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Anchoring policy development around stable points: An approach to regulating the co-evolving ICT ecosystem

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ABSTRACT

The daunting pace of innovation in the information and communications technology (ICT) landscape, of technology and business structure, is a well-known but under-appreciated reality. In contrast, the rate of policy and regulatory innovation is much slower, partly due to its inherently more deliberative character. We describe this disparity in terms of the natural rates of change in different parts of the ecosystem, and examine why it has impeded attempts to impose effective regulation on the telecommunications industry. We explain why a recent movement to reduce this disparity by increasing the pace of regulation – *adaptive regulation* – faces five obstacles that may hinder its feasibility in the ICT ecosystem. As a means to achieve more sustainable regulatory frameworks for ICT industries, we introduce an approach based on finding stable points in the system architecture. We explore the origin and role of these stable points in a rapidly evolving system, and argue that they can provide a means to support development of policies, including adaptive regulation approaches, that are more likely to survive the rapid pace of evolution in technology.

1. Introduction

Co-evolution, as defined in biology, is the dynamic process wherein two or more closely related species each change in response to changes in the other: flowers and the insects that pollinate them, or predator and prey. This term reflects the fact that all evolution occurs in an ecosystem, where the self-directed behavior of each actor (or species) may strongly influence, or sometimes even determine, the evolution of others. Competitive processes are also a form of evolution, where the "survival of the fittest" principle applies. In business, military, or government affairs, successful evolution requires the ability to drive advances in technology, and to incorporate new technical innovations into practice. This requirement to adapt is not unique or specific to information and communications technology; what is distinctive is the pace at which this technology advances, especially relative to the pace of development of business models and public policy. In this paper we explore the natural rate of change of various components of the ICT ecosystem, where some interdependent actors have a natural tendency to evolve faster than others. We will use the Internet as an example of such a co-evolutionary system, and consider the implications of the divergent rates of change for developing sustainable policy. We explore the concept of

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adaptive regulation, an emerging movement to render regulation more responsive to its rapidly change context. The promise of adaptive regulation faces at least five challenges that are particularly relevant in the ICT context: agreeing on policy goals, measuring progress toward them in order to inform the adaptation process, designing specific regulatory approaches that are fit for the specific purpose of the regulation, determining that a policy change did indeed cause the measured outcome, and dealing with potential harm induced from too rapid adaptation. Our engineering perspective lends skepticism to the belief that adaptive regulation will be a panacea for the ICT ecosystem. As a complement, we propose an approach to regulation based on finding stable points in the system around which to anchor public policies.

2. Different rates of change across co-evolving ecosystems

2.1. The rapid pace of information and communications technology evolution

Moore's Law (Moore, 1965) predicts the future rate of improvement in information technology. The prediction is actually an assertion about the best rate of investment in R&D, not a law driven by physics. Moore's Law predicts that the best rate of investment will lead to the performance of information technology doubling about every 18 months, i.e., its growth is exponential.[2] A doubling in 18 months grows by a factor of 10 every 5 years, 100 every 10 years, 1000 every 15 years. The speed of processors, the bandwidth of communication links (e.g., fibers), and the size of disks all grow exponentially. While the rates of growth may differ, the result is the same: technologies that engineers could only contemplate 10 or 15 years ago are now not only possible but practical at low cost, e.g., tablets, smart phones, streaming video, storing all of our data "in the cloud", real-time personal navigation systems. Even broadband was only an emerging aspiration 15 years ago, when most Internet access was still dialup. Today we have consumer devices with amazing capabilities, some that often seem to outrun need. We not only have digital cameras, we have cameras that can recognize that a face is in a picture.

Moore's Law can be exploited by technologists in two ways: more performance for constant cost or constant performance for shrinking cost. For constant performance, costs may drop exponentially, e.g., by 10 every 5 years. Improving performance led to powerful new mobile devices such as tablets and smart phones, but continually shrinking costs have allowed companies to manufacture low-end smart phones overseas for less than 50 dollars, and essentially give them away in the developing world.[3] Indeed, these forces have brought the developing world online.

Exact predictions about the trajectory and role of information technology may vary, but we will continue to experience its increasing penetration into every aspect of our lives. As more aspects of society go online, from money to war to political and civic discourse, we will become completely dependent on this technology, and thus increasingly threatened by its complexity, opacity, and possibility of failure. Economic forces amid growing demand for information and communications technology can lead to instability and vulnerabilities, pressures that will trigger increasing calls for intervention and regulation by governments.[4]

2.2. The different paces of technology integration across the ecosystem

The rapid pace of Moore's Law drives rapid innovation in the private sector, lending advantage to those who invent, discover, or adapt to new technologies sooner than others. But as technology is integrated into industry and society, different parts of the ecosystem exhibit different dynamics, subjecting each part of the ecosystem to evolutionary constraints. The Internet offers an illustrative example of this highly heterogeneous industry structure. Fig. 1 shows a variant of the well-known layered model of the Internet that allows us to describe some of this heterogeneity.

The physical (lowest) layer experiences a rate of change gated by labor and sources of capital, neither of which follow a Moore's Law cost function. For example, the on-going massive rebuilding of the world's communications infrastructure, replacing old copper telephony infrastructure with fiber and radio, requires massive investment, so rates of return on new capital investment limit the pace of this evolution. Factors differ by region, but for many parts of the world, in 10 or 20 years, we will have largely completed this conversion to fiber optics. The resulting massive capacity will pay returns for several decades.

Cloud computing is another example of the interplay of Moore's law and capital investment. The large data center infrastructures supporting cloud computing benefit from both rapidly advancing technology and ever increasing massive arrays of computers. The limit to the capacity of a data center is not primarily Moore's Law, but construction and operational costs.

At the Internet layer (the Internet Protocol, or IP), the durability of the specifications of the core protocols provides a stable foundation for rapid innovation at other layers. This stability was intentional (Clark, 1988), although even its designers did not appreciate just how difficult it would be to evolve the standard past this stable point. Such specifications do evolve, as we see with the current effort to convert the protocol to a new version that supports more addresses (IPv6), but at the

[2] Different versions of Moore's Law give 18 or 24 months as the period of doubling.

[3] Costs for such devices will not continue to decline indefinitely; some components like housings and batteries do not follow an exponential improvement curve.

[4] A vivid example of this sociological dynamic is ICANN's controversial plan to expand the DNS root zone by orders of magnitude, adding thousands of new top level domains (TLDs) with little understanding of its implications for the security and stability of the Internet (Claffy, 2011).