THE RESILIENCE PRINCIPLES: A FRAMEWORK FOR NEW ICT GOVERNANCE

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INTRODUCTION

Modern information and communication systems are enormously intricate and dynamic. Almost everyone has a stake in their successful operation, and the urge to regulate is irresistible. However, this complexity means that the basis for taking regulatory action—let alone the precise policies to be deployed—is a very knotty problem. Decision-makers operate in a world of complexity, contradiction, and confusion. They never have all the data they would like to make a decision, and the information they do have is often inconsistent. Consequently, it is not clear what is happening, and it is not clear what to do about it.

The relentless change in the communications industry has generated a long slate of new policy proposals and continues to prompt new ideas. The question that arises is: Are any new principles emerging that can guide policymakers through the tangle of bottom-up proposals? The meetings held under the "New Models of Governance" project of the Silicon Flatirons Center addressed many burning topics;[1] however, no overarching themes were immediately apparent.[2]

This article analyzes the forces that are driving change in information and communication technologies ("ICT"), and advocates for a new governance approach appropriate for the situation. It provides a framework for action (and forbearance) that reflects the underlying system dynamics, balances conflicting interests, and maximizes the social benefits of the Internet/Web.[3, 4] This approach uses principles-based policymaking to bridge from day-to-day contingencies to long-term policy plans and advances four "Resilience Principles": flexibility, delegation, big picture, and diversity.

1. *See New Models of Governance Project, Toward Policy 3.0*, SILICON FLATIRONS, http://www.silicon-flatirons.org/initiatives.php?id=governance (last visited Dec. 10, 2010).

2. Pierre De Vries, *New Governance for the Internet: Findings, Taxonomy and Model* 2 (Working Paper Series, 2010), *available at* http://ssrn.com/abstract=http://ssrn.com/abstract=1597373 [hereinafter *New Governance*].

3. The approach was developed and is applied to the Internet/Web, but it applies more generally to any policy problem that involves an intricate and evolving interplay of social, technical, and commercial forces.

4. I use the term "Internet/Web" to highlight that one needs to consider both engineering-focused data transport (one of the main connotations of "the Internet") and human-centered activities ("the Web") in order to fully understand today's communication landscape. In this essay, Internet/Web and ICT are used interchangeably.

In recent years, a small but growing number of voices have called for the application of systems thinking to Internet/Web governance. For example, in 2004 Marco Iansiti and Roy Levien proposed an ecosystem as a model for business in general and the information technology industry in particular.[5] Similarly, in 2005 Steven Berlin Johnson likened the Web to a rain forest.[6] In June 2007, a group of business strategists, regulators, and academics at the Rueschlikon Conference[7] seized on the metaphor of gardening as a model of how governance of information in a global economy might deal with the difficulty of predicting how a system will evolve and change.[8] Three papers at TPRC 2008[9] provided ways of analyzing the communications scene from a systems perspective: Rick Whitt and Stephen Schultze proposed a new conceptual framework based on what they dubbed "emergence economics";[10] Linda Garcia and Ellen Surles analyzed the media-ownership policy field in terms of

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5. It is not clear to what extent the metaphor should be taken seriously as a model of the system. Iansiti and Levien note that they "are not arguing here that industries *are* ecosystems or even that it makes sense to organize them *as if they were*, but that biological ecosystems can serve as a source of vivid and useful terminology as well as provide specific and powerful insights into the different roles played by firms." MARCO IANSITI & ROY LEVIEN, THE KEYSTONE ADVANTAGE: WHAT THE NEW DYNAMICS OF BUSINESS ECOSYSTEMS MEAN FOR STRATEGY, INNOVATION, AND SUSTAINABILITY 9 (2004) (emphasis in original).

6. Steven Berlin Johnson, *Why the Web is like a Rain Forest*, STEVENBERLINJOHNSON.COM (Oct. 3, 2005) http://www.stevenberlinjohnson.com/2005/10/why_the_web_is_.html (Berlin Johnson argues that the difference between Web 2.0 and previous technology generations is like the difference between a rain forest and a desert. Information absorption efficiency of Web 2.0 is dramatically higher, just as a rain forest is more efficient than a desert at using energy because there are so many organisms exploiting every tiny niche of the nutrient cycle.).

7. Since 2001, The Rueschlikon Conferences on Information Policy in the New Economy has brought together 40 top-level experts from around the globe to focus on the most pressing policy debates of the global information society, attracting participants from business, government regulators, and academia from four continents. *See Public Area*, RUESCHLIKON CONFERENCE, http://www.rueschlikon-conference.org/r2007/public/public_all.php?pub_id=0 (last visited Aug. 21, 2010).

8. *See* KENNETH CUKIER, GOVERNANCE AS GARDENING: A REPORT OF THE 2007 RUESCHLIKON CONFERENCE ON INFORMATION POLICY (2007). Participants variously observed that regulatory perspectives need to be reconstructed as a game played by agents in a network; that rule sets ought be defined at the lowest feasible level of granularity, with the recognition that significant emergent properties exist; that when innovation blossoms, it is usually unanticipated; and that there is a conflict of values between those who see weeds or wilderness in the same plot of land.

9. TPRC (formerly called The Telecommunications Policy Research Conference), founded in 1972, is a non-profit organization that hosts an annual forum for scholars and decision makers in the fields of telecommunications and information policy. *See About TRPC*, http://www.tprcweb.com/index.php?option=com_content&view=category&layout=blog&id=18&Itemid=29 (last visited Aug. 21, 2010).

10. Richard S. Whitt & Stephen J. Schultze, *The New "Emergence Economics" of Innovation And Growth, and What It Means for Communications Policy*, 7 J. ON TELECOMM. & HIGH TECH. L. 217, 223 (2009).

complex adaptive systems;[11] and I argued that the metaphor of Internet/Web governance as forestry—a managed complex adaptive system—could guide regulatory intuition in communications policy.[12]

This article is divided into three argument sections: Section I outlines the forces that are prompting new governance approaches. Section II argues that these changes can be understood in terms of attributes of complex adaptive systems. Section III presents the Resilience Principles that are derived from experience attempting to steer such systems in other contexts, notably ecosystem management. Finally, Section IV discusses simulation and common-law reasoning as two useful tools for converting the principles into practice, and the last section summarizes my conculsion.

I. CHANGES THAT PROMPT NEW GOVERNANCE

Any change in policy has unintended consequences, and some of them will be adverse. This prompts the question: Which characteristics (if any) of 21st century communications justify, or impel, a change in methods of governance?

Many examples have been put forward for the types of changing circumstances that justify new Internet regulation.[13] This section considers six: modularity, convergence, decentralization, the "third sector," tempo, and scale. I argue that the first three represent cyclical changes, while the latter three are step changes.

A. Modularity

A *module* is a separable part of a larger collection of components that constitute a functional system. Modularity is the design philosophy that builds functionality out of partial, separable, and substitutable components.

Substitutability requires a well-defined interface between modules.

11. Dr. Linda Garcia & Ellen Surles, *The Rise and Fall of Media Ownership Issues: A Network Perspective of the Policy Field* (2008), *available at* http://dlindagarcia.com/wp-content/uploads/tprc-entry.doc.

12. Pierre De Vries, *Internet Governance as Forestry: Deriving Policy Principles from Managed Complex Adaptive Systems* (Working Paper Series JEL 038, 2008), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1229482 [hereinafter *Governance as Forestry*].

13. *See, e.g.,* PETER F. COWHEY & JONATHAN D. ARONSON, TRANSFORMING GLOBAL INFORMATION AND COMMUNICATION MARKETS 17 (2009) (citing three factors that will force change: (1) the modular mixing and matching of technology building blocks; (2) the need to span traditional policy and jurisdictional divides (i.e., convergence); and (3) the need to rely more on non-governmental institutions to coordinate and implement global policy). In *Governance as Forestry*, *supra* note 12, I cite three characteristics of the Internet that require new responses: modularity, decentralized self-organization, and rapid change.

Such an interface definition need not be public; a vertically integrated firm may make extensive use of modularity while keeping the interfaces private. A more limited definition of modularity insists that interoperation crosses the boundary of the private firm; for example, Professors Joseph Farrell and Philip J. Weiser stipulate that "[m]odularity means organizing complements (products that work with one another) to interoperate through public, nondiscriminatory, and well-understood interfaces."[14]

ICT modules include as follows: network connections like a wired Ethernet link or a cellular data service; directories, from the DNS to sites like alluc.org, that organize links to other resources; Web browsers; voice-over IP ("VoIP") functionality used in a free-standing application like Skype or as part of a communications suite like Microsoft Office; a Twitter or Facebook plug-in on a Web page; and a pay-per-view subscription to a video channel that can be delivered via cable, phone, or satellite company.

Modularity complicates regulation since it often leads to large numbers of diverse industry players that complicate the ability to reach a consensus and implement solutions. In the days of the Bell System,[15] a small elite spanned the regulatory and operational divide and could quickly agree on what had to be done and how best to do it. For example, system engineers might have instinctively cooperated with law enforcement to provide surveillance even when the statutory situation was vague.[16] Today there are many more points to monitor on the Internet, and the engineers with the ability to do so are not always cooperative. Further, a third of them are not even American.[17] Rules that used to be unwritten now have to be codified, with all the political

14. Joseph Farrell & Philip J. Weiser, *Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age,* 17 HARV. J.L. & TECH. 85, 95 (2003).

15. The Bell System was the American Bell Telephone Company—an AT&T-led organization that provided telephone service in the United States from 1877 to 1984, at various times as a monopoly. In 1984, a federal mandate broke the company up into separate companies. *See A Brief History: The Bell System*, AT&T, http://www.corp.att.com/history/history3.html (last visited Aug. 21, 2010).

16. In modern times, sometimes they still do, particularly for the National Security Agency after 9/11. *See, e.g.,* Eric Lichtblau, *Senate Approves Bill to Broaden Wiretap Powers,* N.Y. TIMES, July 10, 2008, at A1; *see also* Christopher Soghoian, *Caught in the Cloud: Privacy, Encryption, and Government Back Doors in the Web 2.0 Era*, 8 J. ON TELECOMM. & HIGH TECH. L. 359, 383-98 (2010) (discussing modern Internet surveillance practices by government entities).

17. Data compiled by NationMaster.com from the CIA World Fact Book indicates that 57 percent of Internet hosts were in the U.S. in 2008. *See Host Statistics – Countries Compared*, NATIONMASTER.COM, http://www.nationmaster.com/graph/int_hos-internet-hosts (last visited July 10, 2010).

infighting and unintended side effects that this entails.[18]

Modular technology is not a unique characteristic of the Internet. The standardization of interchangeable parts dates back at least to Eli Whitney's process for manufacturing muskets for the U.S. government in 1798.[19] There is even evidence for the standardization of designs and technological operations in the making of Stone and Bronze Age arrowheads.[20] More recently, there have been a number of periods in the last century when innovators could combine or recombine component parts to create new products, such as vacuum tubes in the 1920s and integrated circuits in the 1970s.

