conceptualization, Measurement, and Initial Test." *Journal of the Academy of Marketing Science* 30(2): 141-158.

Larson, A 1992, 'Network Dyads in Entrepreneurial Settings: A Study of the Governance of Exchange Relationships', *Administrative Science Quarterly*, vol. 37, pp. 76-104.

Leiponen, A 2008, 'Competing through Cooperation: Standard-Setting in Wireless Telecommunications', *Management Science*, vol. 54 (2), pp. 1904-1919.

Leonard-Barton, D 2007, 'Core capabilities and core rigidities: A paradox in managing new product development', *Strategic Management Journal*, vol. 13, no. 1, pp. 111-125.

Luo, Y 2008, 'Procedural fairness and interfirm cooperation in strategic alliances', *Strategic Management Journal*, vol. 29, no. 1, pp. 27-46.

Lundvall, B-Å 2010, National systems of innovation. *Toward a theory of innovation and interactive learning*, Anthem Press, London.

March, JG 1991, 'Exploration and Exploitation in Organizational Learning', *Organization Science*, vol. 2, no. 1, pp. 71-87.

Malerba, F 2004 (Ed.), *Sectoral systems of innovation. Concepts, issues and analyses of six major sectors in Europe*. Cambridge University Press, Cambridge.

Maurer, I & Ebers, M 2006, 'Dynamics of social capital and their performance implications: Lessons from biotechnology start-ups', *Administrative Science Quarterly*, vol. 51, pp. 262-292

McGuire, M. (2002). Managing networks: Propositions on what managers do and why they do it. *Public Administration Review*, 62(5), 599-609.

McGuire, M. (2006). Collaborative Public Management: Assessing What We Know and How We Know It. *Public Administration Review*, 66 (Special issue), 33-43.

McFadyen, AM, Semadeni, M & Cannella, AA 2009, 'Value of strong ties to disconnected others: examining knowledge creation in biomedicine', *Organization Science*, vol. 20, no. 3, pp. 552-564.

Mowery, DC, Oxley, JE & Silverman, BS 1996, 'Strategic alliances and interfirm knowledge transfer', *Strategic Management Journal*, vol. 1, special issue 'Knowledge and the firm', winter 1996, pp. 77-91.

Murtha TP, Lenway, SA & Hart, JA 2001, *Managing new industry creation. Global knowledge formation and entrepreneurship in high technology*, Stanford University Press, Stanford, USA.

Möller, K & Svahn, S 2003, 'Managing strategic nets: A capability perspective', *Marketing Theory*, vol. 3, no. 2, pp. 209-234.

Möller, K & Svahn, S 2006, 'Role of knowledge in value creation in business nets', *Journal of Management Studies*, vol. 43, no. 5, pp. 985-1007.

Möller, K & Rajala, A 2007, 'Rise of strategic nets – New modes of value creation', *Industrial Marketing Management*, vol. 36, pp. 895-908.

Möller, K & Svahn, S 2009, 'How to influence the birth of new business fields – Network perspective', *Industrial Marketing Management*, vol. 38, no. 4, pp. 450-458.

Möller, K 2010, 'Sense-making and agenda construction in emerging business networks – how to direct radical innovation'. *Industrial Marketing Management*, vol. 29, no. 3, pp. 361-371.

Nishiguchi, T & Beudet, A 2000, 'Fractal Design: Self-organizing Links in Supply Chain Management', in G von Krogh, I Nonaka and T Nishiguchi (eds.) *Knowledge Creation: A Source of Value*, Macmillan Press, London, pp. 199-23.

Nonaka, I & Takeuchi, H 1995, *The Knowledge Creating Company; How Japanese Companies Create the Dynamics of Innovation*, New York: Oxford University Press Inc.

Orton, JD & Weick, KE 1990, 'Loosely Coupled Systems: A Reconceptualization', *Academy of Management Review*, vol. 15, no. 2, pp. 203-223.

Perrow, C 1986, *Complex organizations: A critical essay*, Random House, NY.

