ABSTRACT
New information technologies have created new possibilities in resolving long-standing debates in social organization. The debates involving buying versus leasing, business versus government, and markets versus hierarchies captured intellectual imagination, and dominated public consciousness for centuries. All of these debates involve a dichotomy of stability versus flexibility. Three sets of new information technologies have the potential to resolve these debates through new design architectures for social institutions that combine the advantages of both extremes without the disadvantages of either. The technologies are electronic services, service semantics, and ontologies, sensors and sensor networks, and modular design and virtual organization. The resulting architecture is a multi-dimensional and inter-organizational hierarchy, with machine-readable and machine searchable semantics for components, with a modular design that contains compatible and substitutable components at all levels, and with organizational components that are automatically tracked, measured, and evaluated against detailed inter-organizational constraints, plans, and goals.
1. Social Institutions

Social institutions are critical to social organization and stability. Governments, businesses, markets, military, schools, hospitals, families, and churches are all complex institutions providing a multitude of services through an elaborate system of social organization. These institutions are designed to provide specific services to their constituencies by acquiring resources, by converting those resources to services, and by maintaining a permanent bureaucracy to execute the creation and delivery of those services [8, 15]. Despite the complexity and diversity of these institutions, it is possible to identify three fundamental problems that are common to all of them:

a. Ownership of resources is absolute, with little or no sharing among institutions. Institutions typically own their resources, and have unlimited use rights over them. Ownership leads to overuse of resources because the payments are largely independent of usage. Ownership also overly restricts access to resources since those with small needs cannot justify the large fixed payments.

b. Membership in institutions is absolute, with little or no partial membership. Members typically either belong to an institution and have the full privileges of membership, or do not belong and have none of the privileges. Absolute membership leads to over-commitment to the institution because of the high cost of leaving the complete bundle; and it leads to underutilization of institutions because of the high cost of accepting and paying for the complete bundle.

c. Conversion of resources to services follows fixed rules and requires a permanent bureaucracy. Fixed rules and permanent bureaucracies reduce transaction costs and produce efficient operations, but they also lead to stagnant and unresponsive organizations, both because of over-commitment to the existing structures, and also because of conflicts between the goals of the institution and the self interest of the bureaucracy [12, 15].

New information technologies have created new possibilities to solve these long-standing problems in creative ways. It is now possible to have an ownership mechanism that is not absolute where
institutions and even individuals can share resources with others. They would have limited rights over resources to produce and use specific services, as opposed to unlimited rights of usage. It is now possible to have a membership mechanism that is not absolute where members can belong to institutions partially and conditionally. They would have limited rights and responsibilities within the institution, and could change their commitments dynamically and partially, as opposed to long-term, fixed, and total commitments. It is now possible to have institutional bureaucracies and management that are not fixed and permanent, but flexible and dynamic. They would be constituted from existing components, both inside and outside the organization, at the time of need, and to generate specific services; and they would be dissolved into their basic components immediately after the services are delivered. These possibilities require dynamic institutions where ownership, membership, and management are fluid, conditional, partial, and flexible. Such flexibility and dynamism have only become possible with new information technologies such as electronic services, service semantics, ontologies, sensors, and sensor networks.

Such flexibility also requires new organizational forms such as modular design and virtual organizations which are themselves made possible by these new information technologies [16, 20].