I doubt that interoperable modularity[21] will persist as a defining characteristic of communications. Modular technology does not lead inescapably to a modular industry structure. Standard parts did not render pre-Internet industries immune to antitrust problems, and it is unlikely they will do so now. The role of modularity in the relationships between companies waxes and wanes, depending on, rather than driving, industry consolidation and market power. Consequently, it is likely that interoperable modularity will decline in the coming decade. The Web 2.0 phenomenon of the mid-2000s with its catch phrases like "remixing" and "participation" likely represented the high-water mark of interoperable modularity.[22] The tide will recede slowly, but it is becoming clear that key assets of the Web, such as the massive data sets held by Google, eBay, Facebook, and others, have proprietary value and will thus not be made interoperable.[23] Furthermore, the cumulative success of Apple's proprietary products in the late 2000s (the iPod,

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18. Letter from Jonathan Grudin, Researcher, Microsoft Corp., to Pierre De Vries (Jan. 2, 2008) (on file with author). Grudin observes that technology unmasks inconsistencies between rules and practice. Rules such as laws, policies, procedures, and norms enshrine how we believe people should, and conventionally do, behave. In practice, there are many rule violations, and cases of uneven enforcement that lead to the "right" outcome when rules are "obviously" inapplicable. As technology is more deeply integrated into lives, it exposes ever more deviations between rules and practice.

19. *See* Robert S. Woodbury, *The Legend of Eli Whitney and Interchangeable Parts,* 1 TECH. & CULTURE 235, 236 (1960).

20. *See* M.G. Zhilin, *Technology of the Manufacture of Mesolithic Bone Arrowheads on the Upper Volga*, 1 EUR. J. ARCHAEOLOGY 147, 149 (1998); *see also* Heidi Luik, *For Hunting or for Warfare? Bone Arrowheads from the Late Bronze Age Fortified Settlements in Eastern Baltic*, 10 EST. J. ARCHAEOLOGY 132, 138 (2006).

21. That is, modularity in the sense of Farrell & Weiser, *supra* note 14, based on public interoperability interfaces.

22. Tim O'Reilly, *What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software*, O'REILLY.COM (Sept. 30, 2005) http://oreilly.com/web2/archive/what-is-web-20.html; *see also* Pramant Sharma, *Core Characteristics of Web 2.0 Services*, TECHPLUTO (Nov. 28, 2008) http://www.techpluto.com/web-20-services.

23. Kenneth Cukier, *Data, Data Everywhere: A Special Report on Managing Information*, ECONOMIST, Feb. 27, 2010, at 3.

iPhone, and iPad) are underlining the value of a non-interoperable paradigm.[24]

B. Convergence

The digital convergence argument[25] is true enough, but tired. The overlap of broadcasting, telecom, and intellectual property regulation brought about by common digital formats will undoubtedly require regulatory retooling, but I doubt the result will be the abolition of regulatory categories based on commercial and technological realities. The erasing of old structures and the emergence of new ones are symptoms of the reorganization of any system after a collapse. For example, after a fire or storm wipes out a forest, the old niches are replaced by new ones. The reorganization is inevitably followed again by growth, maturity, and then ultimately another collapse and restructuring.

The current blurring of categories is a temporary phenomenon, and eventually the "human rage to classify"[26] will reassert itself. Classification is essential to the regulatory method, where any new problem must be fitted into some existing category in order to apply the rules of that category.[27] Once a regulator can fit a new service into a category, regulatory action follows automatically; one does not have to go back to first principles in every case. While this mechanism may yield strange results in times of transition, it is efficient and expedient and will persist even as categories change.

Today, new regulatory categories are still emerging. One alternative is based on the "layers model."[28] Another classification, judging by

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24. Steven Johnson, *Rethinking a Gospel of the Web*, N.Y. TIMES, Apr. 9, 2010, at BU1.

25. "As a truly global network providing instantaneous connectivity to individuals and services, the Internet has transcended historical jurisdictional boundaries to become one of the greatest drivers of consumer choice and benefit, technical innovation, and economic development in the United States in the last ten years." IP-Enabled Serv., *Notice of Proposed Rulemaking,* 19 FCC Rcd. 4863, WC Dkt. No. 04-36 (Mar. 10, 2004) at ¶1; for a short introduction to convergence, see JONATHAN E. NUECHTERLEIN & PHILIP J. WEISER, DIGITAL CROSSROADS: AMERICAN TELECOMMUNICATIONS POLICY IN THE INTERNET AGE 23-27 (2005).

26. I first heard the term used by Rohan Bastin, Associate Professor of Anthropology at Deakin University, in a Philosopher's Zone interview about Claude Levi-Strauss. Interview by Alan Saunders with Rohan Bastin, Assoc. Professor of Anthropology, Deakin University, at The Philosopher's Zone, A Tribute to Claude Levi-Strauss, *available at* http://www.abc.net.au/rn/philosopherszone/stories/2009/2765201.htm#transcript (Dec. 12, 2009). "The human rage to classify" is also a chapter title in F. ALLAN HANSON, THE TROUBLE WITH CULTURE: HOW COMPUTERS ARE CALMING THE CULTURE WARS 47 (2007).

27. As Bach and Sallet put it, "classifying different services is what regulators principally do." David Bach & Jonathan Sallet, *The Challenges of Classification: Emerging VOIP Regulation in Europe and the United States*, 10 FIRST MONDAY (July 4, 2005), http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1255/1175.

28. Kevin D. Werbach, *A Layered Model for Internet Policy,* 1 J. ON TELECOMM. AND

today's behemoths, might be based on industry structure, i.e., networks, cloud services, devices, and content, replacing the current silos of broadcasting, telecom, wireless, and cable.

As with modularity, however, technology is not destiny. Industry structure keeps changing, and vertical and horizontal integration waxes and wanes. In the 1980s, for example, cable companies used their infrastructure control—and thus, control of access to viewers—to take control of content producers. However, by the 1990s they had started to spin out their media operations, and by the mid-2000s they were back to pipe-only operation.[29] The recently proposed Comcast/NBC Universal merger may signify that the pendulum is once again beginning to swing back.[30]

C. *Decentralization*

A big change in communications systems in the last fifty years has been the conversion of centrally-administered, tightly controlled hierarchical systems to more open, distributed, modular systems. The Internet is no doubt much more decentralized than forebears such as the telephone network. It is by definition[31] an affiliation of many networks, and much of its processing is done "at the edges" rather than "in the middle."

While circuit-switched telecommunications had a small number of providers, often in a monopoly, there are tens of thousands of Internet entities.[32] Content is created at the edges of the network by a multitude of autonomous agents. Some providers are large companies, but a huge amount of content is created by individuals, blurring the distinction between producers and consumers. Additionally, the boundaries between

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HIGH TECH L. 37 (2002); Lawrence B. Solum & Minn Chung, *The Layers Principle: Internet Architecture and the Law* (U. S. D. Sch. L. Pub. L. and Legal Theory, Research Paper No. 55, 2003), *available at* http://ssrn.com/abstract=416263; Richard S. Whitt, *A Horizontal Leap Forward: Formulating a New Communications Public Policy Framework Based on the Network Layers Model*, 56 FED. COMM. L. J. 587 (2004).

29. *See, e.g.,* STEPHEN KEATING, CUTTHROAT: HIGH STAKES AND KILLER MOVES ON THE ELECTRONIC FRONTIER (1999); DAVID WATERMAN & ANDREW WEISS, VERTICAL INTEGRATION IN CABLE TELEVISION (1997); MEGAN MULLEN, THE RISE OF CABLE PROGRAMMING IN THE UNITED STATES: REVOLUTION OR EVOLUTION? (2003).

30. Cecilia Kang, *Merger Plans for Comcast, NBC Ignite Battle over Television Access*, WASH. POST, Dec. 4, 2009, at A1.

31. *See, e.g.*, *Internet*, OXFORD DICTIONARIES, http://oxforddictionaries.com/view/entry/m_en_us1258681 (last visited July 31, 2010).

32. P. FARATIN ET AL., COMPLEXITY OF INTERNET INTERCONNECTIONS: TECHNOLOGY, INCENTIVES AND IMPLICATIONS FOR POLICY 1, 22-24 (2007) (explaining that there are over 26,000 interconnecting entities on the Internet, with a growing diversity of interconnection contract types, including 60,000 interconnection arrangements, and relationships that have broadened from either peering or transit to complex blends, like paid peering and partial transit).

systems are porous, as illustrated by jurisdictional arguments that cross boundaries that are both physical (between countries) and conceptual (between the physical world and "cyberspace").

There is a relationship between a decentralized architecture and modularity: modularity allows decentralization and is amplified by it. Consequently, because a large and increasing amount of modularity will not be a persistent attribute of the 21st century communications industry, decentralization will not persist and grow without end either. The technical decentralization of the Internet does not preclude the concentration of market power, and a "flat" technical architecture does not prevent nation states from asserting control of digital content that flows across and within their borders.

D. The "Third Sector"

Recent decades have seen the rise of self-governing, voluntary private organizations not dedicated to distributing profits to shareholders or directors, but pursuing public purposes outside the formal apparatus of the state. Examples of these institutions, known variously as non-profits, civil society, non-governmental organizations ("NGOs"), and the third or independent sector, include hospitals, universities, social clubs, and professional organizations.

Many key Internet/Web organizations such as the Internet Corporation for Assigned Names and Numbers ("ICANN"), the World Wide Web Consortium ("W3C"), and the Internet Engineering Task Force ("IETF") meet these criteria. For example, NGOs provide an alternative venue for governance; and, as Peter F. Cowhey and Jonathan D. Aronson have pointed out, the IETF's central role in Internet standards came about because the U.S. Government decided to delegate authority to it.[33]

Lester Salamon argues that the prominence of NGOs represents an "associational revolution."[34] Such organizations have clearly been more important in governing the Internet than interstate institutions. The International Telecommunication Union ("ITU"), for example, a state-sponsored-and-run organization which used to be the venue for standards setting, has been overtaken by community-driven

33. PETER F. COWHEY & JONATHAN D. ARONSON, TRANSFORMING GLOBAL INFORMATION AND COMMUNICATION MARKETS 214 (William J. Drake & Ernest. J. Wilson III eds., 2009).

