

Public and Private Interests in Standard Setting: Conflict or Convergence

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Abstract: The growing strategic and proprietary value of standards has led to major changes in standard setting. This shift has been accompanied by a significant loss of transparency of and consistency in the underlying “rules of the game.” Questions arise as to whether, and the extent to which, the incentives that drive individual firms’ standards decisions in today’s highly competitive, networked environment will yield collective outcomes that coincide with broader-based public policy goals. Also, we must ask, if public and private costs and benefits diverge, what alternative institutional and organizational arrangements can bridge the gap?

This paper addresses these questions, first framing the analysis and then applying this framework to interpret the present state of affairs and to anticipate future outcomes. It argues that standard setting is a multilevel, complex process in which outcomes result from the horizontal and vertical interactions among firms, standards organizations, and government policy actors. In the case of networked industries, market failures at the firm level give rise to both collective action and prisoner’s dilemma problems, which are played out and mutually reinforced at the level of standard setting organizations. Intervention at the government level is required to overcome these multiple, and interrelated, failures and dilemmas. The government should not necessarily set standards—an approach that all too often leads to regulatory failures. Instead, the government must help to support the process, thereby reducing collective action problems. Equally important, it must work to eliminate the uncertainties and risks associated with standards bargaining, which typically lead to prisoner’s dilemma outcomes. A major source of such uncertainty is the lack of transparency with respect to property rights and standards. For government to take a deliberate and definitive stand in determining standards setting policy is especially important today, given the overriding need for interoperability in a networked society.

Introduction

Standards are fundamental building blocks of society. In any given context, they constitute an agreed upon set of meanings, scripts, and rules guiding behaviors and governing relations. Embodying critical information in a highly abbreviated format, standards greatly simplify life. Signaling opportunities and constraining choices, they allow for greater efficiency, coordination, and control.¹ In the technological realm, standards reduce transaction costs as well as add value to system components, allowing them to interconnect and interoperate in a transparent, seamless fashion (United States Congress Office of Technology Assessment, 1992; 1994).

Not surprisingly, standards have proliferated and gained importance as societal activities have become more complex. As Emile Durkheim noted three quarters of a century ago, increased specialization and a deeper division of labor generate the need for greater integration and control, and standards—by providing an overarching and common point of reference—help to provide this glue (Durkheim, 1933).

The need for standards will loom larger in the future, given the increased complexity and interdependence of the globally networked economy. Characterizing this situation Robert Axelrod has argued that, in addition to an information revolution, we are witnessing a ‘complexity revolution.’ As he has described it:

If complexity is often rooted in patterns of interaction among agents, then we might expect systems to exhibit increasingly complex dynamics when changes occur that intensify interaction among elements. This, of course, is exactly what the Information Revolution is doing: reducing the barriers to interaction among processes that were previously isolated from each other in time or space. Information can be understood as a mediator of interaction. Decreasing the costs of its propagation and storage inherently increases possibilities for interaction and effects. An information revolution is therefore likely to beget a complexity revolution. (R. M. Axelrod & Cohen, 1999, 26)

Just as standards provided the building blocks of the industrial revolution, so too they are essential to reducing information costs, facilitating interactions, and managing complexity. However, whereas in the industrial age, the need was for product standards, in today’s complex networked environment, IT process—or platform standards—will be key (United States Congress, Office of Technology Assessment, 1992).² These standards will not only serve their traditional functions of achieving efficiency, facilitating coordination, and executing control; equally, if not more importantly, IT platform standards will determine the architecture in which transactions take place (Garcia, 2004).

Notwithstanding the growing importance of standardization, achieving interoperable standards to support complex networked interactions and transactions is far more problematic today. Given the enhanced economic value of network standards, economic actors have intensified their efforts to capitalize on them. Thus, many software manufacturers, aiming to derive maximum returns, typically patent or copyright programs in their entirety, licensing them according to the broad rights granted by the Patent and Trademark Office.

As a result, intellectual property rights are increasingly being incorporated into IT standards specifications, allowing proprietary holders to extract what the market will bear (Burrone, 2002). Commenting on the extent of this problem, Lee Gomes notes, for example:

Even worse is the emerging legal black art of patent blackmail. There are millions of patents out there, any of which can be bought or sold like used cars . . . Some law firms have found a great money-making scheme: buy a general and vague patent, then mail boilerplate notices of infringement to a few hundred companies. If only a small percentage agree to pay a license fee, rather than risk expensive litigation, you’ve made a lot of money for little work. (Gomes, 2004, B1)

Not surprisingly, the growing strategic and proprietary value of standards has led to major changes in standard setting. To increase their payoffs from participating in the process, many firms are shifting their activities from traditional voluntary standards organizations to more ad hoc flexible arrangements—particularly standards consortia. Thus, there are today more than 260 consortia developing IT standards (Cargill, 2002; Spring & Weiss, 1995). Accompanying this shift has been a significant loss of transparency of and consistency in the underlying ‘rules of the game.’

Operating in a relatively closed environment, and on a 'pay-to-play' basis, consortia have been more or less free to set their own rules.

Given the critical role that standards play in society, major changes in standard setting processes will have far-reaching consequences. At the very least, questions arise as to whether, and the extent to which, the incentives that drive individual firm's standards decisions in today's highly competitive, networked environment will yield collective outcomes that coincide with broader-based public policy goals. An equally important and related question is whether, in this context, existing standards arrangements are conducive to aligning public and private outcomes. Finally, we must ask, if public and private costs and benefits diverge, what alternative institutional and organizational arrangements can bridge the gap?

This paper addresses these questions, first framing the analysis and then applying this framework to interpret the present state of affairs and to anticipate future outcomes. The paper argues that standard setting is a multilevel, complex process in which outcomes result from the horizontal and vertical interactions among firms, standards organizations, and government policy actors. In the case of networked industries, market failures at the firm level give rise to both collective action and prisoner's dilemma problems, which are played out and mutually reinforced at the level of standard setting organizations. Intervention at the governmental level is required to overcome these multiple, and interrelated, failures and social dilemmas. The government should not necessarily set standards—an approach that all too often leads to regulatory failures. Instead, the government must help to underwrite the process, thereby reducing collective action problems. Equally important, it must work to eliminate the uncertainties and risks associated with standards bargaining, which typically lead to prisoner's dilemma outcomes. This game's name derives from an imagined scenario in which two criminals are arrested without sufficient evidence against them. The two players can choose between two moves—"cooperate" or "defect"—in an attempt to minimize the length of their prison sentences. Each player gains when both cooperate. However, if only one of them cooperates, the player that does not cooperate will serve a shorter sentence. If both players choose not to cooperate and thus "rat" on each other, they will both serve the longest sentence. This outcome is what game theory grimly predicts will happen. A major source of such uncertainty is the lack of transparency with respect to property rights and standards. The role for government in standard setting is especially important today, given the overriding need for interoperability in a networked society and the emergence of related policy issues, such as privacy and security.

Standard Setting as a Complex Adaptive Process

Standard setting activities do not occur in a vacuum. How they are organized, and to what effect, depend on a variety of factors, including the motives and incentives that lead actors to engage in standard setting activities, as well as the institutional environment in which standards activities take place. These factors relate to one another in complex, non-linear ways. To relate standards setting arrangements to standards outcomes and to identify policy leverage points, we need to consider these relationships.

To capture standard setting in all its complexity, we must employ a multi-level structural approach that focuses not only on the individual components in the process, but also on their relationships and the incentives and rules that govern their interactions. Using such an approach, standard-

setting processes can best be understood as complex, adaptive systems, in which outcomes emerge in relatively circuitous and indeterminate ways.

Complex systems are comprised of multilevel processes in which the parts are interconnected in both a horizontal and a vertical fashion (Kontopoulos, 1993; Monge & Contractor, 2003). In such systems, activities at each level operate according to that level's own set of rules. At the same time, however, outcomes at any one level create opportunities and constraints for activities at other levels, and in this sense partially determine them. As novel structures, activities and outcomes emerge at different levels, they give rise to further emergence. Because the process operates in stages, during which new forms and structures are established, higher-level phenomena exhibit properties that cannot be directly traced to activities at lower levels (Monge & Contractor, 2003). This is, in essence, what emergence is all about.³

How outcomes emerge in any complex system depends on its architecture and on how influences and constraints flow throughout it. The architecture of a complex system can be hierarchical or heterarchical depending on the extent to which network layers overlap. In hierarchical networks, for example, layers are nested with each higher layer incorporating the lower one (Kontopoulos, 1993; Monge & Contractor, 2003).⁴ Heterarchical networks are more or less loosely coupled, or 'tangled' and the layers are imperfectly nested.⁵ In such cases, influence and constraints can be imposed in multiple fashions—from below upwards, downwards from above, or inwards from the external environment (Kontopoulos, 1993; Monge & Contractor, 2003).⁶ Standard setting is a heterarchical system that is constituted of three different levels of horizontal relations, which can be conceived of as *organizational fields*.