2. Ownership of Resources

Ownership of resources leads to overuse of those resources by the owners, and underutilization of those resources by the others. Consider a small farm that owns and maintains a tractor. The marginal cost of use is small, since most of the cost is upfront in the purchase price, and part of the cost of operating the tractor, such as the pollution generated and the wear and tear on the roads, are born by others. The tractor would be overused since most of the cost is either fixed or external to the owner, and hence the marginal cost of use does not reflect the total cost to the society. On the other hand, not enough tractors would be sold because many small farmers cannot justify the initial cost of purchase for the need they have. This is an inefficient market without a mechanism for adequate sharing of the resource [2, 7].
Large capital investments often have this characteristic, and can lead to many unintended and undesirable consequences. Consider farm equipment such as tomato harvesters, cherry pickers, or grain harvesters. They are expensive capital equipment, but acquiring them can confer a significant cost advantage over human labor. Yet, the cost advantage can only be realized by large farms that can utilize the equipment fully. They are beyond the reach of small farms, yet create great cost advantages for the larger farms. Consequently, the average size of a farm rose significantly since the industrial revolution to take advantage of these technologies with numerous unintended consequences. Large farms had to transport their products over large distances, creating negative environmental impact; they had to pick their products earlier, before ripening, resulting in deterioration of product quality; they had to genetically modify their products to withstand transportation, resulting in a reduction of emphasis on nutritional value; they had to import labor over large distances, resulting in social upheaval, migrant labor, and illegal immigration [2, 8].

The problem is not limited to business ventures. Consider a lake owned collectively by a town. The town charges a license fee for fishing in the lake, which entitles the licensees to unlimited fishing. Once the license fee is paid, the licensees have an incentive to maximize their fish intake. The marginal cost of fishing is low with modern fishing gear, and the cost to the ecology of the lake is mostly born by others. Such license fees lead to overutilization by some, and underutilization by others with minimal need for fish, because their needs do not justify the license fee. There are many examples of this problem in forestry and mining in state-owned lands.

The problem arises from the ownership of resources that confers unlimited use rights to the owners. Alternatively, sharing of resources can confer a finer granularity of rights to services derived from those shared resources. Such a service orientation would calibrate the payments to use, and lead to a more socially desirable solution. Yet, a service based economy is complex for three major reasons:
a. Services are difficult to describe unambiguously for the marketplace, and locate correctly when needed, as compared to goods.
b. Service consumption levels are difficult to track compared to tracking ownership of goods.
c. Services are difficult to bundle and unbundle, standardize, deliver, exchange, and transact with, as compared to goods [22]

New information technologies offer feasible solutions to these problems while maintaining the advantages of ownership. Unfortunately, these solutions are not trivial, but involve complex collections of technologies and their novel applications, leading to new ways of organizing social institutions. One cannot achieve these solutions by merely accepting technologies as given, and trying to manage their social implications. Instead one has to ask whether the social welfare can be improved by redesigning and redeploying technologies, and reorganizing and restructuring social institutions. These are not descriptive questions that can be answered empirically with historical data, but they are normative questions that require design and experimentation.

The first set of technologies is service semantics and ontologies. They make it possible to describe goods and services unambiguously, and place them in central repositories for efficient search and retrieval. Complex services can be described both in terms of their own attributes, but also in terms of the tasks and goals they can satisfy. Such elaborate descriptions can be placed in ontologies to provide context, and also to attach constraints to them to further delineate when they are valid. For example, the services of a grain harvester would be described not only in terms of its size, power, and fuel efficiency, but also in terms of the types and quantities it can harvest, appropriate weather conditions for its operations, the maturity of the crops it can handle and the time frame for harvesting, all captured as attributes and constraints, and placed in context by various ontologies. In this environment, farms would describe their harvesting needs, including the timing, labor, and budget constraints, and the type and quality of crops, as service needs in centralized directories. Those with complementary needs would join
together and cooperate, at the time of need, to share the services of a collectively owned harvester. The sharing would be automatically coordinated through electronic marketplaces [3].

The second set of technologies is sensors and sensor networks. They track and measure service usage. Sensor technologies developed over the last decade have not only improved in efficiency, size, and survivability, but also in their ability to communicate wirelessly over peer-to-peer networks and base stations. The sensors placed in heavy agricultural equipment, for example, can track and report not only usage, but also the environment, lighting, weather conditions, type of activity, and crops and operators involved in great detail. In this environment, sensors can track and meter usage to enforce contracts of usage. They can also track the equipment, its status, its maintenance needs, and its ability to meet its expected service requirements [5].