Polanyi, M 1966, *The Tacit Dimension*. Routledge & Kegan Paul, London.

Powell, WW, Koput, KW & Smith-Doerr, L 1996, 'Interorganizational collaboration and the locus of innovations: Networks of learning in biotechnology', *Administrative Science Quarterly*, vol. 41, pp. 116-145.

Powell, WW & Grodal, S 2006, 'Networks of innovators', In J Fagerberg, DC Mowery & RR Nelson (eds), *Oxford Handbook of Innovation*, Oxford University Press, pp. 56-85.

Powell, WW & Packalen, K & Whittington, K 2010, 'Organisational and institutional genesis: The emergence of high-tech clusters in the life-sciences' to appear in Padget and W Powell (eds.), *The Emergence of Organizations and Markets, Ch 13, Princeton University Press*.

Provan, KG, Fish, MA & Sydow, J 2007, 'Interorganizational networks at the network level: A review and commentary on the empirical literature', *Journal of Management*, vol. 33, no. 3, pp. 479-516.

Provan, KG & Kenis, P 2008, 'Modes of network governance: structure, management, and effectiveness', *Journal of Public Administration Research Theory*, vol. 18, no. 2, pp. 229-252.

Pyka, A & Küppers, G (eds.) 2002, *Innovation networks: Theory and practice*, Edward Elgar, Cornwall.

Raab, J & Kenis, PN 2009, 'Heading toward a society of networks: Empirical developments and theoretical challenges', *Journal of Management Inquiry*, vol. 18, no. 3, 198-210.

Rampersad, G, Quester, P & Troshani, I 2009, 'Managing innovation networks: Exploratory evidence from ICT, biotechnology and nanotechnology networks', *Industrial Marketing Management*, vol., 39, Issue 5, July, pp.793-805.

Rosenkopf, L & Schilling, MA 2007, 'Comparing alliance network structure across industries: Observations and explanations', *Strategic Entrepreneurship Journal*, vol. 1, no. 3-4, pp. 191-209.

Rost K (2011), 'The strength of strong ties in the creation of innovation', *Research policy*, 40, pp. 588-604.

Sanchez, R & Mahoney, JT 1996, 'Modularity, flexibility, and knowledge management in product and organization design', *Strategic Management Journal*, vol. 17, winter special issue, pp. 63-76.

Saxenian, A 1996, *Regional advantage. Culture and competition in Silicon Valley and route 128*, Harvard University Press, USA.

Saxenian, A 2001, *Transnational communities and the evolution of global production networks: the cases of Taiwan, China and India*, East-West Center.

Scharmer, CO 2000, 'Organizing around not-yet-embodied knowledge' in G von Krogh, I Nonaka & T Nishikuchi (eds.), *Knowledge creation: A source of value*, Mcmillan Press, London.

Simonin, BL 1999, 'Ambiguity and the process of knowledge transfer in strategic alliances', *Strategic Management Journal*, vol 20, no. 7, pp. 595-623.

Srinivasan, RG, Lilien, G & Rangaswamy, A 2006, 'The emergence of dominant designs', *Journal of Marketing*, vol. 70, pp. 1-17.

Spark, KL 2009, 'Format war, antitrust casualties: The Sherman Act and the Blu-Ray – HD-DVD format war', *Southern California Law Review*, vol. 83, no. 1, pp. 173-226.

Stacey, RD 1996, *Complexity and Creativity in Organizations*, Berrett-Koehler, San Francisco.

Tushman, ML & Rosenkopf, L 1992, 'Organizational determinants of technological change: Towards a sociology of technological evolution', *Research in Organizational Behavior*, vol. 14, pp. 311-347.

Ritter, T, Wilkinson, I F & Johnston, WJ 2004, 'Managing in complex business networks', *Industrial Marketing Management*, vol. 33, no. 3, pp. 175-183.

Swan, J & Scarborough, H 2005, 'The politics of networked innovation', *Human Relations*, vol. 58, no. 7, pp. 913-943.