An 'organizational field' is the entire network of interdependent actors and organizations that, when considered together, comprise a recognized area of institutional life (DiMaggio & Powell, 1991; Fligstein, 2001; Scott, 2001). Organizational fields emerge to provide stability for interdependent organizations that depend on, but also must compete with, one another to create markets and access limited resources. Over time, these organizations develop a set of structured practices unique to their institutional space. When widely recognized as such, organizational fields enjoy a certain degree of jurisdictional autonomy, developing rules of the game and 'conceptions of control' over a given realm of life (Fligstein, 2001; White, 1992). As in all governance systems, organizational fields are sites of contests for power. Fields are organized hierarchically, so the most powerful incumbents dominate the field, defining the boundaries and meaning of the space as well as the roles and relationships of its occupants and the rules of the game (Fligstein, 2001; Fligstein & Brantley, 1992)⁷ Weaker parties typically accept their inferior status, given their dependence and the benefits that accrue from participation.⁸

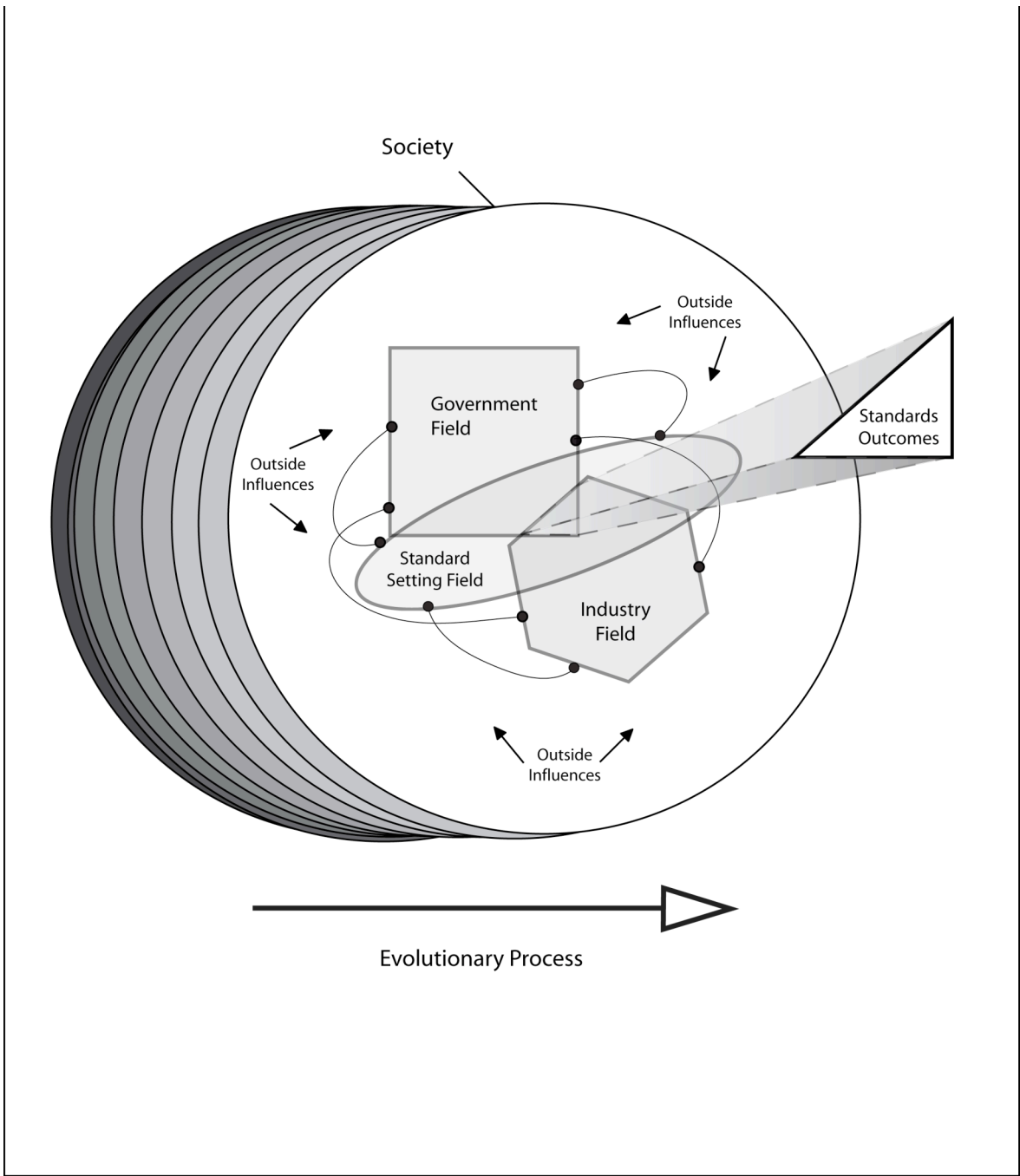
Employing the notion of organizational fields, we can see how actors and activities in standard setting activities are situated in a web of social networks comprised of interconnected and asymmetric positions and roles.⁹ At the same time, we can see how they are located in 'contexts' that serve to structure their opportunity sets and choices (Alexander, 1988; Emirbayer & Mische, 1998). Thus, whether an organizational field is made up of individual firms, standards organizations, or government bureaucrats, the actors and activities within it are embedded in unique institutional environments comprised of informal norms and rules of interaction (DiMaggio & Powell, 1991; Nee & Ingram, 1998; Scott, 2001). Equally important, they are linked through

shared meaning systems associated with social practices, classificatory distinctions, and cognitive schemas (Berger & Luckman, 1966; Meyer & Rowan, 1991; Mohr, 1998).

While complexity theory explains how outcomes emerge as a result of the vertical interactions that take place among actors, organizational field theory provides a basis for understanding relationships among actors linked through horizontal ties at any given level—in the present case, the firms in a techno-economic field, standard setting organizations, and government actors. The unique set of rules and relationships that govern actors and activities within these organizational fields generates emergent outcomes.

The standard setting arena is depicted in figure one below. In this figure, geometric shapes depict fields at each level. At level one are networks of firms that produce goods and services requiring standards as well as the consumers of those products. At level two is the network of standards development organizations that establish standards for these and other industries. Finally, at the third level, one finds the network of government structures and policy makers. As can be seen from this figure, because the system is complex, many factors impinge on standards outcomes, making them highly unpredictable. At each level, standards-related activities are governed by a set of rules specific to that level. However, because the system architecture is heterarchical—that is to say, because the levels overlap—the choices made at any one level influence the operating rules and outcomes at others. In addition—as can be seen in Figure 1—external influences affect each level of the system. Moreover, as the one-way arrow at the bottom of Figure 1 depicts, standard setting is an evolutionary process. As such, it must be examined not only as it presently exists, but also in terms of how it has evolved, and how its past and present together might affect the future (Hodgson, Itoh, & Yokokawa, 2001). As North has emphasized, history matters. Because structures are embedded within structures, they produce increasing returns and societal trajectories. Over

Figure 1: Standard Setting as a Complex Adaptive Process



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time, processes become locked in (North, 1990).¹⁰ Hence, barring major structural changes, future outcomes are constrained by previous choices.

Three Levels of Standards Engagement

We have looked generally at the vertical and horizontal axes of the standard setting arena, and at how they interrelate in complex ways. To anticipate future outcomes, we must consider more specifically how actors at each level engage in the process. Although fields are historically and situationally contingent, they share common characteristics within each level. Viewing these levels as ‘ideal types,’ we can map a field’s orientations and decision criteria along a continuum, locating level one at one end in a primarily techno-economic field, and level three at the opposite pole within the realm of government and politics.¹¹ In between, is level two—a hybrid field that operates according to both economic and political imperatives.

Level One—The Techno-Economic Field

Level one constitutes the techno-economic realm, a system for coordinating production and exchange. Reflecting in part the larger institutional environment in which it is embedded, the techno-economic realm can be structured and governed in a variety of different ways (Mantzavinos, 2001).¹² One feature characteristic of all market economies, however, is institutions delineating private property rights and enforcing private contracts. Thus, decision-making is typically decentralized, while outcomes are contingent on private actors operating to achieve their own ends (Caporaso & Levine, 1992; Lindblom, 2001). The primary actors at this level are firms that function as intermediaries between buyers and sellers, “setting prices, carrying out transactions, producing and distributing information, and forming and monitoring contracts” (Spulber, 1999, 7). Seeking to assure both profitability as well as their survivability, firms must cooperate with one another as well as compete (Fligstein, 2001). The strategies they employ relate not only to the nature and structure of the industry but also to opportunity sets and choices afforded by their surrounding environments (Aldrich, 1999; Pfeffer & Salancik, 2003).

Standards play a major role in the techno-economic realm. They serve not only to determine the size and scope of the field, but also the structure of relationships among firms. Not surprisingly, standards battles are central to how firms contest the terrain. As in all field contests, firms must make standards choices balancing their desire for competitive advantage with their need to stabilize and grow the market (Brandenburger & Nalebuff, 1996).