Third set of technologies is modular design and virtual organization. They make it possible to combine services dynamically to meet specific service needs on demand. Components are described unambiguously, and in a machine-understandable format to combine them in real time to create new services. A human-machine system verifies the compatibility of components, computes their combined contributions, and assigns them dynamically to the required services. For example, harvesting equipment, human operators, transportation, maintenance, and repair services have to be coordinated to provide harvesting services at the right time and place to all participants. Such dynamic bundling of services would require a component-based design to maximize the sharing of components. It would require many intermediaries and electronic markets to combine and match the components, to reduce transaction costs, and to provide trust, insurance, and guarantees. It would require a hierarchy of intermediaries where higher-level long-standing intermediaries would oversee and guarantee the more ephemeral lower-level intermediaries and services [26].

In this new environment, the classic distinction between ownership and renting begins to disappear. Ownership involves payment for the rights to a resource for unlimited use. Renting involves
payment for the actual usage of a resource. A service orientation with shared resources is a compromise that begins to blur the distinction. Shared ownership gives rights to the future use of a resource as in ownership, however not for unlimited use, but only for pre-specified services. Shared ownership levies charges for the use of resources as in rental, however not for the actual use, but for the rights to anticipated future use. Shared ownership is complex and information intensive. Unlike sole ownership, there is no single owner to optimize the use of the resource, and unlike rental, there is no investor who collects rent and schedules the use of the resource to maximize rent, but the owners have to collectively decide on the optimal use. But there are many advantages: Compared to sole ownership, shared ownership eliminates the problem of over-commitment by distributing the use of a resource over many owners; and it reduces the problem of idle time by smoothing out the fluctuations in demand over many users. Compared to renting, shared ownership eliminates the need for a risk-taking intermediary by distributing risk over many owners; and it reduces the high transaction costs caused by many small rental contracts with unknown customers, by replacing them with an ongoing community relationship among the shared owners [17].

3. Membership in Institutions

Membership in institutions leads to over-commitment to the institution by members, and underutilization of the institution by non-members. Consider a nation-state. Its citizens are mostly born to that state, and for most of them, changing their citizenship is not a feasible option. For the few that who have that option, it is a very costly and traumatic experience. The citizens often disagree with the specific policies of the state, but they don’t typically have the ability to exit the state, or even to exclude themselves from those specific policies. Instead, they are forced to take political action and forge alliances with others in an attempt to influence those policies. Such political action is costly; it often leads to compromise solutions that may not fully satisfy any of the citizens; and sometimes it leads to protracted conflict and war to the detriment of all involved. Such over-commitment to institutions is not efficient, because it does not allow orderly exit, and certainly not partial exit, but only dissent within the
institution. Conversely, it leads to under-utilization by outsiders, and further inefficiency, because it does not allow orderly entry into the institution, and certainly not partial entry for only specific services and policies, except at a very high cost of renouncing previous allegiances and memberships[10].

Consider the American Civil War. The conflict over slavery and the impact of the Southern plantation economy on the Northern family-farm economy left only two options: either a complete disintegration of the union, or a protracted debate, conflict, and war to settle the dispute. There was no mechanism for some states to partially exit the union, and adopt incrementally different legal systems, yet stay in the union for other economic and military purposes within a larger legal framework. Such a multi-level system would be more complex than the existing federal system. It would have required long-term commitments and time-tables for increasing the rights of slaves; and it would have required a compensation mechanism to abate the negative impact of the southern plantation economy on the northern family-farm economy. Such a complex system was neither feasible nor enforceable with the existing technologies and the social institutions of the time. The critical question is whether such a system can be designed and implemented with the current information technologies, and the more flexible social institutions they enable [21].

The problem of over-commitment is not limited to governments. Consider churches. One is often born into one, and few people ever change their religion. Any change is costly and often traumatic, since it requires total repudiation of the old, and adopting a completely new religion. The alternative is to try to influence the undesirable policies through political action and organization, which is also costly, time consuming, and rarely successful without a major political struggle. There are similar problems in all social institutions ranging from universities and political parties to families and social clubs [13].