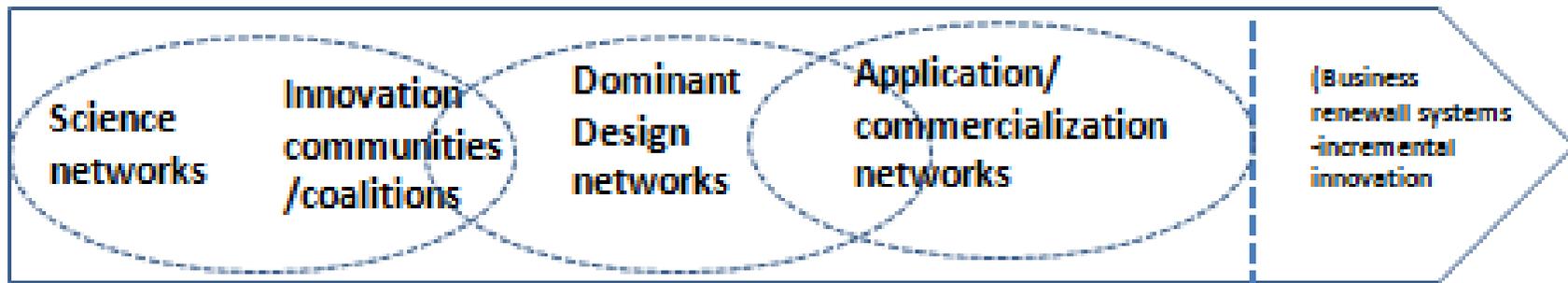
von Hippel, E 2007, 'Horizontal innovation networks—by and for users', *Industrial and Corporate Change*, vol. 15, no. 2, pp. 293-315.

von Hippel, E & von Krogh, G 2003, 'Open Source Software and the 'Private-Collective' Innovation Model: Issues for Organization Science', *Organization Science*, vol. 14, no. 2, pp. 209-223.

Weick, K 1976, 'Educational organizations as loosely coupled systems', *Administrative Science Quarterly*, vol. 21, no. 1, pp. 1-19.

Zahra, SA & George, G 2002, 'Absorptive capacity: A review, reconceptualization, and extension', *Academy of Management Review*, vol. 27, no. 2, pp. 185-203.

Zollo, M, Reur, JJ & Harbir, S 2002, 'Interorganizational routines and performance in strategic alliances', *Organization Science*, vol. 13, no. 6, pp. 701-713.



Life sciences  
Genetics  
Internet  
Nano technology

Genetechnology  
Human gene-project  
Flat display technlgies

Bluetooth  
Symbian coalition  
Blade coalition

Flat panel TVs  
Smart phones & services  
Blu-Ray applications  
Android platform