34. LESTER M. SALAMON ET AL., GLOBAL CIVIL SOCIETY – DIMENSIONS OF THE NONPROFIT SECTOR (1999); *see also* Lester M. Salamon, *The Rise of the Nonprofit Sector*, FOREIGN AFFAIRS, July-Aug. 1994, at 109; Lester M. Salamon, Presentation at The 17th Annual International Association of Volunteer Effort Conference: The Third Sector and Volunteering in Global Perspective (2001). *But see* ROBERT D. PUTNAM, BOWLING ALONE: THE COLLAPSE AND REVIVAL OF AMERICAN COMMUNITY (2000).

organizations like the IETF, W3C, and IEEE.

If the requirement for formal institutional structure is relaxed, the Web 2.0-facilitated rise of private, voluntary engagement in politics represents an impetus, and perhaps even a venue, for new governance.[35] Today, the citizens' ability to know about the activities of their legislators and petition them has never been greater.[36] Tools for organizing into ad hoc coalitions (most famously the role of meetup.com in the 2004 and 2008 U.S. presidential campaigns, for example) have led to a ferment of groups that may grow into more recognizable institutions. Policymakers will have to invent new ways to track and reach these groups.

In addition to increasing civic engagement and public trust, citizen participation could also improve policy by expanding the very limited circle of parties with whom policymakers engage on a daily basis. Realistically, only a few citizens will have the interest and capacity to engage deeply on detailed policy issues, but participation will at least spread beyond the Beltway. The current wave of Web technology may also create new institutions: for example, those engaged in a hybrid of polling and lobbying.[37] In sum, detailed public participation in

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35. U.S. examples at the time of writing include TRANSPARENCY CORPS, http://transparencycorps.org (last visited July 31, 2010) (a site "committed to helping citizens, bloggers and journalists be their own government watchdogs, by improving access to existing information, digitizing new information, and by creating new tools and Web sites to enable all of us to collaborate in fostering greater transparency."); OPENGOV, http://opengov.ideascale.com (last visited July 31, 2010) (a site collecting opinions on the question, "How can we strengthen our democracy and promote efficiency and effectiveness by making government more transparent, participatory, and collaborative?"); and WATCHDOG.NET, http://watchdog.net (last visited July 31, 2010) (a site "trying to build a hub for politics on the Internet."). Tools that facilitate engagement include OPENCONGRESS, http://www.opencongress.org (last visited July 31, 2010) (proclaiming to be "a free, open-source, not-for-profit, and non-partisan web resource with a mission to make Congress more transparent and to encourage civic engagement," which "brings together official government data with news coverage, blog posts, public comments, and more to give you the real story behind what's happening in Congress."); *Lobbying Database*, OPENSECRETS, http://www.opensecrets.org/lobbyists (last visited July 31, 2010) ("an independent website tracking the influence of money on U.S. politics, and how that money affects policy and citizens' lives"); and GOVTRACK.US, http://www.govtrack.us (last visited July 31, 2010) (a site to "help the public research and track the activities in the U.S. Congress, promoting and innovating government transparency and civic education through novel uses of technology.").

36. For example, on May 21, 2009, the Obama administration launched phase one of a three-phase project soliciting public collaboration to create an open government. *See Open Government Initiative*, THE WHITE HOUSE, http://www.whitehouse.gov/open (last visited July 31, 2010). The program aims both to improve the visibility of government activities (e.g., by allowing the evaluation of federal IT investments via the IT Dashboard, and providing access to high value, machine readable datasets via Data.gov) and to allow citizen participation in government activities (e.g., soldiers collaborating in updating Army Doctrine via the *Wikified Army Field Guide*, and citizens sharing ideas for the National Broadband Plan via the Ideascale tool on Broadband.gov).

37. Pierre de Vries, *Polling x Lobbying = ?*, DEEP FREEZE 9 (Dec. 17, 2009, 10:37 AM) http://www.deepfreeze9.blogspot.com/2009_12_01_archive.html.

policymaking could, if successfully implemented, change rule-making institutions.[38]

E. Tempo

While the rate of change of ICT technologies and services is likely to slow down significantly or even stop, the change that has been wrought thus far is significant. After the political system has adjusted to the transient stresses of rapid change, it will have to confront a new reality: technology has brought about a step change in the tempo at which we live our lives.

William Scheuerman, for example, argues that the "social acceleration of time" has created a profound imbalance between the branches of government (e.g., legislative, executive, and judicial) in liberal democratic systems like the U.S.[39] Scheuerman argues that this relatively recent historical process has been brought about by three factors: (1) a more rapid rate of technological innovation; (2) accelerated patterns of basic change in society at large, e.g., the workplace; and (3) the acceleration of everyday life via new means of high-speed communication and transportation.[40]

Even if the rate of techno-commercial innovation slows down, the rate at which global markets generate and propagate novelty will be a challenge for political systems, whose time cycles are set in constitutions, which change only very slowly, and human physiology, which changes hardly at all.[41] The future comes much faster in such a situation, and even

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38. There are, of course, substantial challenges. While Web 2.0 is giving participatory democracy a fillip, much of the "we're listening to you" rhetoric is theater: citizens are asked to submit YouTube videos, and a select few are played to simulate that someone is paying attention. There are risks of decreasing public trust if the process is handled inappropriately. Understaffed and non-responsive government bodies could reduce public trust and interest if citizen feedback is unaddressed, and, as with all legislative feedback, comments received through Web 2.0 technologies represent a self-selecting portion of the population, not the general public. Finally, there are image risks: questions that came into the "Open for Questions" feature on Change.gov regarding President Obama's possible knowledge of the Blagojevich scandal were flagged as "inappropriate" by Obama supporters, who removed them from public view in a way that was perceived in some quarters as a cover-up. *See* Evan Ratliff, *The Wired Presidency: Can Obama Really Reboot the White House?*, WIRED, Feb. 2009, at 77; Jake Tapper & Sunlen Miller, *Obama Transition Web Site 'Open for Questions' -- Except on Blagojevich*, ABC NEWS (Dec. 10, 2008, 10:03 PM) http://blogs.abcnews.com/politicalpunch/2008/12/obama-transitio.html.

39. WILLIAM E. SCHEUERMAN, LIBERAL DEMOCRACY AND THE SOCIAL ACCELERATION OF TIME xvi-xvii (2004); *see also* Barbara A. Cherry, *Institutional Governance for Essential Industries Under Complexity: Providing Resilience Within the Rule of Law*, 17 COMMLAW CONSPECTUS 1, 19-30 (2008) (discussing the implications of Scheuerman's work for ICT policy).

40. Scheuerman, *supra* note 39, at xv.

41. Human thinking will not speed up much, if at all, though tools can make it look as if it does. *See, e.g.*, EDWIN HUTCHINS, COGNITION IN THE WILD xiii (1995) (contending that

good predictions become obsolete much more rapidly. Scheuerman's discussion on the challenges of stability and transparency to constitutions[42] can apply to any set of principles, including those presented in this paper. Institutions, both organizations and rules, have to develop well-founded ways to evolve their own constitutions.

F. *Scale*

From ideas to devices, the growth of ICT has brought about a dramatic increase in the number of entities in modern life. Even if the exponential growth we are experiencing at the moment ceases (as it has for science, some argue[43]), we already have an embarrassment of riches in terms of the material resources available to us in the developed world.

Moreover, we live in a time of enormous diversity in our applications, our devices and services, and our processing power per person. Even if it does not keep growing, it is unlikely to shrink.[44] ICT has enabled major changes in how information is generated, collected, compiled, and aggregated, and neither regulation nor entrepreneurs have done much more than scratch the surface.[45]

G. *Two Kinds of Change*

A change in context that forces a change in governance does not need to be irreversible for the consequences to be profound. Since history is cumulative, a "phase change" in policy making is a change that never really reverts to its prior form, since the context changes with it. However, it is useful to make a rough and ready separation of the six drivers listed above into two categories:[46]

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we need to think in terms of "socially distributed cognition" in a system that comprises people and the tools that were made for them by other people).

42. Scheuerman, *supra* note 39, at 71-104.

43. David Goodstein, *The Big Crunch*, CAL. INST. OF TECH. (Sept. 19, 1994), http://www.its.caltech.edu/~dg/crunch_art.html.

44. The litany barely needs repeating. *See, e.g.*, Ludwig Siegele, *Let It Rise*, ECONOMIST, Oct. 25, 2008, at 3-4; Kenneth Cukier, *A World of Connections*, ECONOMIST, Apr. 28, 2007, at 3-6; Andreas Kluth, *Make It Simple*, ECONOMIST, Oct. 30, 2004, at 3-4.

45. Cukier, *supra* note 23, at 3.

46. I think all of them are rooted in the growing intangibility of our societies, which has been accelerated by ICT: complex software running on powerful processors linked by very fast networks. The ability to compose more components than the mind can manage makes programming/debugging very hard, particularly when those components are so easily mutable: it is easier to change a line of code than to retool an assembly line. *See, e.g.*, Pierre de Vries, *Hard Consequences of the Soft Revolution*, DEEP FREEZE 9 (Dec. 24, 2009, 11:43 AM), http://deepfreeze9.blogspot.com/search/label/hard-intangibles. Similarly, the "soft products" of these technologies, themselves complex, composable, and mutable become the inputs for culture and thus policy making: it's easier to change Web artifacts and social networks than to manage a movement using letters and sailing ships.

- **Cyclical changes**: The drivers in this category are modularity, convergence, and decentralization. The innovations of the last few decades have put us into a qualitatively different policy regime, and reworking regulations will take many years. However, the underlying technical drivers are transient. The Internet/Web is growing up. The flux will subside at different rates for different attributes, and integration of components and systems, vertical integration, and centralization will reappear (and then fade again).[47]

- **Step changes**: The drivers in this category are "third sector," tempo, and scale. The changes wrought by ICT in creating new institutions and increasing tempo and scale represent irreversible step changes. They represent new conditions that change the basis for governance.

These two kinds of change are commonly seen in complex adaptive systems. I now turn to a review of these phenomena, with a view to deriving lessons for ICT governance.

II. INSIGHTS FROM MANAGING COMPLEX ADAPTIVE SYSTEMS

This section outlines some characteristic behaviors of complex adaptive systems that are relevant to analyzing the communications industry, and thus provides a basis for thinking about Internet policy in terms of managed ecosystems.[48]

A. Definitions

A *system* is an organized collection (frequently, a self-organized collection) of elements that acts over time to produce reasonably predictable outcomes. Each element affects the whole, and the whole influences the behavior of the parts. The parts cannot be understood only by studying the whole, and the whole has properties that are not inherent in any of the parts. Systems are not decomposable into sub-processes (e.g., economic, technological, or political) that can be understood and managed in isolation.