The problem arises from the rigidity of the social institutions. Institutions are large collections of services. Their members are entitled to all of these services; and non-members are entitled to none. Such rigid boundaries lead to inefficient and inflexible institutions, because of over-commitment by those inside, and under-commitment by those outside the institution. A more flexible, partial, and transient membership system would enable different members to subscribe to different services of the institution,
but leave others. Such partial and dynamic engagement in an institution allows members to vote with their feet for various services, and impact change in the institution without extensive political struggle. It also allows outsiders to incrementally join in and try out various components, reducing the cost and risk of entry. Yet, such flexibility is complex, information intensive, and difficult to manage. There are three major reasons for the difficulty of creating and maintaining such flexible institutions.

a. Institutions are large bundles of services, and they create great efficiency in search and description by treating the large bundle as a single unit. Members join institutions on the basis of abstract and high-level descriptions, such as lifestyles, careers, moral principles, religious tenets, national identity, or family ties, which allow institutions to bundle a large number of services efficiently under a parsimonious description, both concurrently and over time. Defining an institution as a collection of services, each with its own description, and searching and comparing institutions on the basis of such service descriptions is likely to be combinatorially complex. A nation-state for example is often described in terms of shared history and ideals. Describing it as a collection of security, infrastructure, and welfare services would be unwieldy.

b. Members are often entitled to all services of the institution. That keeps the transaction costs very low, since tracking and measuring usage is not necessary. Unbundling the services of an institution and measuring usage of individual services is likely to be prohibitively expensive, especially when the bundles are large, and contain some public services that are difficult to measure. Citizenship in a state for example entitles one to all the privileges of citizenship over generations. Unbundling and metering usage of the services of security, infrastructure, and welfare services would be difficult.

c. Exit from institutions is difficult, and sometimes impossible, leading to long-term stability in membership. Such stability allows long-term planning and continuity; creation of community, culture and identity; and the possibility of short-term sacrifice with the expectation of long-term benefits. Easy exit creates opportunities for the members to time their entry and exit, to exploit the institution for short-term benefit; and it makes it difficult to do long-term planning. For example, changing one's citizenship is extremely difficult. That allows governments to make multi-generational plans and
long-term investments; and it allows individuals to make great sacrifices for their country, knowing that their fellow citizens are not likely to abandon them when reciprocation is needed [9].

New information technologies created the possibility of novel institutional design architectures that maintain the advantages of social institutions without the disadvantages of absolute, permanent, and unconditional membership. The first set of tools is service semantics and ontologies that describe institutions as collections of services in machine-understandable form, and place those descriptions in central directories for automated search and retrieval. For example, a government is described not as a series of myths and ideals based on history, race, law, and geography, but as a collection of services involving security, infrastructure, environment, and social welfare, each with machine understandable semantics. Search and comparison is further facilitated by forming multi-level aggregates of services, and describing aggregates similarly, and from multiple perspectives, by placing them in multi-dimensional ontologies. In such a design, a government agency would be described from multiple perspectives, as a collection of services, a set of goals and ideals, a history of accomplishments, a legal framework that controls its behavior, a target constituency whose interests it serves, and a set of problems it attempts to solve under a set of constraints. Each of these perspectives constitutes a separate dimension of a multi-dimensional ontology for automated search; and each is placed in a hierarchical structure with respect to its type and its components [19].

The second set of tools is sensors and sensor networks. They allow tracking of members, their changing needs, and their usage of services. Such sensor data are collected, recorded and analyzed to match services to members, to create new services and to modify the existing ones dynamically to meet changing needs, and to enforce constraints on service availability and usage. Automating these functions allows members to subscribe to services either individually, or in aggregate on the basis of goals and plans, at a low transaction cost, since the subscriptions can be fulfilled, adjusted, and enforced automatically, alleviating the need to entitle all members to all services. In such a design, a government agency is not only a dynamic collection of services, but it is also a sensor network that constantly observes the changing needs of its citizens to adjust and modify those services, and tracks
the usage of those services to enforce various limits and restrictions on those services. In such an environment, citizens and groups are allocated specific service levels, and they are constrained and tracked in their usage of public goods and services, as in environmental limits, pollution control, highway congestion, fishing, forestry, and water usage. "Cap and trade" pollution control systems are typical examples of such systems [5].