The nature of standards battles, and the frequency with which they occur, depend, in part, on the particular technology / products involved and the type of business strategies associated with them. Thus, for example, in the case of generic, mass-produced goods, firms—competing primarily on the basis of price—might seek stable, broad-based standards solutions (Storper & Salais, 1997). In contrast, in rapidly advancing high-fixed cost, high-tech industries, firms typically opt for higher-risk, innovative strategies that employ standards less to reduce transaction costs or increase the size of the market, and more to gain competitive advantage and build market share (Lazonick, 1991; Shapiro & Varian, 1999).

Even when firms aim to create standards, the market may make suboptimal choices and/or fail to achieve standards in a timely fashion.¹³ For example, in highly competitive markets, comprised of many firms, the transaction and coordination costs required to achieve standards may simply be too high. Alternatively, in oligopolistic markets, in which firms of relatively equal size can sustain propriety solutions, the market may not 'tip' in favor of a common standard.

The public goods aspects of standards also give rise to market failures. Public goods are those goods whose benefits are available to everyone (non-rivalry) and from which no one can be excluded (non-exclusivity), so no one can fully appropriate the benefits (Cornes & Sandler, 1986). Thus, public goods are typically under produced. Standards often fall in this category (Berg, 1989; Kindelberger). The nature of information compounds this situation. For firms to choose efficient standards, they must have accurate and timely information. However, information about standards, like standards themselves, is a public good, which is typically under produced and unevenly distributed (Noll, 1996).

Level Two-The Standard Setting Field

Faced with significant market failures, firms may opt to organize to carry out their activities (Coase, 1960; Williamson, 1985).¹⁴ When these organized activities are differentiated and specialized, they shift to another plane, taking on a life of their own. It is here that we find level two—the standard setting field.

Embedded between the techno-economic field and the government field, the standard setting field shares properties of both. In one respect, standards organizations reflect the imperatives of the market: for the most part, the field is comprised of firms that seek to pursue their own private business strategies, carefully weighing the costs and the benefits of, first, participating in the process, and, second, making standards choices. However, the process of organizing is more or less political in nature, entailing the establishment of rules of the game, structured role relationships, and an authority / conflict resolution structure to hold it all together. Depending on how, and the extent to which, standards organizations are structured, incentives will deviate from the marketplace model, and firm behavior will be politicized as a result. Whereas in competitive markets, economic actors are assumed to be relative autonomous price-takers, in structured, organized relationships, actors make choices based on a broader range of criteria, typically bargaining and making side payments that are unrelated to price (Miller, 1998, 9).¹⁵

As the proliferation of standards organizations might suggest, there are many benefits associated with organizing to create standards. First and foremost is the reduction in transaction and coordinating costs entailed in amassing the players needed to create a critical mass in support of a standard. Equally important, when operating within an organizational context, firms can share information allowing for negotiation, bargaining, and compensatory side payments (Farrell & Saloner, 1988). Moreover, to the extent that organizations are governed by common norms, standardized rules and operating procedures, as well as mechanisms for dispute resolution, they can provide credible commitments, reducing the risk of opportunism and unanticipated events when firms opt for one standard over another.¹⁶

Notwithstanding these benefits, organizational arrangements are—like markets—subject to failures, and for many of the same reasons (Heckathorn, 1996; Kollock, 1998; Miller, 1998). In the context of organizations, failures occur when the dominant strategies pursued by individual actors lead to outcomes that are sub-optimal for the collectivity as a whole. Such situations are commonly

referred to as 'social dilemmas'¹⁷. Two types of social dilemmas are found in the standard setting field. The first is the problem of collective action associated with creating a public good. The second relates to common pool problems entailed in allocating and appropriating benefits—sometimes referred to as a 'prisoner's dilemma'. Moreover, these two dilemmas are interrelated; attempts to resolve one dilemma can exacerbate the other.¹⁸

To appreciate these dilemmas, we must first consider the costs of organizing to create standards, and their associated collective action problems. These costs include not only those entailed in bringing actors together and coordinating their activities, but also in setting up a governance structure and maintaining it over time (Litwak & Hylton, 1962). The greater the interdependence among the actors, the more costly organizing will be. As described by Gulati and Singh, these coordination costs arise from:

. . . The complexity of ongoing coordination of activities to be completed jointly or individually across organizational boundaries and the difficulties associated with decomposing tasks and specifying a precise division of labor across partners in the alliance, all of which require ongoing communication and decisions. The extent of such alliance is best encapsulated by the level of interdependence that is necessary for the alliance partners to complete tasks. (Gulati & Singh, 1998, 2)

One major question for standard setting, then, is who will lead the organizational effort and bear these costs? Whether this dilemma can be solved or not depends on the quantity of aggregate benefits to be gained, the size, composition, and exclusivity of the group participating in standards activities, and how costs and benefits are distributed among participants throughout the course of their cooperation (Cornes & Sandler, 1986; Olson, 1971). Generally speaking, organizing will be easier and less costly the larger the aggregate benefit.¹⁹ Large aggregate benefits will likely exceed costs and facilitate compensatory side payments. Although many participants can lower unit costs, collective action may be discouraged if participants are alike. For, in such cases, no leader may emerge to underwrite the effort. Uncertainty is also problematic because actors will not invest their time and efforts if costs and benefits are not transparent.

Thus, in terms of organizing standards activities, the best situation occurs when potentially large gains can be made, and when rewards can be divided up among a small number of actors who, notwithstanding their unequal resources, trust that everyone will play by the rules (Olson, 1971; Sened, 1997). Organized on this basis, firms can be said to constitute a 'club' insofar as they are comprised of a group of like-minded actors who voluntarily assemble for a common end (Cornes & Sandler, 1986). Moreover, the standards that they produce are 'club goods' rather than 'public goods.' Although club goods are shared goods, they are shared on an exclusive basis among the members of the club²⁰.

However, standard setting clubs are not merely cooperative enterprises. To the contrary, standards activities are highly contested. These contests occur because the very attributes that lead to the successful formation of clubs—limited numbers, interdependencies, and asset specificities—contribute to the emergence of prisoner's dilemmas once organizations are in place. At this point, the bargaining process takes over, and participants must agree to divide the benefits gained from cooperating in a way that serves not only each private actor's needs but also those of the group as a whole. However, given actors' interdependencies and asymmetric resources, some are unlikely to cooperate. In fact, those with the most autonomy have a strong incentive to act opportunistically²¹.

Both bargaining costs and incentives to deceive are directly linked to levels of risk and uncertainty. In any collective negotiation, there are many possible equilibrium outcomes. For negotiations to lead to the most efficient outcome, all participants must have equal and accurate information about others' preferences and payoffs. However, in any bargaining situation, individuals are unlikely to afford this information. Each is better off concealing his or her preferences, while getting others to make theirs' public. This type of behavior constitutes a secondary social dilemma (Miller, 1998) and as Miller emphasizes, "Bargaining is a costly process—and all bargaining costs incurred are a deadweight loss" (Miller, 1998, 43).²²

Even after a bargain has been struck, a group will require some type of governance system to collectively monitor and enforce it. Monitoring and enforcement can occur via informal norms, formal rules, or both. Once again, and paradoxically, although these kinds of governance structures help to resolve the prisoner's dilemmas associated with allocating collective goods, they generate new collective action problems by increasing the costs of organizing (Heckathorn, 1996).²³

Consider the role of informal norms.²⁴ Providing the basis for trust, these norms reduce the need for monitoring and specifying the rules of the game (Mantzavinos, 2001). In norm-based governance systems, cooperation is based on implicit and open-ended contracts that are socially—not legally—binding.²⁵ Even so, they require significant organizational resources. In order for norms to be effective, organizations must be ongoing, participants must be well connected, and their relations must be continually reinforced (R. M. Axelrod & Cohen, 1999; Jones et al., 1997; Kollock, 1994).²⁶ Absent these conditions, actors cannot adequately assess others' behaviors, and their commitment to cooperate will decline as a result (Yamagishi & Cook, 1993). For the same reason, when organizations are established on a temporary, ad hoc basis, norms are inadequate to deter the most opportunistic members; instead, such actors typically maximize gains in the short run, and exit (Boone & Macy, 1999).²⁷

Trust is often inadequate; it can always be betrayed. Moreover, it is not available on demand, when needed most (Nooteboom et al., 1997). Thus, there is a demand for more formal and explicit rules and authority structures that address the broad range of anticipated and unanticipated contingencies (Nooteboom et al., 1997). However, establishing rules entails far greater costs and commitment. Given the uncertainties and risks involved, it is extremely difficult to identify and specify all possible breeches in conduct *ex ante* as well as to set up adequate and ongoing procedures for dispute resolution after the fact (Schmitt, Swope, & Walkert, 2000; Williamson, 1985).

Level Three: The Government Field

If, as is often the case, industry actors cannot extricate themselves from these social dilemmas, they may turn to government for help.²⁸ Alternatively, lobbying for government involvement in standards might come from private sector actors outside the field, or from interested policy makers within the government (Campbell & Lindberg, 1991). In any case, when standards issues are raised to the level of government, the criteria for evaluating outcomes are typically cast far more broadly, in terms of the public interest. Therefore, major dilemmas at the government level are how to determine the public interest in standard setting and, having done so, how to keep government accountable while reconciling private and public sector goals.

