



The Architecture of Enterprise

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In the words of Lawrence Lessig, professor of constitutional law at Stanford University, “architectures allow.”¹ He was speaking ostensibly of challenges faced by legal frameworks that allow or encourage openness and innovation in the end-to-end architecture of the Internet, or more generally, in the virtual spaces we call *cyberspace*. But the term is no less relevant to more traditional architectures, those of buildings, transportation systems, social systems, and the infrastructures that underwrite institutions of government and economy. This brief paper outlines the *architecture of enterprise*, operational frameworks that encourage innovation and growth in commerce. Such architectures are in contrast to enterprise frameworks that are closed, benign, or worse, that discourage innovation through legal, proprietary, predatory, or repressive practices.

Innovation is a driver of growth. In the development of technology, commerce and government, and in the development of life within our biosphere, growth is a necessary component of *viability*, a gradient along which adaptation takes place. And viability is an obviously necessary property of sustainable, conscious systems (whether real or virtual) immersed within evolving contexts. Adaptability, in turn, requires that viable systems be reactive, responsive to both internal and external stimuli, and aware enough to assimilate their unfolding experiences into knowledge (policies) and processes (mechanisms) that keep them in dynamic (homeostatic) equilibrium with their surroundings. This balance, this dance, this ability to perceive and selectively evolve, and the agility exhibited during such exchanges, is essential to a system’s survivability.

Enterprise, whether governmental or commercial, biological or mechanical, whether focused on political, social or technical matters, must clearly be a dynamical system in order to offer and promote a useful value proposition to its clients. This value must be sustainable, depending in no small measure on the enterprise’s agility in adapting to forces exerted by environmental (e.g., financial, technical, competitive) pressures. A true measure, therefore, of appropriate enterprise architecture is its capability to exhibit sustainable value under such dynamic forces.

The architecture of a system therefore can be defined by specifying of its dynamic *structure*, its value-adding *functions*, and its *performance* characteristics. Structural properties include its static and dynamic organization. Its functions are those services which the enterprise exists to provide its clients, both internal and external. And its performance characteristics are the objective measures by which it and others gauge its viability. The operating domain defined by an architecture “allows” the system to be viable, to evolve, and to sustain its principal value propositions – to develop and sustain its contributions to the community in which it is immersed. Architecture in and of itself does not guarantee viability. It only enables it.

¹ Lessig, Lawrence; *Code and Other Laws of Cyberspace*, Basic Books, 1999



The notion that systems must grow (expand, evolve, adapt, create, sustain) in order to survive is key to the argument that viable systems must be *open* to information and energy flows, out of and in to their containing environments. With an appropriate energy budget, information becomes a catalyst that, depending on the state of dynamic equilibrium of the system, may push it into new (improved or higher) states of equilibrium. Such changes in state constitute positive growth when one or more value propositions are enhanced, and constitute a step toward extinction when one or more value propositions are diminished.

Thus, strategic goals of a viable enterprise include remaining open to information flow and using resources efficiently in order to evolve along lines of increasing value. Not unilaterally or selfishly, however. Expansion assumes that the community of enterprise is freely associative, and elastic. Information and resources are shared among entities with “common cause” on behalf of their mutually enlightened self-interests. Effective enterprise architecture provides a platform for creative behaviors individually and in associations in the same sense the Internet architecture enables connectivity and information exchange among interdependent entities.

Viability in open, free market environments has other important determinants. As mentioned, enterprises do not operate alone. They are members of communities of interest, or common cause, where growth is sustained by both competitive and cooperative behavior, by individuals and the community as a whole. In today’s business climate, cooperation is increasingly required to sustain growth factors of 10% or more. This growth must be accompanied by profitability (e.g., sustainable returns on assets deployed) while at the same time providing customers with increased functionality in products and services, all at lower prices. So operating dynamics of viable business would logically require an enterprise architecture that not only allows innovation, but encourages it – for products, for services, for infrastructure, for operations, and for financing.

The last decade of global business development witnessed consolidations in almost all segments of the market, with expansion of individual businesses often a result of *synthetic* growth caused by mergers and acquisitions, versus *organic* growth brought about by innovations in core value propositions. On one hand, the complexity of assimilating acquisitions has absorbed valuable time and financial resources of enterprise managements that could otherwise have been applied to innovation in other dimensions. On the other hand, many industrial sectors have witnessed the elimination of entire businesses. At minimum, their redundant and inefficient infrastructures and poor business practices have been purged. As a byproduct, these consolidations have fueled an expansion of information technologies in the form of “enterprise resource planning”, “systems integration”, and the wholesale adoption of the Internet and its more open distributed computing model.