The third set of tools is modular design and virtual organization. These tools dynamically aggregate members into a multi-level hierarchy of communities to meet their diverse needs. Such a hierarchical structure allows partial membership in institutions, with complex and conditional contracts, by mixing, matching, and bundling communities. Higher-level communities are composed from lower-level communities, often dynamically, to meet the diverse and varying needs of members efficiently. High-level communities get into long-term and large-scale contracts, which support the small and transient transactions of lower-level communities, by providing trust, insurance, and bundling services to them. Consider a state higher-education community. Members can take courses and attend lectures in a variety of colleges within the state, by dynamically mixing and matching the offerings from multiple schools. A high-level contract with the state higher-education community entitles a student to a variety of courses and activities throughout the state; and it keeps track of her record and confers and aggregate degree or certificate on the basis of many small and transient transactions with many colleges. The student can enter and exit various colleges with great ease, giving her the flexibility to bundle the services of many colleges to fit her needs, while voting with her feet for or against various services by merely using them. The student pays a single membership fee to the community for a bundle of services from many colleges, and the community makes transfer payments to each college on the basis of services rendered. Such aggregate transactions reduce transaction costs greatly, while providing trust and insurance for the small individual transactions. The colleges can also take advantage of the flexibility, and specialize narrowly in their areas of competitive advantage, while taking advantage of services from other colleges to supplement their offerings. They can dynamically combine offerings from various colleges to build new
concentrations, degree programs, or research centers with little effort. More importantly, a variety of larger communities can be built from existing communities, and individuals can join communities at various levels of aggregation, which entitles them to the corresponding aggregations of services. The new communities can be built automatically from machine-readable semantic descriptions, leading to a very dynamic environment of many virtual communities [1, 4].

In this environment, the fundamental distinction between government and business begins to disappear, potentially ending one of the most intense political disputes in human history. Governments are characterized by public decision making, collective purchase of services, with each citizen paying for public services according to his ability, and each citizen using those public services according to his need. Businesses are characterized by private decision making, individual purchase of private services, and each person paying for services per usage. When citizens can subscribe to some government services and reject others, they are treating government more like a business to deliver some services in exchange for payment. Every citizen still pays according to his ability, but has the power to allocate his taxes to the services he approves, either through explicit subscriptions or through tracking of usage. Keeping track of subscriptions and usage, using those data for automatic evaluation of government services, and redistributing tax dollars accordingly among various services, all have the effect of government acting like a business. A government welfare system for example, becomes more like a private charity when individual taxpayers can pick and choose the programs they would like to support. Given the popularity of private charities compared to government welfare programs, such convergence of the two may actually increase participation in government, and increase tax revenues. Similarly, when consumers and businesses form communities, and purchase goods and services collectively, they are acting more like a government acquiring and delivering services according to need. Members still have the option of leaving the community, but while they are in it, they operate communally and for the collective interest. Unlike a business, their primary concern is not private profit seeking, but serving the collective needs of their members. They can band together and bargain more effectively; they can inform themselves better about products and
services eliminating information asymmetry; and they can provide support and insurance to their members in distress; all with the effect of consumers and businesses acting more like a government. For example, a community of citizens can acquire medical services from a variety of hospitals, physicians, laboratories, and pharmacies, and provide them to its members collectively, assisting its members in the bargaining, search, selection, evaluation, and insurance for various medical services. This is similar to what large employers often currently do for their employees, and also similar to the community insurance program currently under consideration by the US Congress.