Systems self-organize many of their interactions without outside intervention, and their characteristic structural and behavioral patterns

47. This prediction contradicts Ray Kurzweil's contention that technological change accelerates at an exponential rate, and will continue to do so. For Kurzweil's theory, see Ray Kurzweil, *The Law of Accelerating Returns*, KURZWEILAI (Mar. 7, 2001), http://www.kurzweilai.net/the-law-of-accelerating-returns; *see Accelerating Change*, WIKIPEDIA, http://en.wikipedia.org/wiki/Accelerating_change (last visited July 31, 2010), for an introduction. *But see* Erik Larsen, *Ray Kurzweil's Impossible Vision*, http://www.iscid.org/papers/Larson_KurzweilReview_012303.pdf, for a critique.

48. This material is treated in more detail in *Governance as Forestry*, *supra* note 12, at 17.

are mainly a result of interaction between the sub-systems.

There are many schools of *systems thinking*—the process of understanding how things influence one another within a whole.[49] The common thread is a shift in emphasis from an analysis of separate parts to that of the ensemble, and from static analysis and description to dynamic activities and processes.

A *complex adaptive system* is a collection of interacting adaptive agents.[50] Attributes that distinguish complex adaptive systems from other collections of agents include self-similarity, complexity, emergence, and self-organization. Complex systems typically have a nested hierarchical structure, with interactions across the levels (or scales) of the hierarchy. Processes respond non-linearly to inputs; there is a mix of fast and slow processes; time lags play a critical role; outcomes are path dependent; and components adapt to disturbances through feedback loops.[51]

B. Attributes of Complex Systems

Introductions to complex adaptive systems abound.[52] In this section I will highlight four important attributes that are easily recognized in the ICT industry.

1. Cycles and Transitions

Complex adaptive systems can have many stable states. Sometimes they return to states previously visited, showing cyclical behavior. In other cases, a system might flip to an entirely new equilibrium state unlike any previously occupied (note the similarity to the cyclical and

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49. For surveys, see GEORGE P. RICHARDSON, FEEDBACK THOUGHT IN SOCIAL SCIENCE AND SYSTEMS THEORY (Pegasus Commc'ns 1999); LARS SKYTTNER, GENERAL SYSTEMS THEORY: IDEAS & APPLICATIONS (2001); and *Systems Theory*, WIKIPEDIA, http://en.wikipedia.org/wiki/Systems_theory (last visited July 31, 2010).

50. *Complex Adaptive System*, WIKIPEDIA, http://en.wikipedia.org/wiki/Complex_adaptive_system (last visited July 31, 2010). The term "complex adaptive system" is often associated with the research field that developed in the 1980s at the Santa Fe Institute.

51. For a discussion of these effects in a biological setting, see Brian Walker & Nick Abel, *Resilient Rangelands – Adaptation in Complex Systems*, *in* PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 293 (Lance H. Gunderson & C. S. Holling eds., 2002) [hereinafter PANARCHY]. For a commercial setting, see JOHN D. STERMAN, BUSINESS DYNAMICS: SYSTEMS THINKING AND MODELING FOR A COMPLEX WORLD (2000). For applications in economics, see ERIC D. BEINHOCKER, THE ORIGIN OF WEALTH: EVOLUTION, COMPLEXITY, AND THE RADICAL REMAKING OF ECONOMICS (2007).

52. *See, e.g.*, ROBERT AXELROD & MICHAEL D. COHEN, HARNESSING COMPLEXITY: ORGANIZATIONAL IMPLICATIONS OF A SCIENTIFIC FRONTIER (2001); Beinhocker, *supra* note 51; JOHN H. MILLER & SCOTT E. PAGE, COMPLEX ADAPTIVE SYSTEMS: AN INTRODUCTION TO COMPUTATIONAL MODELS OF SOCIAL LIFE (2007).

step changes in ICT discussed above).[53] The route that a system takes between these states is a function of its history: path dependency and self-reference are traits of complex systems and are well known in economics and planning.[54]

Holling's panarchy theory proposes that biological systems exhibit a four-stage cycle: growth, maturity, collapse, reorganization, and back to growth.[55] This adaptive cycle operates at different rates in each of a system's many spatial and temporal scales. During the *growth* stage, there is rapid colonization of recently disturbed areas; for example, after a fire or windstorm has removed large amounts of biomass in a forest. The connectedness between organisms is low, which leads to high resilience where the loss of one species does not lead to the loss of another. As the forest matures it moves into the *maturity* phase of the cycle, dominated by the accumulation of material. The network of connections between biomass and nutrients becomes increasingly tight and fragile; every niche in the forest is filled, and every resource is used. Organisms become much more interdependent as food chains become dense and interconnected. The maturity phase is followed by a dramatic *collapse* phase, triggered in a forest by fire, drought, insect pests, etc. Energy is unbound, and networks are broken up. This sets the scene for the fourth phase, *reorganization*, where opportunistic species that have been suppressed by the stable configuration of the maturity phase move in. This is a period of innovation and restructuring which lays the groundwork for a return to another growth phase.

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53. A favorite two-state model of ecologists is lake turbidity, in which biological and political processes are intertwined. Marten Scheffer, *Searching Explanations of Nature in the Mirror World of Math*, 3 ECOLOGY & SOC'Y (1999); *see also* Marten Scheffer et al., *Dynamic Interaction of Societies and Ecosystems – Linking Theories from Ecology, Economy, and Sociology*, in PANARCHY, *supra* note 51, at 195. The more vegetation in a lake, the clearer the water, that is, the lower the turbidity. As one adds nutrients, e.g., from agricultural run-off, turbidity increases as phytoplankton grows. For a given nutrient load, two states are possible within a certain range: low and high turbidity. (This is true within a certain range of nutrients. If the nutrient inflow is very low, one only finds the clear state. If the nutrient load exceeds a critical amount, a lake will always be turbid.) However, once a critical nutrient load is exceeded, the lake-bottom plants die off because of lack of light, the water-clearing fauna that depended on them die as well, and the lake flips into a high-turbidity state from which it won't recover even if nutrient loads are reduced below the critical point. Nutrients have to be reduced well below the critical point to bring back plant life and switch the lake back to the low-turbidity state. Economic analysis and political pressure tends to drive the system to the point where nutrient input from agriculture is high, but just below the tipping point to high turbidity—a point that is unstable to small variations in inputs, which can lead to a rapid transition to high turbidity from which it is costly and politically difficult to return. This is an example of narrow economic efficiency reducing system resilience.

54. *See, e.g.*, W. Brian Arthur, *Inductive Reasoning and Bounded Rationality*, 84 AM. ECON. REV. 406, 406-11 (1994); Horst W.J. Rittel & Melvin M. Webber, *Dilemmas in a General Theory of Planning*, 4 POL'Y SCI. 155, 160 (1973).

55. PANARCHY, *supra* note 51, at 296 (using the terms exploitation, conservation, release, and reorganization for the four stages).

Collapse is inevitable and necessary for renewal in an ecosystem. Since complex systems operate at many concurrent scales, however, the collapse phase at one scale need not trigger the collapse of the entire ensemble. A system is resilient if the cycles at different scales are not in sync. A forest, for example, is able to resist catastrophic fire damage if its peak maturity (and thus susceptibility to fire) does not coincide with a temperature peak in the regional climate cycle.

The Holling adaptive cycle can be applied to phases in industry development. When technology or some other disturbance opens up a new market, there is a *growth* phase where economic connectivity is low and supply chains are rudimentary.[56] Consolidation follows, representing a *maturity* phase where revenues grow steadily and everybody finds their niche and stops competing at the margins. Here, innovation begins to decline. Then follows a *collapse* phase, where some disruptor breaks the reigning industry model and a lot of money is lost.[57] Revenues drop in the market as previously defined, even though economic productivity continues to grow. New entrants flood in to *reorganize* the industry with a boom in experimentation.

Economies also show the characteristics of complex adaptive systems.[58] Many, if not all, commodity markets show booms and busts.[59] There have also been a number of cycles in communications technology: the rise of the telegraph, then broadcasting, then the Internet.[60] For example, there was a blossoming of telephone companies in the 1900s-1920s, which ended with the creation of the AT&T monopoly. This was broken up in 1982, leading to a plethora of competitors who decreased

56. Even though economic connectivity may be low, social networks may be rich. Peter Haynes points out that most innovation takes place in geographical concentrations where there is very high inter-personal connectivity and quick cycle speed (personal communication). Dependencies remain low, though; the failure of one start-up doesn't lead to the failure of a series of others.

57. In Holling's analysis, the mature phase of a forest—the one just before collapse—contains a very large number of species in very many, very specific, tightly interlocked niches. The analogy to business isn't direct; there aren't necessarily many firms at the peak. A large number of interconnected products at the peak may well be internalized to a monopolistic firm. One will see a great deal of diversity and interconnectivity within the firm (e.g., feature bloat in Windows and Office), but not in the industry at large. At this point, the system is particularly vulnerable to cascading failure, e.g., through security flaws, app compatibility or robustness bugs, new market entrants, or antitrust attack.

58. Paul Samuelson worked on this in the 1930s. *See, e.g.*, PAUL SAMUELSON, FOUNDATIONS OF ECONOMIC ANALYSIS 504 (1947); Beinhocker, *supra* note 51, at 77 provides a contemporary survey.

59. Sterman, *supra* note 51, at 113.

60. Carlota Perez's analysis of 40-year technology innovation cycles provides a longer-scale context in which financing interacts with technology to generate periodic booms and busts. CARLOTA PEREZ, TECHNOLOGICAL REVOLUTIONS AND FINANCIAL CAPITAL: THE DYNAMICS OF BUBBLES AND GOLDEN AGES 9-12 (2002).

again to a handful in the early 2000s.[61] Similarly, there have been booms and busts in applications: the Windows consumer "ecosystem" of the mid-'90s, the dot-com booms of the early 2000s, and today's Web 2.0 phenomenon.

One learns from ecology that disruptive cycles are unavoidable and indeed healthy since they lead to innovation—they get rid of incumbents for a while and allow experiments in a new system configuration. The trick is to ensure that the collapses are localized. For example, periodic, small, and local forest fires keep the litter load down and prevent massive fires that burn so hot they essentially sterilize the soil, precluding seed germination and reducing soil health.[62] This suggests that diversity and taking a big picture view, both principles to be discussed below, are useful tools in complex system management. A rigid, unchanging structure is liable to result in catastrophic collapse, while a diverse and flexibly-managed arrangement is more resilient.