We come full circle, again, to a realization that communities of common cause increasingly have become bound by life on the electronic frontier – its codes of conduct, or lack of them. Here innovation is more often found external to the enterprise – on the frontier, outside at the fringe of the network, far removed from the core value propositions of the dominant



enterprises. It is here that openness is a requirement of sustainable growth; where “property” (e.g., copyrights, patents) is more likely to be shared (legally or illegally); and where the law, as Lessig likes to say, is the *code*.

It is within this context then, that we should pose our questions about the principles of enterprise architecture, architectures that are appropriate for sustainable growth and innovation. What is enterprise in a global networked economy? What is the *code* of these enterprises? How do we manage proactively an enterprise that must survive in a web of globally competing and cooperating entities; where distance is technically irrelevant, and timeliness matters more than ever? How do we deal with real-time decision and control in “always on” commerce, where timescales have been reduced from years, to months, to days, to hours, to (on the shop and trading floors) minutes and seconds? These are but a few of the pertinent questions whose answers challenge traditional business management practices. Most of these practices were firmly entrenched in the post-WWII industrial economies, and most are predicated on the *socio-financial structures* of management – as opposed to the architecture, instrumentation and engineering of enterprise. Answers are emerging, many at the intersection of these two philosophies. There is already evidence that the architectures that will win – that will enhance enterprise viability in a global, real-time, networked economy – will exhibit new characteristics.

First, enterprise managements will recognize the need for new tools to simultaneously satisfy the growth objectives of their two distinct and equally important clients: the financial community (investors) that provide capital and expect financial returns at least as good as other financial markets; and the consumers of products and services that expect quality, price and performance at least as good as the best competitor. Second, satisfying these two constituents requires a level of innovation that will continually exceed an enterprise’s internal capabilities, requiring the creation and management of external value-producing alliances. Third, to be effective such alliances require an “intellectual commons”, a place (most likely in cyberspace) where intellectual property rights are relaxed if not suspended, at least in principle, so that members of the alliance community can freely engage in the creation of added value that sits above and extends beyond current knowledge and best practices and generates meaningful financial returns for all participants. Fourth, partnerships will require more efficient engagement rules, supported by more efficient contracts with less onerous intellectual property laws, supporting the sharing of the resulting intellectual property derived from association. And fifth, dynamic and complex enterprises will need to be managed more holistically, taking advantage of information technology in concert with the science and engineering practices typically associated with automation and control of complex systems (cybernetics).

On this last point, *enterprise engineering* must emerge from its traditional academic embryo in departments of manufacturing or industrial engineering. Enterprise engineering is not only about programming machine tools, or doing a better job of production scheduling. It also must be about providing instrumentation for automating processes that aid decision and control at higher levels of the enterprise. Since we can automate whatever we can exactly specify, and architecture is specification, we can automate many processes that have



traditionally been the purview of ad hoc practices. Thus, enterprise engineering can and should be about autonomic behavior in complex command and control systems, and about releasing management resources to deal with knowledge and institutional learning in anticipation of change, rather than monitoring and responding to routine operational issues. Enterprise engineering must become an accepted and widely applied business discipline that merges the best practices in business and finance with those of systems science, including what we now associate with “IT”.

Enterprise engineering is the merger of business and engineering. It is, in principle, capable of creating practical implementations of enterprise architectures that will “allow” the kinds of adaptive enterprises needed on the frontier. Just as bio-informatics and bioengineering are providing a new and exciting framework for research and development in biology and chemistry, we expect that enterprise engineering will enable an equivalent revolution in research and development and design of global, real-time, distributed enterprise – enterprise appropriate for the codes of cyberspace.

This argument is in not offered as a criticism of traditional business practices or of academic disciplines currently in use. It is an observation that we have reached a new plateau, and if we are to successfully architect (i.e., proactively and holistically design) enterprise systems for a global networked economy, ones that are agile and that encourage innovation, we must imbue current practices with more disciplined applications of management, systems science and technology. A decade of ad hoc application of computing and communications technologies, while significantly increasing productivity and quality in many aspects of business and government, has yet to realize anything close to an enterprise architecture and associated “bridge”, where captain and officers meet and in real-time, cooperatively manage the present and plan for the probable futures of an enterprise – let alone to do so with expressed commitments of stewardship for the ecology of relevant local and global communities – and their associated intellectual commons.