The government field is the realm of power and authority. Whereas, in the private sector, actors interact to achieve their own private ends, in the government field they cooperate and compete to achieve collective goals. Thus, the means of executing changes in this arena are participation and persuasion, while information, rhetoric, and the means of communication are critical resources (Knoke, 1990; Stone, 2002). Working together in groups and alliances, individuals employ information to shape attitudes and beliefs, in an effort to restructure the 'rules of the game' in their favor. Policy outcomes take time to materialize, and are highly uncertain. Emerging in the course of a 'prolonged process of trial and error learning' as well as intense struggles and negotiations for power and influence, they are rarely optimal (Campbell & Lindberg, 1991; Kingdon, 2002; Sabatier, 1999). Equally problematic, the key decision-making criteria in this field—the public interest—are subject to change, as actors define problems and frame debates in accordance with their own policy agendas.²⁹

Conceptually, there are three distinct ways of thinking about the public interest and the implications for government. For example, the term public interest can refer to private interests, such as property rights, which are held in common, and which the government acts to ensure. The concept might also be used to describe specific, consensual goals that a government administration pursues through its policy initiatives. Alternatively, the term public interest might be used to specify that which is good for the polity as a whole—such as national defense, economic growth, and freedom of speech (Caporaso & Levine, 1992; Stone, 2002).

An argument can be made for government involvement in standard setting based on each of these grounds. For example, because standards constitute a form of property rights—insofar as they determine actors' abilities to appropriate and/or dispose of their resources as they see fit³⁰—the government might be expected to establish policies that govern them and/or the processes that determine them (Libecap, 1989; Sened, 1997; Weber, 2004).³¹ Similarly, because standards constitute a set of performance criteria, all government policies have a standards component. Finally, because standards serve as a public infrastructure, the government must factor them into its efforts to assure national security as well as provide for the nation's political and economic welfare.

Pursuant to its standards goals, the government might play any of a number of possible roles. At a minimum, for example, the government acts as *rule maker*, establishing not only property rights in standards—and hence the obligations of and relationships between economic actors—but also the process by which these relationships can legitimately be negotiated within the standard setting field. Moreover, to ensure these rights, the government takes on the roles of *adjudicator* and *enforcer*. The government can also facilitate the standards setting process, acting as an *educator* to reduce uncertainties; a *broker* to bring together players and aid in negotiations; or a *subsidizer* to provide critical resources. Acting more directly, the government plays the role of *regulator*, specifying and standardizing the characteristics and/or capabilities of a product, process or technology. The government is also a user or *consumer* of standards. Moreover, when necessary, the government is a *developer* of technology standards through its own research and development efforts.

Although the government can help promote its standards goals, it is not an impartial or disinterested party. Government assumes the costs associated with engaging in the process, not solely out of its own good will, but also in exchange for the economic and political benefits that ensue. The way outcomes are structured will depend on the costs and benefits as the relevant political decision makers assess them at any point in time (Sened, 1997). Under these circumstances, the challenge is how to assure that government remains accountable and that

policies are in the public interest (North, 1990). This problem of government accountability is compounded by a problem of bounded rationality. Assigning rights and responsibilities with respect to standards and standard setting, so as to maximize society's interests, while accommodating private sector needs, requires a degree of knowledge—both global as well as local—that decision makers are unlikely to have under the best of circumstances, much less in the case of rapidly advancing technologies.

In the end, the quality of policy outcomes will depend on the quality of the decision-making process. As Campbell and Lindberg point out, government policy outcomes are not to be equated with the interests of individual actors, because these interests are both constituted through and constrained by actors' interactions with others in a variety of contexts. Outcomes, then, are the product of collective 'search processes,' that entail learning by trial and error, compromise and negotiation, as well as coercion and political struggle (Campbell & Lindberg, 1991). The decisions that emerge as a result are more likely to approximate the public interest, and to be adaptive to changing circumstances, to the extent that channels of communication are open and actors are interconnected in complex, and overlapping ways. Under such circumstances, not only will there be a greater variety of inputs into the process; equally important, there will be more adequate feedback mechanisms to continually sort out and select appropriate options as circumstances and technologies change over time (R. M. Axelrod & Cohen, 1999).

The Evolving Standards Process

As we have seen, standard setting is a complex process, which entails interactions and feedback across both horizontal and vertical boundaries. Thus, to assess this process adequately, and to characterize the relationships between public and private sector goals and outcomes, we must view the process in its entirety, as it has evolved over time in relationship to its changing societal context and unique historical circumstances. In the case of the US standard setting process, two distinct periods stand out: that between the 1850s to the mid 1980s, and the period beginning in the mid-1980s up through the present. As described below, the first period corresponds to the age of industrialization whereas the more recent period is associated with the rise of the networked economy.

Standard Setting in the Industrial Era

The emergence of standard setting as an institutionalized process is directly linked to the advent of industrialization. With the transition from local agrarian based economies to a nationally based industrial economy, firms had to contend with far greater uncertainty and information asymmetry. At the same time, advances in communication and transportation technologies, combined with the mechanization of industry, generated a crisis of control, forcing firms to invent new ways to speed up production processes (Beniger, 1986). To meet this challenge, firms adopted two basic strategies—the bureaucratic, vertical integrated firm and mass production.³² Standardization was integral to both strategies.

The relationship between standards and mass production was self-reinforcing. As tasks became more specialized and societal actors more interdependent, interoperable parts allowed for standardized production processes, which drove the need for standardized machine tools and precision gauges, which led in turn to standardized measures (H. F. Williamson, 1951).³³ Likewise, industrial organizations gained greater access to resources and reduced their transaction costs

when they adhered to standardized rules and procedures institutionalized in their environments (Beniger, 1986). In so doing, organizations themselves became standardized, as the prevalence of bureaucratic forms and structures clearly attests (DiMaggio & Powell, 1991).

Although standards were at the heart of the industrial process, many firms were unable to achieve adequate standardization acting on their own. The railroad industry provides a case in point. Because of its networked characteristics, the railroad industry had to cope with high fixed costs, fluctuating demand, large-scale operations, problems of coordination, and the need for highly specialized and dedicated skills. These problems were exacerbated by the fierce competition among the diverse railroad owners who employed control over different segments of the system to their full advantage (Kennedy, 1991; Neuman, McKnight, & Solomon, 1997). Faced with increasing uncertainty and massive transaction costs, the railroad companies began to standardize. To this end, they set up formal associations and organizations tasked with standardizing schedules, signaling, gauges and safety procedures (Kennedy, 1991). As a result, rail companies were together able to lay more than 240,000 miles of track by the end of the century.

As the railroad case suggests, organizing to generate standards did not initially cause collective action problems, because the gains for all were so large. Producers, for example, employed standards as trademarks, using them to differentiate their products, and to price products for different markets. Suppliers benefited as well; producing to standardized specifications, they greatly reduced production costs. Consumers likewise gained from far less expensive mass produced goods, as cars, refrigerators and vacuum cleaners became more accessible to all. Merchants, meanwhile, benefited from greatly increased sales.³⁴

Not surprisingly, given these benefits, standards organizations emerged voluntarily in response to specific needs.³⁵ In keeping with the climate of the industrial era, standards organizations became highly specialized, developing administrative lives of their own. By 1935, there were approximately 365 national organizations accredited to develop standards. Together, they constituted a clearly identifiable organizational field, in which participants carried out their business in much the same fashion (Garcia, 2004). However, despite their growing administrative apparatus and bureaucratic structures, the cost of participation remained low. Standards organizations financed their operations not only through membership fees but also—and increasingly—through standard sales.

As one might expect, it was at this point, when the organizational stakes increased, that prisoner's dilemma problems arose. Having turned to publishing for financial support, standards organizations began to compete ferociously for sales and clientele. The result was a major and long-standing contest to control the field: the American Standards Institute (now the American National Standards Institute) determined to become the umbrella standards organization; but the other major players, including ASME and IEEE, successfully resisted such efforts. This acrimonious and divisive turf war, which dated back to the twenties, undermined the coherence of the standards process with repercussions that are still visible today (United States Congress Office of Technology Assessment, 1992). Reporting to the government in 1977 on the state of cooperation within the standards setting field, Stanford Research Institute lamented that the situation was only deteriorating (SRI, 1971). Twenty years later, the Office of Technology Assessment concluded on a similar note in its report to the Congress, *Global Standards: Building Block for the Future* (1992).³⁶ Throughout these years, the only thing that American standards organizations were able to agree upon was that the government must not involve itself in standard setting.

Government, for its part, remained relatively neutral in these turf wars, leaving it to standards organizations to work out their differences. On the other hand, the government intervened in standard setting in times of crisis, and under political pressure to protect the public interest.