2. Incomplete Knowledge

It is not possible to set up analytical models for complex systems. Any model that purports to capture the behavior of a system necessarily under-represents it.[63] No model less complex than the system itself can exactly, and in detail, forecast its behavior. It is a trade-off. Analytical tools work either for complicated systems that are relatively predictable, or for simple systems that are uncertain, but not for systems that are both complex and uncertain.[64]

Conflicting explanations compound a deeper issue: the lack of agreement on the problem at hand. Many policy debates entail *deep uncertainty*, defined as the condition where the decision-maker does not

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61. Scheffer et al., *supra* note 53, at 335 tells the story of AT&T in terms of the Holling adaptive cycle. After open competition at the beginning of the telephone industry, the Bell System emerged with a dominant monopoly in the late 19th century (maturity). Patent expirations in 1893-94 led to partial breakdown of its monopoly (disruption). This triggered reorganization and a phase of open competition from independent telcos (restart and competition). Around 1907 it started absorbing the independents, evolving into a monopoly again (maturity). An antitrust crisis in 1915-19 led to the creation of a regulated monopoly, which survived into the '80s (rapid disruption, restart and re-consolidation). The court-ordered break-up of 1982 led to a period of renewed competition (disruption, restart, innovation). However, the Telecom Act of 1996 allowed consolidation to restart, and the industry is rapidly maturing again.

62. R.E. Masters, *Effects of Fire Suppression*, FOREST ENCYCLOPEDIA NETWORK 170 (Nov. 14, 2008); Alison Berry, *Forest Policy Up in Smoke: Fire Suppression in the United States*, PROP. & ENV'T RES. CTR. (2007).

63. Steven C. Bankes, *Tools and Techniques for Developing Policies for Complex and Uncertain Systems,* 99 PROC. NAT'L. ACAD. SCI .U.S.A. 7263, 7263 (2002).

64. There are, though, pockets of predictability in complex adaptive systems. *See, e.g.*, J.V.Andersen & D. Sornette, *A Mechanism for Pockets of Predictability in Complex Adaptive Systems*, 70 EUROPHYSICS LETTERS 697 (2005).

know, or multiple decision-makers cannot agree on the system model, the prior probabilities for the uncertain parameters of the system model, and/or the value function used to rank model outcomes.[65] Horst W.J. Rittel and Melvin M. Webber coined the term "wicked problems" to describe a similar set of challenges in making social policy, including the absence of a definitive problem formulation, the lack of a stopping rule or an ultimate test of a solution, and the lack of an enumerable set of potential solutions.[66]

Systems thinker David Weinberg posited the "complementary law," which states that different perspectives on a system will reveal truths regarding that system that are neither entirely independent nor entirely compatible.[67] In other words, a complex system has many distinct but equally valid descriptions. This means that conflict in policymaking is unavoidable. Since people have different perspectives, they will form different assessments of the situation and varying valuations of desirable outcomes.

Regulators seldom if ever have sufficient knowledge and control of a system to be able to drive it toward a specific outcome. There are many reasons for this. One is the fact that any chosen path towards an outcome is made obsolete as participants adapt to being regulated. Another is that the system changes more quickly than the political process that regulates it. Consequently, the problem that regulation is intended to solve may be misidentified due to the complexity of the situation. Even if correctly identified, the problem may fix itself without intervention. Finally, any regulation will immediately have unintended consequences beyond just those required to address the problem at hand.

The incompleteness of any model of a complex system and the necessity for complementary perspectives suggest that policymakers take a big picture approach, i.e., a broad view of how problems might be solved. The deep uncertainty about these systems also implies the need for flexibility since, more often than not, one cannot be sure of either the problem or the best solution.

3. Hierarchy and Cross-Linking

Systems consist of nested sub-systems with linked dynamics at different scales. As a system grows, its complexity increases and a hierarchy emerges. Each level is made up of several sub-systems, which can themselves be decomposed. The higher levels control aspects of the lower level sub-systems. However, while the higher layers may be

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65. Robert J. Lempert et al., *Confronting Surprise*, 20 SOC. SCI. COMP. REV. 420, 422 (2002).
66. Rittel & Webber, *supra* note 54, at 155-69.
67. SKYTTNER, *supra* note 49, at 92.

complex, their intricacy is dwarfed by the aggregate complexity of the lower layers.[68]

Cross-scale interactions are particularly important at times of change and renewal. Critical change in one cycle can cascade up to larger and slower scales when they are vulnerable, such as when a ground fire in a forest spreads to the crown of a tree, then to a patch in the forest, and then to a whole stand of trees before it is finally extinguished. Conversely, renewal at a given level can be supported by drawing on resources at larger/slower scales, as when a burnt forest draws on its accumulated seed bank and soil nutrients to re-grow.

The hierarchy implicit in a complex system helps to explain why a layers approach can help guide policy. For example, one can represent the four layers of Werbach[69] or Solum & Chung[70] as a sequential unpacking (Figure 0).

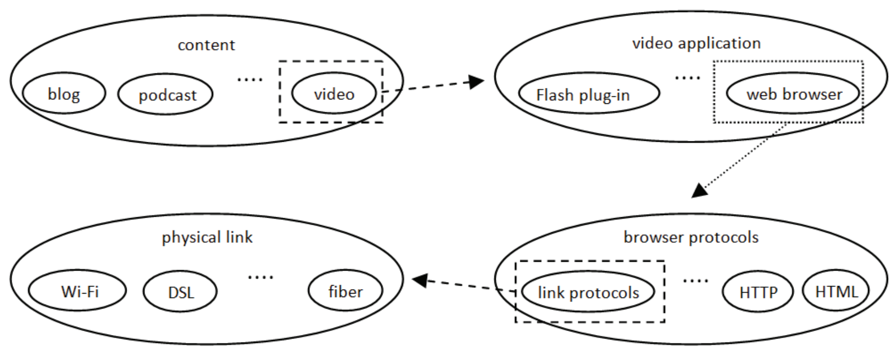

Figure 0: The Layers Model as a set of hierarchically nested sub-systems

The consideration of nesting and cross-linking should prompt policymakers to prefer diversity in the structure and constituents of a system, and to attend to the importance of weak coupling between system layers, referred to as "delegation" below.

4. Novelty and Surprise

It is very difficult to discern cause and effect in most complex systems. The interlocking interactions of sub-systems generate behavior

68. *Id.* at 60.

69. Kevin D. Werbach, *A Layered Model for Internet Policy*, 1 J. ON TELECOMM. & HIGH TECH L. 37, 37 (2002). A draft of this article was presented in September 2000 at The 38th Research Conference on Communication, Information and Internet Policy held by TRPC.

70. Solum & Chung, *supra* note 28.

that usually cannot be tied back to the isolated behavior of single components. In cases where cause and effect can be linked, the distance between the events (in time or space) can be very large, making the chain of causality quite tenuous. System responses to perturbations, including restoration efforts in ecosystems or interventions in markets, can be highly nonlinear and lead to management surprises.

Even systems that have been developed to have deterministic behaviors, such as biological organisms and human-engineered machines, are unexpectedly and catastrophically fragile in some rare configurations.[71] John Doyle and Marie Csete give the Internet as an example of such robust-yet-fragile behavior, where a small protocol error can cause a system failure.[72] Anderson et al. point out that the proven resilience of the Internet does not necessarily apply to all failure modes.[73]

Further, humans have an innate tendency to overestimate their ability to predict key trends and discontinuities.[74] Surprise stems from several sources, such as: extrapolating the present even though discontinuous jumps are common shapers of the future, under- or over-estimating the impact of an anticipated event, failing to anticipate the timing of events, differences between our revealed ability to respond to events versus what was anticipated, over-estimating one's confidence in knowing the future, and self-limiting prophesies where predictions elicit responses that counter their expectation. Human intuition is particularly prone to break down under conditions of complexity.

Thus, human intuition is a frail guide to action when dealing with

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71. J.M. Carlson & John Doyle, *Complexity and Robustness,* 99 PROC. NAT'L. ACAD. SCI. U.S.A. 2538 (2002). Such systems are highly structured, non-generic, and have self-dissimilar internal configurations at different scales and levels of abstraction, very unlike the sand piles and flocks of dumb automata so often treated in complexity theory. Their external behavior is typically robust, but there is a risk of rare but potentially catastrophic cascading failures initiated by quite small perturbations. Carlson and Doyle argue that there is a trade-off between internal simplicity and robustness: simple systems cannot operate in highly fluctuating environments; robust systems necessarily have to be complex. However, such systems can be catastrophically disabled by cascading failures initiated by tiny perturbations. For example, organisms work well under most conditions, but a single rogue mutation can trigger a fatal cancer.

72. John Doyle & Marie Csete, *Rules of Engagement*, 446 NATURE 860, 860 (2007). The use of TCP/IP allows plug-and-play between modules that use the same protocols, and TCP can run transparently on any hardware that supports IP. Complexity and fragility are hidden because the protocols allow robustness to outright failures; modules can come and go. However, a small protocol error can cause catastrophic problems.

73. Tom Anderson et al., *Design Guidelines for Robust Internet Protocols,* 33 COMPUTER COMMC'N REV. 125, 125 (2003). The authors note that systems obeying the syntax of a protocol may in fact be behaving incorrectly, and remark that such failures occur with surprising regularity.

74. NASSIM NICHOLAS TALEB, FOOLED BY RANDOMNESS: THE HIDDEN ROLE OF CHANCE IN LIFE & IN THE MARKETS 28-42 (2001); Lempert et al., *supra* note 65.

adaptive complex systems.[75] The large number of variables exceeds our cognitive capacity, and the linear models our brains tend to prefer do not fully capture the reality of non-linear interactions. Long delays between causes and effects confound our ability to understand dynamics. Complex adaptive systems typically have both slow and fast variables, yet people respond better to fast variables. Changes in slow variables may not be recognized because they are imperceptible on human time scales or because they do not fit into the mental models of observers. However, these changes can often tip a system into a new state. Even when slow variables are recognized, the fact that collective action is needed to address them constrains responses. This leads to an emphasis on short-term welfare that is counter-productive in the long run.[76]

In summary, one cannot understand or predict the behavior of a complex adaptive system with much accuracy. This is true even for relatively constrained policy domains, since policy interventions almost by definition stress the system in unanticipated directions. The novelty and surprise of complex adaptive systems suggest that policies need to be flexible to respond to unexpected developments. Policymakers should also take a holistic approach to the problem in order to minimize side effects. As John Sterman points out: "There are no side effects—only effects. Those we thought of in advance, the ones we like, we call the main, or intended, effects, and take credit for them. The ones we didn't anticipate, the ones that came around and bit us in the rear—those are the 'side effects'."[77]

C. *Internet as a Managed Ecosystem*

It is easy to imagine the Internet as a large ecosystem, and the metaphor is common. Strictly speaking, however, the conceptual mapping is rather weak since there are many mismatches when comparing an industry to an ecosystem.[78]

Regardless, the ecosystem concept has gained traction because it reveals a deeper truth: the Internet and ecosystems are both examples of complex adaptive systems. Thus, the Internet is to an ecosystem as a whale is to an elephant. For example, it could be useful to think in terms of elephants if one has to manage oceans but does not know much about

75. The frailties listed here contribute to surprises when managing complex adaptive systems. They are to be distinguished from the ignorance-in-principle discussed under "Incomplete Knowledge" in Section II.B.2.