4. **Organization Design**

Organizations are designed and structured to convert resources to goods and services. They often lead to over-commitment to the existing structures by their bureaucracies and under-utilization of the organization by the society in general. Consider a church. It is run by a permanent bureaucracy which is committed to its basic tenets, principles, and structures, and has a stake in maintaining them. It is very difficult to change the basic tenets or the structure of a church without an extended and traumatic political struggle, although disagreements are common. It is also difficult to establish a new church, since it takes a complex structure and a dedicated bureaucracy to run a church efficiently; and hence it would require attracting away much talent from existing churches in the form of organizational, intellectual, and charismatic skills. Such over-commitment to existing structures and principles is inefficient since it does not foster adjustment to changing conditions, without creating a completely new organization, or without an extended political struggle. It certainly does not allow experimenting with parts of the organization, while keeping fixed the remaining parts. Conversely, the society underutilizes churches as an agent of social change, since they are difficult to establish and keep current.

The problem is not limited to non-profit organizations. Consider a stock exchange. It is run by a professional cadre of managers, dealers and brokers, and they have a stake in maintaining the existing structure. Technologies such as automated online exchanges with full transparency threaten their
privileges, and are not likely to be adopted. New exchanges such as Electronic Communication networks (ECN) on the other hand have great difficulty attracting a critical mass and liquidity, since markets have network effects and economies of scale that limit the number of markets an economy can sustain. The only feasible alternative is a protracted political struggle inside the organization to effect change.

The problem arises from over-commitment to existing structures by the organizational bureaucracies. Bureaucracies are created and heavily structured for efficient operation, yet such rigid structures preclude fast adaptation and experimentation. Any experimentation has to be done by outsiders in new organizations, or it requires extensive debate and political struggle to limit the harm to the bureaucracy. A more flexible organization would enable parallel bureaucracies where the employees can easily move between them without disrupting the organization. Such flexible bureaucracies can be viewed as multiple organizations that are running in parallel, with minor differences among them, where the bulk of their structures are shared. It would allow employees to vote with their feet by easily moving between alternative structures, and impact change in the organization without extensive political struggle. It would also allow organizations to outsource components, or combine components from other organizations to build new components, thereby reducing the risk of experimentation and the cost of entry for new organizations. Yet, such flexibility is complex, information intensive, and difficult to manage for three major reasons:

a. Rigid hierarchical structures allow simple descriptions of organizational roles and jobs. Disaggregating a role description into a collection of services, each with alternatives, in a multidimensional hierarchy, would be tedious. Each employee would have to learn many service descriptions, in multiple versions, and constantly choose among the alternatives to incrementally improve the organization. For example a simple job description of an associate dean in a university would be converted to a collection of hundreds of services and their alternatives.
b. As employees switch between alternative ways of performing their tasks, compatibility with other tasks has to be maintained. Unambiguous descriptions and substitutability of alternatives require a complex infrastructure. For example, when a stock exchange experiments with remote online trading, the floor trading services would be disrupted without a complex infrastructure that integrates the two seamlessly.

c. Constant experimentation makes it difficult to optimize operations. It also creates opportunities for some to exploit the constantly changing system. For example, a university that is constantly experimenting with new courses may find it difficult to avoid duplication, or to ensure that all prerequisites for graduation have been met. Some students may exploit the experiments to avoid difficult courses [6, 16].

New information technologies have created the possibility of new organizational architectures that maintain the advantages of a stable structure without the disadvantages of inflexibility and non-responsiveness. The first set of tools is service semantics and ontologies, which describe jobs and tasks unambiguously as collections of services. Alternatives to each service both within and outside the organization are described similarly, and such a combined structure allows employees to move between alternatives with ease. Comparison of services is facilitated by placing these descriptions in ontologies, and enhancing them with third-party evaluations. Search is facilitated by placing these descriptions in machine-readable centralized directories, and also bundling them into aggregate services each with its own semantic description. For example, a university would be described in terms of courses, lectures, research centers, dormitories, and athletic facilities, with explicit comparisons to alternatives. Aggregate services such as degrees, educational goals, and athletic programs would be placed in multi-dimensional ontologies and described in terms of the careers supported, jobs offered, and long term earning statistics.