Standard setting first became a public policy issue almost a century ago, when consumers called on government to reduce the dangers associated with industrialization. Accordingly, in 1906, Congress passed the Pure Food and Drug Act in response to a growing number of scandals in the meat packing industry.³⁷ Mishaps associated with the rapid expansion of technology likewise led to safety standards. Explosions averaging 1,400 per year led the American Society of Mechanical Engineers (ASME), for example, to write a comprehensive boiler code in 1910.³⁸ Wartime efforts also involved the government in standard setting. For example, with the outbreak of the First World War, the government stepped in to rationalize and streamline American industry, setting up the Commercial Economy Board of the Council of National Defense (Cochrane, 1966). In the post-war period, a weak economy induced the government to continue to promote economic efficiency through greater standardization. Secretary of Commerce Herbert Hoover heralded this campaign, setting up agencies within the Department of Commerce to provide standards assistance to businesses at their request (Library of Congress Science Policy Research Division, Donnelly, & Gulick, 1974).

Although the government refrained from setting standards, its involvement in the process opened the door to a broader based public debate. In particular, consumers called on government to employ standards on their behalf. Ralph Nader took the lead in 1965 with his book, *Unsafe at Any Speed*, which accused the Society for Automotive Engineers of having developed unsafe standards. Continued complaints led to investigations, which identified significant problems. To assess consumer claims, Congress set up a National Commission on Product Safety in 1967. The Commission concluded that the process for determining consumer product standards was tainted by the dominant role of industry, and therefore was 'chronically inadequate both in scope and permissible levels of risk' (National Commission of Product Safety, 1970, as cited by Hamilton, 1978). Likewise, a Federal Trade Commission's investigation concluded that the entire standards process should be regulated to assure 'fairness.' However, proposed legislation to require standards setters to meet substantive 'fairness' criterion was highly controversial, and a new administration decided to enforce standards infringements of antitrust law on a case-by-case basis (United States Congress Office of Technology Assessment, 1992).

Somewhat ironically, the major outcome of these debates was greater government support for the voluntary standard setting process—but with conditions. After numerous years of jockeying and politicking, the government adopted its first official standards policy in 1982, when it promulgated Circular A-119. This executive order required government agencies to use 'voluntary standards' whenever possible. Although due process requirements, which had appeared in earlier drafts, were watered down in the 1982 version of A-119, they were subsequently reincorporated into the National Technology Transfer and Advancement Act of 1995 (NTTAA), which codified the OMB Circular. As defined in the NTTAA, a voluntary consensus standard is characterized by five attributes—openness, balance of interest, due process, an appeals process, and consensus. As described below, the government's standards policy had unintended consequences, giving rise to both prisoner's dilemma and collective action problems. On one hand, the policy served to stabilize the standards setting field, legitimating the way in which standards organizations conducted their business. In doing so, however, it reinforced what was an essentially flawed

business model. Competing at the expense of one another to sell their standards, standards organizations failed in many cases to promote industry interests adequately, causing agency problems and the underproduction of standards. At the same time, the government's voluntary consensus requirements increased the cost and complexity of organizing at a time when the need for speed and flexibility was becoming paramount.

Standard Setting in the Networked Economy

The past several years have witnessed a major shift from national industrial economies to a networked global economy. This transformation is associated with the rise of multinational corporations, the growing importance of information as an economic resource and basis for competitive advantages, as well as a shift from mass production to customized flexible production systems. Networked information technologies are, both driving and facilitating this transformation which allows businesses to flatten their hierarchies and restructure their activities on a much more flexible and versatile basis. Organized in loosely coupled networks and alliances, business can now extend their markets, spread their risks, and respond more quickly to changing circumstances. Equally important, by employing global networked production systems, businesses are able to specify the quality of inputs as well as customize their products without sacrificing economies of scale and scope (Hemphill, 2004; United States Congress Office of Technology Assessment, 1994).

Just as interoperable parts provided the building blocks for the industrial economy, so too will interoperable standards constitute a critical platform for economic activities in the networked economy (Libicki, 2000; United States Congress Office of Technology Assessment, 1994).³⁹ Open, interoperable systems not only reduce transaction costs, they also provide businesses the flexibility needed to customize applications and support changing business processes and flexible business relations. Moreover, with the freedom to mix and match a wide variety of new components, businesses can employ information technology to add value and develop new products and services. Equally important, interoperable systems promote technology diffusion and equity of access.

Notwithstanding the importance of interoperability, achieving interoperable network standards will be very difficult. Because network components and networked industries are so interdependent, interactions among them—whether at the firm or at the standard setting level—are especially prone to market failures and social dilemmas. Moreover, the decision-making environment is highly uncertain due not only to nature of the technology and the speed at which it is advancing, but also to the changing parameters of the global economy.

Market failures at the firm level are associated with externalities and network interdependencies. Having large installed bases, network industries are subject to networking effects and path dependencies. As a result, it is particularly costly for suppliers to redeploy technology, and for users to purchase new technologies, even if a new one is far superior to the old (Shapiro & Varian, 1999). In such markets, firms are more inclined to pursue a 'winner takes all' strategy rather than to promote interoperability. For, by acting quickly to lock in customers, they can use their technologies to gain competitive advantage, thereby capturing the lion's share of the market (Rohlf's, 2001; Shapiro & Varian, 1999). Equally troublesome, even when firms do agree to standardize, they often opt for the 'wrong' standards, due either to 'excess inertia' and/or 'excess momentum' (Farrell & Saloner, 1987).^{40 41}

Not surprisingly, under these circumstances, firms are turning to standard setting organizations to develop networking solutions. Here a major problem is that of information disclosure, especially as it relates to intellectual property rights in standards. Given the high stakes in outcomes involving network standards, as well as the asymmetries among the standards players, participant firms have a major incentive to withhold such critical information while bargaining with one another. At the same time, standards organizations are hesitant to eliminate such uncertainties because it would increase their organizational costs as well as the costs of members. Thus, for example, ANSI specifies and accredits standard-setting organizations based on their voluntary consensus processes, but it defers to its associated members when it comes to decisions about property rights and information asymmetries.

Just how problematic information asymmetries can be in affecting standards outcomes is evident in the case of Rambus (Mungovan & Papastavros, 2004). Between 1991 and 1995, Rambus, a company that designs and licenses computer memory systems, participated in the Joint Electronic Device Engineering Council's (JEDEC) standard setting procedures for semiconductors. Upon leaving the organization, Rambus acquired patents for technology that JEDEC subsequently incorporated into its semiconductor standards. Once the standards were in place, Rambus sued Infineon, a semiconductor manufacturer, for infringement of its patents. The court initially ruled in Infineon's favor, determining that Rambus had intended to defraud JEDEC members by not disclosing its patents and intentionally manipulating them to fit forthcoming JEDEC standards. However, in a surprising overturn, the Appellate Court for the Federal Circuit found Rambus not guilty of the intent to defraud⁴² (*Rambus, Inc. v. Infineon Technologies, 2003; Rambus, Inc. v. Infineon Technologies, 2001*).

Prisoner's dilemma outcomes such as this are likely to become increasingly prevalent in the future, given the recent shift away from traditional standards organizations towards standards consortia, which are modeled after network alliances. While more flexible and less costly than traditional standards development organizations, consortia are far more prone to opportunism.

Standards consortia began to arise in the 1980s, when many vendors, discouraged by the slow, lagging standards process, started to circumvent traditional standards development organizations in favor of more focused, interest-based alliances. Bringing the essential players together, these kinds of organizational arrangements allow firms to stabilize the market and mitigate the risks entailed in conducting business (Ring & Van de Ven, 1992). Moreover, because consortia are ad hoc in nature, and their membership is limited, rewards for participation are relatively high. This organizational structure allows consortia to treat standards as club goods, rather than public goods. Anticipating a real 'payoff,' participants are willing to pay sizeable amounts to be at the table. At the same time, they expect their influence to be commensurate with their level of contribution. Characterizing this situation, Updegrove notes:

There are two hard economic realities affecting consortia: the first is that completely voluntary, low budget organizations have difficulty producing standards in real time. The second is that, for the most part, only the large hardware vendors and the small number of large software companies which currently exist have sufficient revenue to pay the membership fees typically required to produce 'good' standards. Not surprisingly, the members which pay the lion's share of the budget of a consortium expect to receive greater privileges as a result (Updegrove, 1995).

Unfortunately, while solving many collective action problems associated with traditional standards development organizations, consortia engender prisoner's dilemma problems. One need only consider the problems of monitoring and enforcing sanctions to control opportunistic behavior. Established to carry out very specific tasks, consortia have little administrative structure. Formal rules are rarely laid out in detail (Teece, 1992). At the same time, because consortia members all have diverse agendas, and little incentive to reveal them, contracts are likely to be very incomplete (Das & Teng, 2000). Equally problematic, informal norms are likely to be ineffective in constraining opportunism, given the ad hoc nature of consortia in which members have minimal contact and are free to come and go at will. In fact, the ad hoc nature of consortia only encourages firms to maximize their benefits and run. Under such circumstances, uncertainty and information asymmetry will be the norm, leading to even greater opportunism.