76. Walker & Abel, *supra* note 51, at 293.

77. Sterman, *supra* note 51, at 505.

78. See my blog for example, *The internet is not an ecosystem, but…*, DEEP FREEZE 9 (Feb. 10, 2010, 3:41 PM), http://deepfreeze9.blogspot.com/2010/02/internet-is-not-ecosystem-but.html. There are mismatches in number, metrics, topology, time scales, choice, foresight, and goals.

whales, since both are large, social mammals. However, the differences between the two, e.g., living on land vs. in water, could end up being the decisive factor in some cases.

At the very least, lessons from managed ecosystems can illuminate the dynamics and pitfalls of managing the Internet, and principles derived from one can be applied to the other.

For one, the Internet/Web conceived as a complex social system rather than a deterministic technical problem alters presumptions about the roles of participants. Entrepreneurs, consumers, and policymakers are no longer the controllers of, or mere parameters in, a techno-economic system. Rather, they are adaptive agents in an integrated socio-techno-economic system. The surprise and novelty of such a system further bolsters the importance of management principles such as flexibility (since behavior cannot be predicted) and taking a big picture view (since innovation can come from any, and across many, scales).

While many of the attributes of the Internet/Web that require complex thinking may be new, this novelty is not required for systems thinking to be applicable. The more pertinent novelty is the emerging availability of the tools of complex science to tackle technology- and communication-based policy problems in new ways.

Managed ecosystems, such as forests, are a particularly illuminating metaphor since the analogies with the Internet/Web are relatively straightforward. Most of the action in both forests and communication systems happens spontaneously, but systems management is required of regulators in both cases. Further, the existence and form of the forest is the result of human intent, subject to the vagaries of influences such as weather, pests, and politics. In the same way, the Internet/Web is more than just an autonomous market or culture of complex interacting companies and customers. While Internet/Web innovation is driven by entrepreneurs and technologists with their own agendas, it is shaped by government decisions.[79] Similarly, a forest is neither pure nature nor pure culture; it is nature in the service of culture. Likewise, the Internet/Web is neither pure technology nor pure politics. The communications market, left to its own devices, will not automatically provide all needed social goods any more than nature. Left to its own devices, nature will not necessarily rebuild a flattened forest as an idyllic stand of pines rather than an overgrown bramble patch.[80]

Looking back, the ecosystem management metaphor provides a cogent way of understanding the change in communication systems that has taken place over the last few decades. The old silos of traditional

79. This metaphor is worked out in detail in *Governance as Forestry*, *supra* note 12, at 14.

80. See the story of Cathedral Pines in MICHAEL POLLAN, SECOND NATURE: A GARDENER'S EDUCATION 176 (1991).

communications regulation resembled commercial farming. There were a limited number of well-defined fields, each with its own crop: corn, wheat, beans, vegetables, and so on. It was clear who was responsible for the farm and the measures of success, e.g., bushels per acre per dollar of inputs, were well defined. Today's Internet/Web is more like a planet-wide patchwork of parks and forests, and making Internet policy is like public forestry or gardening on a global scale. Control is decentralized, and there is a great deal of variety. There are many competing uses and users, from logging to pleasure to ecological services. Given this pluralism, success metrics are ambiguous at best, and *ex ante* rulemaking is a perilous undertaking.

D. An Uncertain World

For the foregoing reasons, the best response to an uncertain and ever-changing situation is to accept it and aim at resilience rather than efficiency. Any diagnosis and prescription should always be provisional and made with the knowledge that it will have to be changed. Policymaking is an "eternal experiment."[81] Using efficiency as the measure of a solution, as neoclassical economics might, assumes that one has enough knowledge of the entire system to find an optimum solution, and that we have enough control to effectuate it. In fact, in today's regulatory landscape, an optimum probably does not exist. If it does exist, it may be unstable, and even if a stable solution can be identified, decision-makers would have so little control over the system that the solution could never be implemented.

In such uncertainty, D. J. Snowden and colleagues have developed a useful categorization of problem contexts for which different approaches are needed.[82] *Simple* and *complicated* contexts both assume an ordered universe, where cause-and-effect relationships are perceptible, and right answers can be determined based on the facts. In a simple context there is one right answer, but a complicated context may contain many. *Complex* and *chaotic* contexts are both unordered; there is no immediately apparent relationship between cause and effect, and the way forward is determined based on emerging patterns. No single right answer exists in complex contexts, and in chaotic contexts a search for right answers would be pointless because cause-effect chains are impossible to determine.

The presumption of this paper is that the methods for dealing with simple and complicated contexts are relatively well understood, and that

81. My thanks to Mark Crawford (personal communication) for this expression.

82. For an introduction to the Cynefin (pronounced ku-*nev*-in) framework, see D.J. Snowden & M. Boone, *A Leader's Framework for Decision Making,* HARV. BUS. REV., Nov. 2007.

we lack heuristics for handling the complexity that is the hallmark of contemporary communications policy. The principles outlined in the next section are proposed as part of a new policy making toolkit to deal with such complex contexts.

III. THE RESILIENCE PRINCIPLES

Supervising the Internet/Web, or any complex adaptive system, entails dealing with cycles and step changes, incomplete knowledge, cross-linked hierarchies, and surprise. Further, since communications systems are constantly changing, a policy approach should be built on a few simple and enduring principles that apply no matter which phase of the adaptive cycle the Internet/Web or its successors finds itself in. This section defines and discusses four policy principles (see Table 1) that provide a way to balance the competing pressures of innovation and public interest mandates, and the need for both stability and disruptive innovation.[83]

A. The Importance of Resilience

Occasional catastrophic failures cannot be designed out of a complex adaptive system. They are a consequence of its adaptability and essential for long-term productivity.[84] Striving for immutability sets up the conditions for a catastrophic collapse.

For example, the intensive use of lawn chemicals may lead to superficial health, but such use force-feeds the grass while denuding the soil of organisms. This leads to feeble grass that is vulnerable to diseases and weeds.[85] In politics, the periodic replacement of political leadership flushes out corruption and provides new insights, even though a price is paid in the loss of expertise. Policy for the Internet/Web should therefore not only prepare for collapses, but build in the conditions that allow periodic small collapses and minimize the likelihood of rare catastrophes.

A *resilient* system is one that can maintain its structure and function in spite of experiencing disturbances.[86] In cases where there is uncertainty about outcomes—almost always the case in complex systems—it is better

83. One should not expect this approach, or any other, to give unique, unambiguous, or uncontested answers to complex policy problems. The consequences of a principle may be arguable, there may be debate about the applicability of competing principles, or the principles may imply conflicting courses of action. Policymaking is judgment, not arithmetic. Questions will ultimately be settled by reasoned argument as in a court of law, rather than by analytical calculation.

84. Carlson & Doyle, *supra* note 71, at 2540; PANARCHY, *supra* note 51, at 216.

85. Beth Botts, *Set your lawn free: Getting to the root of healthy, happy grass*, CHI. TRIB., May 06, 2007, at C4.

86. C.S. Holling & Lance H. Gunderson, *Resilience and Adaptive Cycles*, *in* PANARCHY, *supra* note 51, at 25; Scheffer et al., *supra* note 53, at 202.

to choose robustness over optimality. A robust strategy is one that performs reasonably well compared to the alternatives over a wide range of plausible scenarios.[87] To contrast, optimality would select the strategy that performs best in the most plausible scenario, not necessarily the one that is most resilient regardless of scenario.

Thomas Homer-Dixon points out that resilience is a public good and tends to be underprovided because no individual competitor is willing to carry the buffer needed for robustness in the face of catastrophe.[88] Ensuring resilience therefore becomes the responsibility of policymakers.

A variety of techniques increase the resilience of policies. These include the following: trying not to pick or determine a single preferred outcome; including contingency plans for the worst case; designing policies that adapt to changing circumstances by evolving over time in response to new information; modeling the systems dynamics of the problem under consideration; loose coupling between sub-systems at different scales of hierarchy; experimentation; avoiding monoculture; and analyzing the robustness of chosen strategies against many plausible futures. I have grouped these considerations into the "Resilience Principles":

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87. Lempert et al., *supra* note 65, at 423.

88. THOMAS F. HOMER-DIXON, THE UPSIDE OF DOWN: CATASTROPHE, CREATIVITY, AND THE RENEWAL OF CIVILIZATION 286 (2006).

Table 1: The Resilience Principles

Flexibility	***Determine ends, not means.*** Describe and justify the outcomes sought, not the methods to be used to achieve them. When prescribing rules, prefer *ex post* to *ex ante* regulation. Use technology- and business-model neutral rules. Give new entrants glide paths to meet policy objectives. Regularly review the need for ongoing regulation, e.g., by sun-setting regulations.
Delegation	***Most problems should be solved by the market and civil society.*** Government's role is to provide incentives and guidance, and to address identifiable, critical shortcomings. Provide backstop powers to regulators. Intervene if players close to the action fail to solve problems.
Big Picture	***Take a broad view of the problem and solution space.*** Recognize that interaction occurs at many different scales, from packet flows to social networks. Prefer generic- to sector, technology-, or business-specific legislation; avoid silo-specific regulation wherever possible.
Diversity	***Multiple solutions are possible and desirable.*** Legislation and rules should allow and encourage multiple solutions. Do not entrench one solution through regulatory preference. Encourage competition and market entry.

B. Flexibility

Since the evolution of a system is so uncertain, it is unwise to pick, predict, or optimize for a specific preferred outcome. Ignorance of the details of how a rapidly evolving system works, combined with the likelihood of unwanted and unexpected side effects, means that regulation should fix as few parameters as possible in order to achieve its goal.

This demands regulatory humility, since it can be difficult to know when to encourage innovation and when to allow mature incumbents to deliver the benefits of scale. Regulators do not have the luxury of having two policy regimes—say, one for stability and another for change—since different parts of the systems may be in different phases at a given moment. There may be geographical diversity (Internet access is mature in the U.S., but booming in Asia), functional diversity (messaging services are mature, but online content is still changing rapidly), or structural diversity (in the network stack, data transport is mature while social networking applications are still evolving). Policies should be flexible enough to adapt to developments and support sub-industries that are in different phases of the development cycle at the same moment.