The second set of tools is sensors and sensor networks, both human and machine. They allow tracking of organizational processes and employee performance. Such sensor data are collected,
recorded, and analyzed to help employees decide dynamically among various alternative processes. A university for example may offer various versions of the same course, some within the university and some outside, and track the performance of the courses and provide real time feedback to the instructors, as well as students and administrators. One can imagine alternative course sequences as requirements for the same degree, and subsequent tracking of the professional performance of the graduates, to assess and evaluate the alternatives on an ongoing basis, and consequently to assist the individual students and faculty in choosing among the alternatives [25].

The third set of tools is modular design and virtual organization. These tools aggregate organizational components into a multidimensional hierarchy, where alternative hierarchies exist side by side, and lateral movement between hierarchies is common. The nodes may share some of their components with their siblings, leading to a lattice structure where a component node may have multiple parents. Such an organizational hierarchy is characterized by many sibling nodes that are slight variations of each other, due to sharing most of their sub-components. Such alternative nodes may reside in different organizations leading to a virtual organization where components are shared between organizations. The nodes can change their composition with ease by replacing some of their sub-components with alternatives available inside or outside the organization; and new higher-level nodes can be composed with ease from existing components both inside and outside the organization. For example, a course module can be shared between universities to build slight variations of the same course; the instructors can combine modules provided by various other universities to build a virtual course; the instructors can switch dynamically between alternative modules, constantly voting with their feet for or against various versions of the same course; all the while staying within the larger structure that encompasses all the universities involved [20].

In this environment, the classic distinction between markets and hierarchies begins to disappear. Hierarchies behave more like markets, when each component may be a part of many super-components and can switch its membership dynamically among them; and similarly when each component can dynamically change its composition by switching between various alternative sub-
components available from lower levels. Such dynamic coupling and decoupling is a characteristic of markets, not hierarchies. Markets behave more like hierarchies when the components from other organizations are tightly integrated into an organizational hierarchy, and operate as part of that organization under complex constraints, targets, plans, and goals that are automatically enforced. Such tight integration of components is a hallmark of hierarchies, not markets. Eliminating the sharp distinction between markets and hierarchies has the potential to reap the benefits of both: the stability and reliability of hierarchies, and the dynamism and responsiveness of markets. This is only possible by making hierarchies more dynamic with shared and alternative components, and making markets more stable by tightly integrating components into multiple organizational structures through inter-organizational constraints, plans, goals, and standards, and inter-organizational performance monitoring [9, 14].

5. Conclusions

Social institutions are critical to social organization and stability. Yet, they suffer from great inflexibility in a rapidly changing world, and become obsolete at an increasing rate. This dichotomy between stability and flexibility has been an enduring debate among social scientists. The complex choice between buying and leasing of resources, the long-standing controversy between government and business; and the classic debate between markets and hierarchies are all examples of this dichotomy. In all such dichotomies, both solutions have advantages and disadvantages, yet compromise solutions retaining the advantages of both are not feasible, leading to protracted philosophical debates. New information technologies created new possibilities in resolving these long-standing conflicts. Semantics and ontologies created tools to effectively describe and search resources, people, and organizational processes; sensors and sensor networks created tools for tracking and controlling them according to pre-established criteria; and modular design and virtual organization created tools to dynamically combine or replace components of resources, people and organizational processes to build new components. The effective combination of all these tools creates new design opportunities where the distinctions between buying and leasing, governments and business, and
markets and hierarchies begin to disappear. Compromise solutions that maintain the advantages of both, without the disadvantages of either become feasible through extensive automation and flexible structures. Components are described unambiguously and their descriptions are placed in machine-readable ontologies. Sensor networks employing both human and machine components track resources, people, and processes, and automatically enforce inter-organizational constraints and goals. Multidimensional hierarchies maintain multiple inter-organizational hierarchies simultaneously, usually as a lattice, where each component may have multiple parent nodes, and each component may share some of its sub-components with many other nodes, leading to very flexible structures at one level, that remain stable at a different level. The detailed implementation and optimization of these structures in a variety of contexts require much future work.

BIBLIOGRAPHY