Dell Computer Corporation's approach to the development of the VL-bus illustrates this kind of problem. This standard—which controls how instructions are transferred between a computer's central processing unit and its peripherals—was established under the auspices of VESA (Video Electronic Standards Association), a consortium that sets standards for both computer hardware and software manufacturers. VESA's information disclosure policy requires company members to identify their existing intellectual property rights. Although Dell certified that it had no intellectual property rights relating to the proposed standard, it did in fact. It was only after VESA had adopted the standard that Dell revealed its patent in an effort to enforce it against firms implementing the VL-bus standards. In 1996, the Federal Trade Commission brought a complaint against Dell Computer Corporation claiming that, once the standard had become widely accepted, Dell would gain an unfair market advantage. Noting that Dell had failed to act in good faith by not identifying and disclosing its patent, the FTC prohibited it from enforcing its patent for a period of ten years ("In The Matter of Dell Computer Corporation," 1999).

The lawsuits surrounding such cases have done little to reduce this uncertainty. Beginning in the 1980s, the number of court cases involving intellectual property in standards increased significantly. Both standard setting organizations and the courts contributed to the continuing uncertainty surrounding such cases. Standard development organizations and consortia were often unclear about their intellectual property policies. Moreover, when litigation ensued, the courts did little to establish a legal standard; instead, their positions varied greatly from case to case. One need only consider antitrust cases, for example. In some instances, standard setting organizations were found guilty of antitrust violations, in others, the court deemed the same type of behavior to be "pro-competitive."⁴³

Nor have government policies served to clarify what constitutes acceptable standard setting behavior. One need only consider the National Technology Transfer and Advancement Act of 1995—legislation that, ironically, aimed to clarify the government's position regarding standardization.⁴⁴ Section 12d of the NTTAA codified OMB Circular A-119, which mandated the use of voluntary consensus standards "except where inconsistent with law or otherwise impractical" ("National Technology Transfer and Advancement Act of 1995," 1996). In addition, Section 4.a of the revised OMB Circular defines voluntary consensus standards as those that are developed through a process that entails 1) openness, 2) balance of interest, 3) due process, 4) an appeals process, and 5) consensus, defined as general agreement, but not necessarily unanimity ("OMB Circular A-119," 1998). However, while directing agencies to look towards these standards in their procuring technologies, the Circular maintains, "this policy does not establish

a preference among standards developed in the private sector." According to Section 4(B) of the Circular, other private sector standards include 'non-consensus standards,' 'industry standards,' 'company standards,' or 'de facto standards' and do not meet OMB's defining characteristics of 'openness' ("OMB Circular A-119," 1998).

The legislative history of the Act is equally ambiguous. Legislators equivocated in specifying which types of standards organizations qualified for procurement benefits under the Act. Thus, the role and nature of consortia was never addressed specifically. In fact, it appears that policymakers sought to avoid the issue all together. According to Representative Morella (R-MD), a major proponent, "We meant to cover only those standards which are developed through an open process in which all parties and experts have ample opportunity to participate in developing the consensus embodied in that standard ("Congressional Record - House," 1995). However, the Congresswoman later added, "We would expect government procurement of off-the-shelf commercial products to be exempted by regulation from any review under the act. We also do not intend through this section to limit the right of the government to write specifications for what the government needs to purchase" ("Congressional Record - House," 1995).

These unresolved issues have led to inconsistencies in the Act's implementation. Thus, in an apparent contradiction with a strict interpretation of the Act, government agencies must report their progress in adopting voluntary consensus standards to the National Institute of Standards and Technology (NIST). However, in the case of consortia standards, they are not required to do so. At the same time, the Act makes the National Institute of Standards and Technology responsible for coordinating federal agencies' adoption of voluntary standards. To this end, NIST has developed a special relationship with the American National Standards Institute (ANSI), an umbrella organization that represents US standards organizations in the international standards community. Together, NIST and ANSI have developed a National Standards Strategy designed to enhance US competitiveness by promoting a more unified national approach to standard setting. While acknowledging the contribution that consortia make to standards development, the National Standards Strategy diminishes their role by recommending that the US government encourage the use of standards approved through the ANSI accreditation process.

The Standards Development Organization Act of 2004 goes even further in differentiating between traditional standards development organizations and standards consortia. This Act amended the Cooperative Research Act of 1984, which set out safe harbors for collaborative research and production efforts, to include standards development activities that adhere to the openness and transparency requirements of OMB Circular A-119, which serve to define 'voluntary consensus' standards ("Standards Development Organization Act of 2004," 2004).

Thus, a major outstanding question is: What is the role of consortia in developing interoperability standards for the network economy? Certainly, the government recognizes the benefits to be derived from having timely standards that meet the rapidly changing needs of the market. Moreover, in passing the National Cooperative Research Act of 1984, which helped to spawn the advent of consortia, the intentionally fostered collaboration among firms for the purpose of promoting the research and development of innovative technologies. For consortia to

play their intended role, however, their appropriate place in the system must be more clearly defined. Absent such clarification, contests among standards settings organizations are likely to dissipate many of the public benefits associated with standards.

Social Dilemmas in an Evolving Complex Environment

Social dilemmas occur when the decisions of rational individuals give rise to suboptimal collective outcomes. In a complex, heterarchical system, such as standard setting, social dilemmas occur across two dimensions—the horizontal and the vertical. Thus, in setting standards policies—whether at the firm, field, or governmental level—these potential interactions must all be taken into account.

As we have seen during the industrial era, standard setting organizations solved their collective action problems by specializing along industry lines and by financing their operations through the sale of standards. In so doing, they not only generated prisoner dilemma problems among themselves, but their actions also gave rise to suboptimal outcomes both at the government and the firm levels. At the government level, contention among standards organizations led to incoherent standards and impeded government efforts to present a united front in international standards negotiations. At the same, the competition for standard sales diverted the attention of standards organizations from the needs of their members. The shift from traditional standards organization to consortia was one result.

In the networked economy, outcomes have likewise been complex, however in a different fashion. Responding to the inability of standards organizations to meet their business needs, firms—especially those in networked industries—turned to consortia. By converting standards from public goods to club goods, consortia served to overcome collective action problems. Firms paid to participate in consortia because they could reap exclusive benefits. However, given the relatively informal organizational structure of consortia as well as the asymmetries and interdependencies among their members, these organizations have been subject to prisoner's dilemma problems—especially with respect to intellectual property rights in standards. At the same time, the rise of consortia at the expense of traditional standard setting organizations has exacerbated power struggles within the standards community, increasing uncertainty as well as the incentives for opportunism. Rather than providing flexibility, ambiguities in government policies relating to the appropriate behavior of standards organizations have served to compound these social dilemmas.

Implications for Future Government Policy

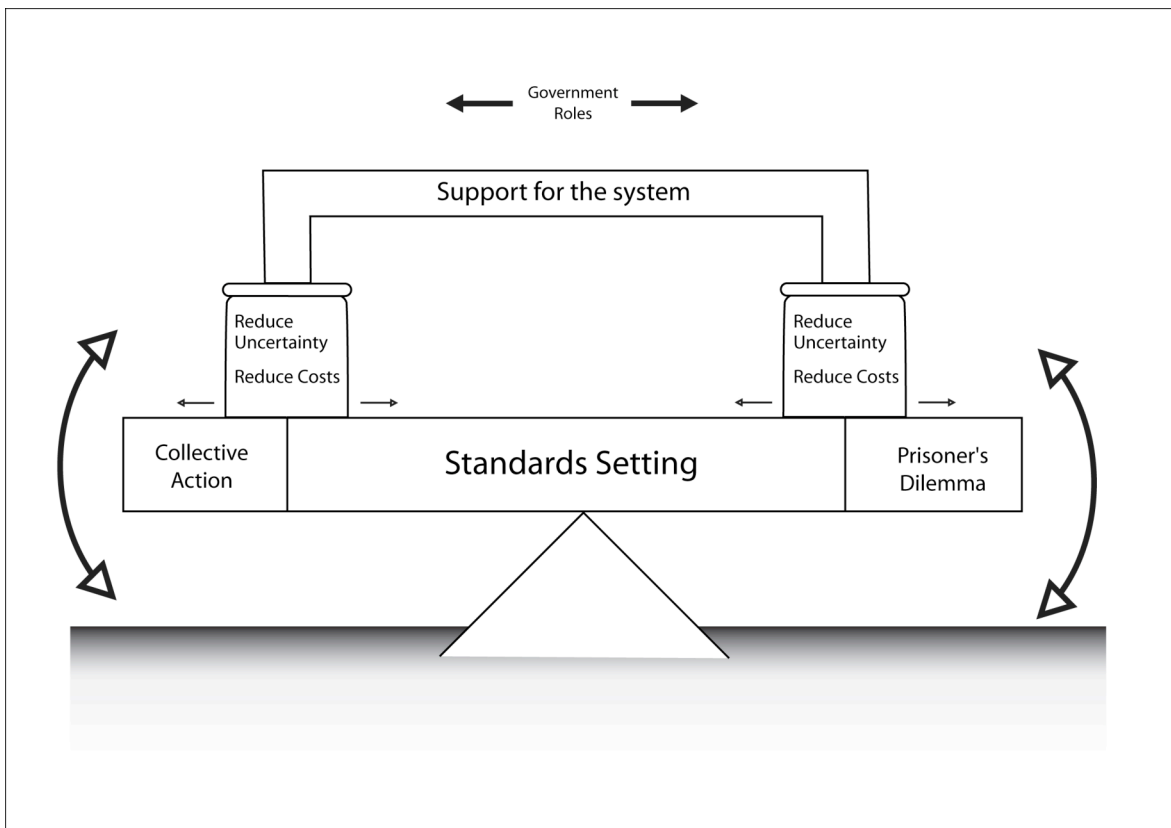
We have looked at the standard setting process from the industrial era to the networked economy, identifying the complex relationships between firms, government, and standard setting organizations. What are the implications of this analysis for future policy? Four major points stand out:

- The standards setting process is a complex system that links firms, standard setting organizations, and government both vertically and horizontally. Thus, whether the government plays a deliberate role or not, its action will have a definitive impact on the system.
- In an effort to influence standards outcomes, the government **need not set standards**. It can employ a number of different strategies, and assume a number of roles. For example, the government can act as rule maker, broker, or regulator, to name a few.