Neutral, open-ended policies are more likely to cope effectively with changing, contradictory situations than detailed rules. However, policymakers should be ready and able to act in case something goes wrong by having the authority to impose regulations rapidly, for example.

One mechanism to achieve this is to prefer regulation after the fact (i.e., *ex post* rather than *ex ante*), since this allows policymakers to respond to problems that actually arise, rather than committing them to hypothetical scenarios. The more specific a regulation, the longer it takes to change, since it enshrines scores of hard-fought trade-offs. However, regulation before the fact may still be necessary in order to maintain the systems diversity that is required for resilience when there is a clear and present danger of the entrenchment of market players who already have significant market power (see Section III.E below).

David D. Friedman compares speed limits (*ex ante*) with penalties for reckless driving (*ex post*), and he observes that *ex post* punishments are most useful when the behavior is determined by private knowledge that the regulator cannot observe until after the event.[89] When an object of governance is thing-like, changes in attributes can be easily observed, e.g., a data breach occurs, some packets don't cross the network. This quality makes *ex ante* rules attractive. On the other hand, when governance concerns behavior, particularly behavior that is difficult to observe, e.g., the way in which a company uses data, whether a particular network management technique discriminates against a competitor, the regulator has to fall back on *ex post* enforcement. The difficulties with *ex post* regulation are well-known, of course, ranging from providing sufficient clarity up-front about what constitutes a breach, to the political difficulty of exacting very occasional but very large penalties from powerful players. In complex contexts, however, the uncertainty about relationships between cause and effect often means that the certainty purportedly offered by *ex ante* rulemaking is illusory.

Since the passage of time and the evolution of markets invariably invalidate the premises of regulation, it is useful to build in checkpoints and termination dates or "sunsets." Most regulations should sunset at a fixed date unless there is a proven need to the contrary. If an open-ended rule is unavoidable, there should be regular opportunities to make the case for its demise. The more detailed a rule, the more likely it is to become obsolete in the face of social, technological, and commercial innovation. Consequently, the more detailed the rules, the more rapidly

89. *Ex ante* punishments can be imposed only on behavior that a traffic cop can observe; so far, at least, that does not include what is going on inside my head. *Ex post* punishments can be imposed for outcomes that can be observed due to behavior that cannot—when what is going on inside my head results in my running a red light and colliding with another automobile. DAVID D. FRIEDMAN, LAW'S ORDER: WHAT ECONOMICS HAS TO DO WITH LAW AND WHY IT MATTERS 75 (2000).

regulations should expire or be revisited. For example, policies about the definition of prohibited speech might change only on the scale of decades, but taxes and requirements on specific technologies, such as an implementation of text access for the deaf, might be obsolete in only five to ten years.

Two caveats are in order. First, a call for flexibility may be taken, wrongly, as a license for ambiguity. On the contrary, clear statements of aspirations and incentives by policymakers will motivate private sector action and yield better results.

Second, it is important to separate outcomes from implementations. Even if policymakers had the expertise to define implementations, these would undoubtedly be a limited, and probably inadequate, sub-set of what the Internet/Web could come up with on its own. Further, as with any complex system, policymakers have only limited control over outcomes. Regulators should therefore focus on ends, not means, and strive to be agnostic about technology and business models. If intervention is necessary, regulation should set performance targets, not specifications. Policymakers should give clear expectations for the time scale over which targets should be met, that is, a "glide slope."

Wireless regulation offers an encouraging precedent for the use of flexible rule-making in communications. Regulators have successfully used a hands-off approach in spectrum allocation in both unlicensed and flexible-use licensed cases. For example, unlicensed allocations have set a few generic limits on device characteristics, such as maximum transmission power, and prohibited harmful interference to licensed services that may share a spectrum band. Device manufacturers and service providers are free to innovate in both technologies and services within these constraints. In the 2.4 GHz ISM band, for example, one finds a plethora of technologies and service models. Flexible-use licensed spectrum, which gives licensees broad discretion in their use of their assignment, has also allowed dramatic innovation such as the conversion of analog to digital networks during the 1990s. These policies have gained momentum as U.S. policymakers and scholars have concluded that "command and control" policies that manage the uses and users of spectrum in fine detail have failed to use resources efficiently.[90]

Overall, regulators can guide outcomes in a positive direction by providing clear statements of what is required overall; setting up appropriate incentives and deterrents without specifying implementations; giving individuals, civil society, and the market time to

90. J.H. Snider, *The Art of Spectrum Lobbying: America's $480 Billion Spectrum Giveaway, How it Happened, and How to Prevent it from Recurring*, NEW AM. FOUND., August 2007, at 39; Thomas W. Hazlett, *Optimal Abolition of FCC Spectrum Allocation*, 22 J. OF ECON. PERSP. 103, 111-115 (Winter 2008).

meet the challenge; and finally, intervening with detailed rules if voluntary action has failed.

C. *Delegation*

Just as a forest's plants and animals know more about making and running a forest than foresters, the participants that make up the Internet/Web know more about making it work than regulators. Foresters and policymakers are able to exert only limited control over their charges because their time, knowledge, and resources are limited. This limitation is exacerbated by difficulties in tracing cause and effect, which severely complicate diagnosis, prognosis, and prescribing remedies.

Close management is often harmful. Managing single target variables in natural systems leads to slow changes in other ecological, social, and cultural components that can ultimately lead to the collapse of the entire system.[91] For example, effective flood control leads to more human settlement in fertile valleys and large investment in vulnerable infrastructure. When a flood eventually overwhelms the dams and dikes, the result is usually painful. A telecom-specific example of this risk happened with the regulation of international call settlement rates. The management of a single parameter led to instability because high government-protected rates for call termination resulted in competitive international carriers finding ways around domestic incumbents when terminating calls. This reduced incumbent revenue, destabilized their business model, and eroded the cross subsidy of local by international calls. In general, technocratic management of single parameters leads to instability of the entire system.

Control of a system can be achieved only if the repertoire of the controller is at least as great as the variety of the situation to be controlled.[92] Further, the weaker and more uncertain the regulatory capability, the more hierarchy is needed in the organization of regulation and control to get the same result.[93] These systems laws imply that a regulator cannot control a system directly, but rather should work through intermediaries. This accounts for the current control hierarchy in communications policy, where the U.S. Congress enacts general laws and the Federal Communications Commission ("FCC") implements more detailed regulations at the federal level and with analogous structures of delegation at the state and local levels.

One of the benefits of delegation is that it allows discretion and

91. C.S. Holling, Lance H. Gunderson & Donald Ludwig, *In Quest of a Theory of Adaptive Change*, *in* PANARCHY, *supra* note 51, at 6.

92. *See* SKYTTNER, *supra* note 49, at 92 (Ashby's "law of requisite variety").

93. *Id.* (Aulin and Ahmavaara's "law of requisite hierarchy").

expertise, essentials in a world of change and uncertainty. Decentralized searches for consumer benefit are more efficient at finding solutions than central planning. Accordingly, policymakers should rely on firms and civil society first, and regulate only if they fail. Regulators can make consumer action more effective, however, if they require firms to divulge more information in an accessible and meaningful form.

A form of delegation that has attracted renewed attention in recent years is self- or co-regulation.[94] In the typology used by Ofcom, the U.K. telecommunications regulator, *self-regulation* occurs when "industry administers and enforces its own solution to address a particular issue without formal oversight or participation of the regulator or government."[95] *Co-regulation* is a form of regulation where the industry wields the initial oversight responsibility, but that responsibility fits within the ambit of a public agency's regulatory authority. In U.S. usage, self-regulation usually refers to this latter form of industry self-policing through an independent body subject to government oversight: examples include Better Business Bureau's National Advertising Division and the Motion Picture Association of America's ("MPAA") rating system.

Delegation to self-regulatory organizations has been raised as a policy solution in the network neutrality arena. The June 2008 Silicon Flatirons summit concluded that a self-regulatory strategy could effectively address the question of how to determine what constitutes "reasonable network management" and whether that standard of conduct was violated in a particular case.[96] As explained in the report, such a body could create a trusted environment for the development of norms that provide all stakeholders with the increased certainty and predictability that facilitates innovation and technological development. Such a body could also review the reasonableness of network management techniques and provide an environment for developing best practices. It could also develop standards of conduct, provide "advisory opinions" to broadband providers that particular practices are reasonable, and enforce these standards. In this vein, Google and Verizon's "Joint Submission on the Open Internet" supports the creation of a self-governance framework with a backstop of federal government involvement on a case-by-case basis.[97] A key element of their proposal is the creation of technical

94. The approach is not new. An early American exponent was Charles Francis Adams. *See* T.K. MCCRAW, PROPHETS OF REGULATION: CHARLES FRANCIS ADAMS, LOUIS D. BRANDEIS, JAMES M. LANDIS, ALFRED E. KAHN (1984).

95. *Identifying Appropriate Regulatory Solutions: Principles For Analysing Self- and Co-Regulation - Statement*, OFCOM (Dec. 10, 2008), http://www.ofcom.org.uk/consult/condocs/coregulation/statement.

96. PHILIP J. WEISER, FLATIRONS SUMMIT ON INFORMATION POLICY: EXPLORING SELF REGULATORY STRATEGIES FOR NETWORK MANAGEMENT (Aug. 25, 2008).

97. Google and Verizon Joint Submission on the Open Internet, GN Dkt. No. 09-191,

advisory groups that would develop best practices, act as a forum for dispute resolution, issue advisory opinions, and coordinate with standards bodies.[98]

In some cases, there may not be an economic rationale for market participants to address a social problem. This can occur in the provision of Web access to the disabled, for example. A market may also be too fragmented or fractious to come to a solution that has the necessary economies of scale. This was arguably the case with the conversion to digital cellular service in Europe. Regulators may still, however, be able to achieve the desired outcome without having to act simply by taking powers and/or threatening action. For example, the video game industry set up the Entertainment Software Rating Board in 1994 under the threat of Congressional action.[99] Policymakers got the outcome they desired without having to get into the details of defining ratings themselves.

Delegation is not abdication of responsibility. Governments retain the responsibility of ensuring that social goals are met in areas (such as communications) where they have taken on this task. If they have adequately described the end result they seek, as recommended in Section III.B on Flexibility, a basis exists for testing whether self-regulation is leading to the desired outcome. It will also allow third parties to monitor both the regulators and the regulated, and flag regulatory capture.

D. Big Picture

Many properties of the Internet/Web cannot be traced directly to the behavior of a particular part. For example, packet traffic volume depends on the amount of fiber capacity, transport and application technologies, the financial health and business arrangements of service providers, the shifting popularity of particular applications and sites, and legal initiatives. Each of these factors depends on the others and the resultant traffic volume is an emergent property.