**Continuum of orchestration** →

Figure 1. Innovation network orchestration framework



	Science networks	Innovation communities/coalitions	Dominant Design networks	Application/commercialization networks
Agenda setting	<ul style="list-style-type: none"> <li>•Sensitize scientists for application orientation</li> <li>•Co-creation of common interests and goals</li> </ul>	<ul style="list-style-type: none"> <li>•Attraction through visionary innovation agenda</li> <li>•Joint framing and direction – “premise control/meaning power”</li> </ul>	<ul style="list-style-type: none"> <li>•Presumes an articulated technology/business agenda</li> <li>•This favors strong incumbents/high-tech firms</li> </ul>	<ul style="list-style-type: none"> <li>•Articulated orchestrator provided agenda with clear goals and milestones</li> </ul>
Mobilization	<ul style="list-style-type: none"> <li>•Hotspots identification and knowledge scanning</li> <li>•Agenda communication top researchers &amp; groups</li> <li>•Agenda communication in conferences, workshops and articles</li> <li>•Selective research project funding</li> <li>•Joint university/corporate research groups</li> </ul>	<ul style="list-style-type: none"> <li>•Use of professional relations to commit top actors</li> <li>•Innovation agenda articulation through actor cocreation</li> </ul>	<ul style="list-style-type: none"> <li>•Emphasizing future benefits to motivate investments</li> <li>•Recruiting targeted top players through CEO-level relations – strategic alliance logic</li> <li>•Spreading the design via an open platform</li> </ul>	<ul style="list-style-type: none"> <li>•CEO driven recruitment of top players – strategic alliance logic</li> <li>•Urgency – time-to-market competition</li> </ul>
Network stability	<ul style="list-style-type: none"> <li>•Network identity creation through social construction of shared meanings and goals</li> <li>•Identity and bonding enhancement through joint research seminars</li> <li>•Emphasizing neutrality and fairness</li> </ul>	<ul style="list-style-type: none"> <li>•Creation of joint governance form</li> <li>•Co-creation of ground principles – roles, investments, risk sharing and appropriation</li> <li>•Joint forums &amp; multi-party task groups</li> </ul>	<ul style="list-style-type: none"> <li>•Agreeing on governance form, alliance forum or new legal entity</li> <li>•Agreement of ground principles, roles, investments, appropriation</li> <li>•Joint forums &amp; task groups – identity creation</li> </ul>	<ul style="list-style-type: none"> <li>•Formal governance, hub lead, forum, or new legal entity</li> <li>•High risk, investments &amp; interdependence favor shared governance</li> <li>•Task group system</li> </ul>

Figure 2a. Innovation Network Orchestration Profiles



	Science networks	Innovation communities/coalitions	Dominant Design networks	Application/commercialization networks
Knowledge transfer	<ul style="list-style-type: none"> <li>• Supporting knowledge sharing and co-creation via interdisciplinary projects, seminars &amp; forums</li> <li>• Illustrating good reputation and trust</li> <li>• Emphasizing and maintaining neutrality and integrity</li> </ul>	<ul style="list-style-type: none"> <li>• Collaborative knowledge creation &amp; problem solving</li> <li>• Emphasis on boundary spanning via tasks groups &amp; multiparty projects</li> <li>• Emphasis on rapid codification of findings and solutions</li> </ul>	<ul style="list-style-type: none"> <li>• A combination of actor specific problem and joint tasks force problem solving via knowledge sharing &amp; co-creation</li> <li>• Similar structures and mechanisms as in the innovation coalitions</li> <li>• Boundary spanning culture essential</li> </ul>	<ul style="list-style-type: none"> <li>• Similar structures and mechanisms as in the dominant design networks</li> <li>• Higher level of knowledge &amp; task specification enables faster &amp; more specific problem solving</li> </ul>
Innovation appropriability	<ul style="list-style-type: none"> <li>• Open norms on researcher, university and investor appropriation rights</li> <li>• Incentives on application research</li> </ul>	<ul style="list-style-type: none"> <li>• Jointly created appropriation principles</li> <li>• Encouraging fairness and equity</li> </ul>	<ul style="list-style-type: none"> <li>• Jointly negotiated appropriation principles</li> </ul>	<ul style="list-style-type: none"> <li>• Jointly negotiated appropriation principles</li> </ul>
Coordination	<ul style="list-style-type: none"> <li>• Co-creation of articulated research agendas</li> <li>• Via active participation in science forums and project funding</li> <li>• Joint university &amp; corporate research projects</li> </ul>	<ul style="list-style-type: none"> <li>• Combination of partner self-organization &amp; centralized coordination</li> <li>• Direct &amp; web-based, results sharing forums</li> <li>• Architecture of interlinked projects</li> <li>• Project management platform</li> </ul>	<ul style="list-style-type: none"> <li>• Similar structures and mechanisms as in the innovation coalitions</li> </ul>	<ul style="list-style-type: none"> <li>• Similar solutions as the dominant design coalitions</li> <li>• High competitive pressure requires systematic and integrated project management &amp; monitoring systems</li> </ul>

Figure 2b. Innovation Network Orchestration Profiles