- The standard setting field is subject to major problems. In particular, given the asymmetries and interdependence among standards players, standard setting suffers from both collective action and prisoner’s dilemma problems.
- These two dilemmas are interdependent, especially in the networked economy. Thus, to be successful and to achieve a system-wide balance, government policies must address both of these problems at the same time.

Figure 2 depicts this situation. As can be seen, the problem of collective action is situated at one end of the policy seesaw and the prisoner’s dilemma is at the other. The weight at the center represents government policies that are applied simultaneously to reduce both uncertainty and the costs of organizing. The horizontal arrows indicate that by employing different roles, the government can adjust its policies to recalibrate the system and keep both dilemmas in check.

Figure 2: The Policy Seesaw



Design courtesy of L.A. King

Table 1 below depicts the relationship between government roles, policies, and standards dilemmas. While it is beyond the scope of this paper to analyze specific policy options, this list is intended to illustrate the type of policies that can reduce both prisoner’s dilemma and collective actions problems simultaneously.

Table 1: How Government Roles can Resolve Social Dilemmas

Role of Government	Prisoner’s Dilemma: reduce uncertainty	Collective Action: reduce costs
Rule Maker	Establishing clear intellectual property policies Establishing clear standards policies with respect to SSOs Establishing clear rules for access (i.e., reasonable and non-discriminatory licensing)	Establishing clear intellectual property policies Establishing clear standards policies with respect to SSOs Establishing clear rules for access (i.e., reasonable and non-discriminatory licensing)
Adjudicator/ Enforcer	Remove discretion from courts Promote consistency with respect to legal decisions	Remove discretion from courts Promote consistency with respect to legal decisions
Educator	Facilitate access to information with technology-based strategies (i.e., provide information on patent holders, patent policies, legal rights/ramifications) Reduce information asymmetry Reduce forum shopping	Facilitate access to information with technology-based strategies (i.e., provide information on patent holders, patent policies, legal rights/ramifications) Reduce information asymmetry Reduce forum shopping
Broker	NIST can broker the government’s relationship with all SSOs as a neutral party	NIST can broker the government’s relationship with all SSOs as a neutral party
Subsidizer	Provide benefits to consortia to increase transparency (i.e., subsidize education in standards, subsidize sale of standards, provide grants for research and development of standards, provide tax breaks/incentives to businesses that participate in	Provide benefits to consortia to increase transparency (i.e., subsidize education in standards, subsidize sale of standards, provide grants for research and development of standards, provide tax breaks/incentives to businesses that participate in

	open standards processes)	open standards processes)
Regulator	Regulate/mandate open standards	Regulate/mandate open standards
Consumer	Adopt only open standards Participate in open standards processes	Adopt only open standards Participate in open standards processes
Developer of Standards	X	X

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Endnotes

¹ One need only consider, for example, the role of language and simple gestures. Based on a common understanding, they provide the shared frame of reference and sense of reality required for intimate relationships and the establishment of common goals (Shutz, 1967). Moreover, cooperation among individuals engaged in interdependent activities is greatly facilitated when people do not act randomly, or on a trial and error basis, but rather when they conform to shared expectations embodied in socially constructed roles (Berger & Luckman, 1966).

² Product standards embody information. By specifying the characteristics of a product, they allow for product identification, interoperability, and quality control. In contrast, process standards facilitate and support socioeconomic transactions and interactions. They define roles and relationships, establish the rules for interpreting behavior, and specify the way in which a particular procedure or process is executed. Process standards are inherent in all social interactions (United States Congress Office of Technology Assessment, 1992).

³ As Kontopoulos points out, "All these constraints shape the stochastic history of material phenomena in a cascading pathway so that the end result is some sort of emergent hierarchy of

phenomenological levels populated by novel ‘structural’ entities which appear to us, at each focus level, as some kind of ‘individualities’” (Kontopoulos, 1993, 30).

⁴ In hierarchical networks, outcomes can be determined from the bottom up—in a ‘reductionist’ fashion, in which all the elements of the system are aggregated into higher-level structures. Alternatively, they can be determined from the top downwards, in a ‘holistic’ or transcendent fashion. When emergence is holistic, the ‘whole is greater than the sum of the parts’ (Kontopoulos, 1993).

⁵ According to Kontopoulos, “Any three contiguous levels of a level structure could be either nested or nonnested, where nesting implies successive, at least partial (if not complete) inclusion of lower levels into higher ones in the form of parts or wholes. However, in nonnested relations, there are no parts or whole relations across levels that make the structures of any particular level parts of the next high level, but wholes relative to the level below” (Kontopoulos, 1993, 52).

⁶ As Kontopoulos put it, in heterarchies, “. . . there is no single governance structure. To the contrary, various levels exert a determinate influence on each other in some particular respect. This is possible because the heterarchies involve multiple accesses, multiple linkages, and multiple determinations” (Kontopoulos, 1993, 55).

⁷ As Fligstein points out, “Markets (and this includes almost all modern production markets) are mainly structured by sellers looking for buyers. A given market becomes a ‘stable market’ (i.e., a field) when the product being exchanged has legitimacy with customers, and the suppliers of the good or service are able to produce a status hierarchy in which the largest suppliers dominate the market and are able to reproduce organizations to make the good and create social relations between competitors to govern competition” (Fligstein, 2001, 21).

⁸ As Schwartz characterizes this situation, “Challenges and incumbents share a common interest in preserving the field itself, even if they are sharply divided on how it is to be controlled” (Swartz, 1997).

⁹ As described by Wasserman and Faust, “The concept of network emphasizes the fact that each individual has ties to other individuals, each of whom in turn is tied to a few, some, or many others, and so on. The term social networks refers to the set of actors and the ties among them” (Wasserman & Faust, 1994, 9).

¹⁰ As Pierson notes: “In the context of complex social interdependence, new institutions and policies are costly to create and often generate learning effects, coordination effects, and adaptive expectations. Institutions and policies may encourage individuals and organizations to invest in specialized skills, deepen relationships with other individuals and organizations, and develop particular political and social identities. These activities increase the attractiveness of existing institutional arrangements relative to hypothetical alternatives. As social actors make commitments based on existing institutions and policies, their cost of exit from established arrangements generally rises dramatically” (Pierson, 2000, 259).

¹¹ As described by Cardoso and Levine, “At root the differences run deep, involving opposing judgments regarding the nature and ends of private interests, the meaning and the extent of the autonomy of persons, the nature of freedom implied in exchange contracts, the meaning and significance of public or collective life, and fundamentally, the kinds of bonds that connect persons into larger groups” (Caporaso & Levine, 1992).

¹² As Hodgson points out, “Given the potential variety of systemic combinations and the reality of path dependency and cumulative causation, an immense variety of institutions and forms are feasible” (Geoffrey M. Hodgson, 2001, 2).

¹³ A market failure here refers to the failure to achieve ‘Pareto optimality’. As described by Cornes and Sandler, “A position is said to be a Pareto optimum if it is impossible to improve the well-being of one individual without harming at least one other individual. To derive a Pareto-optimum position, one individual’s utility is maximized, subject to the constancy of the utility levels of the other individuals and subject to the relevant resource constraints” (Cornes & Sandler, 1986, 15).

¹⁴ Depending on the level of uncertainties, the size and scope of their activities, and the time frame involved, organized relationships can be governed in a variety of ways. For example, governance structures can take the form of narrowly focused contracts, loosely coupled strategic alliances, joint ventures with shared equity, or vertical integration. Likewise, they can vary with respect to command structure and authority systems, incentive systems, standards operating procedures, dispute resolution procedures and non-market pricing (Gulati & Singh, 1998, 792).

¹⁵ As noted by Nooteboom, Berger, and Noorderhaven, exchange relationships are also based on trust, which may “form part of the utility of a relationship . . . Social Exchange relies more on unspecified, implicit obligations, which depend on shared systems of meaning, belief and ethics, than on formal contracts” (Nooteboom, Berger, & Noorderhaven, 1997, 310).

¹⁶ A major concern relates to the unfair appropriation of rents. As Gulati and Singh note, “Such concerns arise from the uncertainties associated with future specifications, cost uncertainties, and problems in observing partners’ contributions, all of which aggravate the potential for moral hazards. Such appropriation concerns occur to varying degrees in most alliances” (Gulati & Singh, 1998, 788).

¹⁷ As described by Kollock, “Social dilemmas are situations in which individual rationality leads to collective irrationality. That is, individually reasonable behavior leads to situations in which everyone is worse off than they might have been otherwise” (Kollock, 1998, 183).

¹⁸ As Heckathorn points out, collective action is dynamic in nature, so that at different points within a cooperative framework actors face a different set of choices and costs and benefits. Strategies, so their behavior will like differ at different points in the process as well (Heckathorn, 1996).

¹⁹ As Kollock has pointed out, "A key characteristic of public goods dilemmas is the relationship between the level of resources contributed toward the production of a public good and the level of that public good that is provided. This relationship is known as the production function." As he notes, in any particular case, the outcome will depend on the shape of the production function. The production function may be downward sloping, linear, upward sloping, or it may exhibit a step-level function (Kollock, 1998, 188-189).

²⁰Characterizing the situations in which goods can be considered 'club goods,' Cornes and Sandler note that club goods will be provided when its efficient to provide an exclusion mechanisms, which might take the forms of a toll booth, guard, fence, ticket office, etc (Cornes & Sandler, 1986, 3).

²¹ As Nooteboom, Berger, and Nooderhaven point out, "Together it is the value of the partner and switching costs determining captiveness, or dependence, which provides the partner with an incentive to defect by taking advantage of it. But this advantages only works to the extent that dependence is asymmetric" (Nooteboom et al., 1997, 317).

²² As Miller he describes: "The costs associated with a solution. . . may be incurred by the time spent, the resources used in marshalling arguments, the hiring of an arbitrator to make an impartial decision, or the hiring of a lawyer to represent one's position before an arbitrator. The transaction costs associated with bargaining are essentially limitless" (Miller, 1998, 47).

²³ As characterized by Heckathorn, Collective action involves two distinct levels. Level one refers to personal contributions to produce the collective good. . . . Level two refers to what are termed 'second order collective goods' such as selective incentives to reward first-level cooperators or punish first-level defectors. As he notes, the intersection of these two situations give rise to additional actor strategies that again give rise to social dilemmas. Thus, for example, actors might refuse to contribute to the forming the governance structure, but act to compel others to do so. Or they might help to create the governance structure, but fail to support enforcement when the need arises" (Heckathorn, 1996, 243).

²³ As described by Jones, Hesterly and Borgatti: "Network governance is composed of autonomous firms that operate like a single entity in these tasks requiring joint activity; in other domains these firms often are fierce competitors. To enhance cooperation on shared tasks, the network form of governance relies more heavily on social coordination and control, such as occupational socialization, collective sanctions, and reputations, than on authority or legal recourse" (Jones, Hesterly, & Borgatti, 1997, 916).

²³ As described by Kollock, "If actors encounter each other repeatedly in a risky situation, reputation is likely to be an important concern, both in terms of establishing a particular reputation for oneself as well as making some judgments about the reputation of one's potential exchange partners" (Kollock, 1994, 320).

²⁴ As defined by Axelrod, "A norm exists in a given social setting to the extent that individuals usually act in a certain way and are often punished when seen not to be acting in this way" (R. Axelrod, 1986, 1097).

²⁶ As described by Kollock, "If actors encounter each other repeatedly in a risky situation, reputation is likely to be an important concern, both in terms of establishing a particular reputation for oneself as well as making some judgments about the reputation of one's potential exchange partners" (Kollock, 1994, 320).

²⁷ Explaining this phenomenon, Mantzavinos notes: "Whenever the exit costs of a certain situation are low, more available strategies will exist for anybody at any moment in time. Hence the discipline of reciprocity and the 'shadow of the future' is relatively low when anybody can easily stop dealing with a particular person and enter a relation with another" (Mantzavinos, 2001, 116).

²⁸ Generally speaking, demand for a new set of rules occurs at the point when private and social costs and benefits begin to diverge significantly. As described by North and Thomas, "It is the possibility of profits that cannot be captured within the existing arrangemental structure that leads to the formation of new (or mutation of old) institutional arrangements" (North & Thomas, 1973, 39).

²⁹ As Stone has described it, "Ideas are at the center of all political conflict Policy making, in turn, is a constant struggle over the criteria for classification, the boundaries of categories, and the definition of ideals that guide the way people behave" (Stone, 2002, 11).

³⁰ As characterized by Eggertsson, ". . . property rights define the opportunity set, the basic system of incentives, and the transaction costs associated with various investments" (Thrainn Eggertsson, "A Note on Economic Institutions," as cited by Alston, Eggertsson, & North, 1996, 8) .

³¹ There are two different ways to think about property rights, one economic and one legal. As described by Barzel, "One, primarily developed by Alchian and Cheung, is essentially the ability to enjoy a piece of property. The other, much more prevalent and much older, is essentially what the state assigns to a person." Both approaches can be reconciled by taking into account the fact that the more enforceable a right, the greater its value. Thus, even when actors can establish private contracts, they often seek to legitimate them by gaining government support (Barzel, 1997, 3).

³² As Williamson describes: "Chief among the other elements in the pattern of mass production is the principle of standardization. Stemming from the rudimentary division of labor, standardization involved the continuous pursuit, and progressive realization, of uniformity of the materials, operation and products of industry, which made possible the future subdivision and mechanism of labor. (H. F. Williamson, 1951, 722)

³³ As noted by Harold Williamson, "Chief among the other elements in the pattern of mass production is the principle of standardization. Stemming from the rudimentary division of labor, standardization involved the continuous pursuit, and progressive realization, of uniformity of the materials, operations and products of industry, which made possible the future subdivision and mechanization of labor" (H. F. Williamson, 1951, 722).

³⁴ No one understood the value of standardization better than Henry Ford, who in 1913, limited production at his Highland Park Plant to the standard, black Model T. Between 1914 and 1924, Ford produced more than 15,000,000 standardized Model Ts, the cost of which dropped during the same period from \$950 to \$240 (Giedion, 1948).

³⁵ The first American standards organization was the United States Pharmacopial Convention, which was set up in 1829 to establish uniform standards for drugs. The American Iron and Steel Institute, established in 1855, was the first trade association to develop standards. The American Society of Civil Engineers, which was formed in 1852, was the first scientific and technical society involved in standards development (United States Congress Office of Technology Assessment, 1992).

³⁶ As described by OTA, “Unresolved disputes and disagreements not only distract from the main purposes of setting standards; they also undermine the legitimacy of the system, both in the opinion of its members as well as in the eyes of the rest of the world. . . . Paralleling the lack of unity in the private sector standards community is a lack of coordination and policy making at the Federal level. While this is not a new problem, its consequences will be more serious in the future” (United States Congress Office of Technology Assessment, 1992, 12, 15).

³⁷ The legislation not only protected against misbranding and food adulteration; it also standardized containers for marketing fruits and vegetables, thereby eliminating false measurements and deceptive shapes.

³⁸ Writing in 1928, Van Schaack described the growing impetus for safety standards: “It was only natural that the astonishing progress in machine production which had placed the United States in the forefront of industrial nations should direct its attention to the human waste accompanying it. . . . This waste made its first appeal to the moral sense, but this was soon supplemented by a steadily increasing belief that accidents in industry have more than a humanitarian aspect—that they have such an impact on production that they must be taken into consideration from an economic point of view” (Van Schaack, 1928, 70).

³⁹ Thus, for example, according to Philip Bond, Undersecretary for Technology at the US Department of Commerce, standards now directly affect approximately 80 percent of global commodity trade (Bond, 2004).

⁴⁰ As Farrell and Saloner point out, “Excess inertia arises when not enough users are willing to go out on a limb by adopting the new technology. This is most likely when network externalities are strong and there is a great deal of uncertainty about whether a lead would be followed.” At the same time, because networking technologies exhibit increasing returns to adoption, the wrong standard might be chosen, if users—not wanting to be left off the network—rush too quickly to jump on the bandwagon (Farrell & Saloner, 1987, 11).

⁴¹ As Ring and Ven point out, this uncertainty stems from commercial risk (the probabilities of finding and appropriate niche in the market), technological risk (the probability of bringing a specific technology to market) corporate risk (the probability a correctly ascertaining growth projections and costs), and corporate strategy risks (the probability of anticipating the appropriate strategic partners (Ring & Van de Ven, 1992).

⁴² As Andrew Updegrave stated, “even Rambus thought it had engaged in ‘egregious behavior’” (Hyman, 2003).

⁴³ See, for example, *Society of Mechanical Engineers, Inc. v. Hydrolevel Corp.*, 1982, and *Clamp-All Corporation v. Cast Iron Soil Pipe Institute, et al.*, 1988.

⁴⁴ The 1982 version of OMB Circular A-119 called for the use of voluntary standards, but it lacked enforcement mechanisms. As revised in 1998, agencies were required to report on their progress in adopting voluntary consensus standards. Its codification in law put some teeth into this requirement (Gonzalez, 2004).