More generally, systems have global properties that cannot be predicted by an analysis of their sub-systems. Further, one cannot optimize the system piecewise: if each sub-system is operating at its best, then the system as a whole will not be at maximum efficiency.[100]

WC Dkt. 07-52 (Jan. 14, 2010), *available at* http://www.scribd.com/doc/25258470/Google-and-Verizon-Joint-Submission-on-the-Open-Internet.

98. *Id.*

99. Peter M. Nichols, *Should Video Game Makers Police Themselves? The Issue Sparks a Dispute Between the Industry's Titans, and a Chance of Legislation from Congress*, N.Y. TIMES, Dec. 17, 1993, at D22.

100. SKYTTNER, *supra* note 49, at 92.

Piecewise regulation ignores these emergent properties of a system and will lead to sub-optimal results. Consequently, policymakers should take a holistic view of the potential sources and kinds of solutions to their problems.

A narrow focus reduces the robustness of a managed system. While fires sometimes destroy forests, suppressing them for too long increases the leaf and branch litter that can lead to catastrophic burns.[101] The soil structure and large trees around which forest communities are built survive through medium-sized fires, allowing rapid rebuilding; but in big fires, the soil is sterilized and large trees are felled. Similarly, while occasional disruptions in industry revenue arrangements are uncomfortable for incumbents (and their political protégés) and stressful for entrants, they prevent wrenching restructuring later on. The inflexibility and regulatory capture that results from industry-specific rules can limit competition and reduce welfare, as has been seen in the attempt to protect rural telephone companies from wireless competition, for example.

The Big Picture principle also serves to remind regulators of global considerations that may be discounted while dealing with individual problem cases.

Policymaking should include developing contingency plans for adverse events, particularly low-probability, high-impact scenarios such as the failure of key company or protocol. System resilience can be improved by not operating a system in a regime that is vulnerable to shocks, even if such a system is the most economically efficient. The bigger the downside risk, the less one should optimize for a particular expected case. Finally, policymakers must be wary of the complacency that comes with a mature industry. Resilient systems have good connectivity, but not too much. Overconnecting, a characteristic that comes with maturity, leads to fragility.

Different sectors in the U.S. communication industry are regulated by different titles of the Communications Act. These silos have the advantage of being a sub-set of the entire system, and are thus easier to characterize and control. However, convergence requires that one take a "no silos" approach. One of the challenges of network neutrality has been to find rules that can encompass the telecom, cable, and cellular industries, and the success to date of the Internet Freedoms[102] suggests that a big picture solution can be achieved using a principles-based approach.

"No silos" does not mean "no classification." Regulatory categories

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101. Masters, *supra* note 62.

102. Michael K. Powell, *Preserving Internet Freedom: Guiding Principles for the Industry*, 3 J. ON TELECOMM. & HIGH TECH. L. 5, 11-12 (2004).

are unavoidable, as noted in Section I.B above on Convergence. However, in a dynamic context such as the Internet/Web, categories are constantly shifting and changing. Categorization has little lasting value. A principled approach therefore, as advocated here, provides a stable framework within which classification can evolve.

The linkages in the big picture of communications regulation are daunting. While it is essential that all participants in a complex adaptive system, including policymakers, innovate to stay ahead of ever-changing circumstances, every implemented solution has irreversible consequences that are difficult to foresee. Experimentation before deployment can reduce the risks of dramatic failure. Accordingly, trying out new rules in limited geographies is a common approach. System simulation and modeling (see Section IV.A. below), i.e., computational public policy, provides a new way to try out regulatory ideas safely and explore widely-ramified interactions that are difficult to bear in mind at the same time.

E. Diversity

Historically, a lack of bio-diversity has contributed to several agricultural disasters, including the Irish potato famine of 1846, the European wine industry collapse in the late 1800s, and the U.S. Southern Corn Leaf Blight epidemic of 1970. A diverse range of organisms improves the resilience of agricultural and wilderness ecosystems, including their capacity to recover from environmental stress and their ability to evolve.[103]

System diversity consists of having a large variety of different agents with different goals and means at many different scales in time and space. In an industry context, diversity entails nurturing new entrants, both new firms and new industries. Once a tree seedling planted during a wetland restoration has become established, it no longer needs protection from off-trail walkers. Similarly, early stage companies and industries may need protection from competition for a limited time during their infancy, but not once they are on the way to maturity. Diversity of system elements increases resilience by increasing the number of ways a system can resist, and recover from, a shock.

Diversity in a managed system may need to be maintained, particularly in socio-economic systems. The competition that is at the root of the success of markets also provides incentives for firms to establish monopolies, duopolies, or cartels. While market dominance has benefits in terms of standardization, stability, and efficiency, it reduces diversity and thus system resilience. Dominance may also reduce

103. T. Elmqvist et al., *Response Diversity, Ecosystem Change, and Resilience*, 1 FRONTIERS IN ECOLOGY & THE ENV'T 488, 488 (2003).

innovation.[104] It is therefore advisable to constrain the ability of large firms to limit entry by abusing market power.

It may be argued that a reduction in diversity, such as through *de facto* or *de jure* standardization, is beneficial because it allows economies of scale and provides some stability in otherwise chaotic markets. Standardization is a regular feature of the information technology industry: HTTP won out over Hyper-G, TCP/IP overshadowed X.25, and the Windows platform became a monopoly. However, reduction in diversity amounts to an efficiency/resilience trade-off. The resulting system is more efficient, but less resistant to shocks. Differences in regional technology policy can protect diversity, as evidenced by the regulatory standardization on GSM in Europe in contrast to the variety of cellular air interfaces in the U.S.

The European approach to telecommunications regulation provides a framework for encouraging diversity through market entry.[105] If a national regulator finds that a firm possesses Significant Market Power ("SMP") within a defined market, it may impose obligations including transparency, non-discrimination, accounting separation, access to and use of specific network facilities, and price controls. If there is no SMP, such obligations must be rolled back. The current review of the E.U. Framework Directive indicates that European regulators continue to be mindful of diversity as an important component of a healthy communications system. It proposes that regulators will focus their resources on the market sectors in which the dominance of incumbents has been least challenged.[106]

The amplification of citizen engagement with government through Web 2.0 technologies (see Section I.D above) may constitute a step change in the diversity in the Internet/Web policy system. Investment in computation to help make sense of citizen input would therefore improve system resilience. Semantic analysis tools developed to filter spam, mine search queries, collate machine-submitted bug reports, and extract signals

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104. The link between firm size and innovation is unclear, particularly when research networks, partnerships, and collaborations are taken into account. For example, Tether casts doubt on the belief that small firms are more innovative, or more efficient innovators, than large firms. B.S. Tether, *Small and Large Firms: Sources of Unequal Innovations?*, 27 RESEARCH POL'Y 725, 726 (1998). Nicholas argues that strong market positions are powerful engines of technological progress, despite market power abuses. Tom Nicholas, *Why Schumpeter Was Right: Innovation Market Power and Creative Destruction in 1920s America*, 63 J. ECON. HIST. 1023, 1024 (2003).

105. J. Scott Marcus, *The Potential Relevance to the United States of the European Union's Newly Adopted Regulatory Framework for Telecommunications* (OPP, Working Paper Series No. 36, 2002).

106. *See, e.g.*, *Main elements of the reform*, EUROPE'S INFO. SOC'Y, http://ec.europa.eu/information_society/policy/ecomm/tomorrow/reform/index_en.htm (last visited Aug. 20, 2010); Matthew Howett, *EU: European telecoms framework review*, OVUM, http://www.ovum.com/news/euronews.asp?id=6374 (last visited Nov. 22, 2010).

intelligence can be used to make sense of a mountain of input. Old technologies should be still be used, but used more intensively: regulators should poll citizens and not just depend on lobbyists and lawyers to tell them what's important.

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Table 2 summarizes the main links between the complex system attributes outlined in Section II.B above and the resilience principles.

Table 2: Complex System Themes and Suggested Principles

	Incomplete Knowledge	Cycles and Transitions	Hierarchy and cross-linking	Novelty and Surprise
Flexibility	X			X
Delegation			X	
Big Picture	X	X		X
Diversity		X	X	

IV. TWO TOOLS IN SERVICE OF THE PRINCIPLES

A provisional, experimental, principles-based approach is appropriate to dealing with complex contexts. However, principles are a starting point for rule-making, not the destination. This section discusses two techniques—one of them new, the other out of fashion—that can be helpful when applying a principles-based approach to governance of rapidly changing situations: simulation and common law reasoning.

A. Simulation

Simulation and modeling use computing to explore the kinds of outcomes that may be possible given a starting point, and alternative strategies gives one a feel for how resilient or fragile different proposed solutions may be.[107]

Simulations of the ICT ecosystem can help to improve policymakers' intuition of non-linear systems with many variables, including the slow ones that humans tend to miss. Exploring the

107. For the purposes of this paper, I will not distinguish between simulation and modeling. *See, e.g.*, Gene Billinger, *Modeling & Simulation: An Introduction*, MENTAL MODEL MUSINGS, http://www.systems-thinking.org/modsim/modsim.htm (last visited Aug. 9, 2010).

consequences of policy choices in simulation can identify which courses of action are most robust under a variety of possible outcomes. Policy simulation allows decision-makers to "sweat in training rather than bleed in combat." It can eliminate policy choices that are brittle and work in only a narrow set of circumstances, leading to more resilient final measures. Since any solution embodies a set of assumptions and biases, constructing a wide range of simulations can expose hidden preconceptions. Simulation can also be a part of resulting regulation. For example, Ofcom uses modeling of radio signal propagation rather than measurement to determine whether Spectrum Usage Rights licensees are guilty of causing harmful interference with other licensees.[108]

This field of practice is just emerging. I provide here only a brief survey of applications in ICT to give a flavor of the possibilities; more examples are given in my article, *Internet Governance as Forestry*.[109]

A variety of modeling techniques are available. The emerging discipline of systems dynamics seeks to understand the behavior of complex systems through simulating the many interlocking, sometimes time-delayed, relationships among its components.[110] It focuses on stocks and flows,[111] with feedback loops among participants. For example, ChintanVaishnav "uses a system dynamics model to study the dynamic complexity surrounding the current VoIP regulation and to understand policy options for preventing undesirable outcomes."[112]

A number of social scientists have turned to agent-based modeling and simulation to examine social phenomena.[113] Agent-based modeling simulates the interactions of many autonomous individuals on a network.[114] Oleg Smirnov and Allan T. Ingraham used agent-based computation to "model news dissemination in large media markets."

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108. *See, e.g.*, William Webb, *Licensing Spectrum: A Discussion of the Different Approaches to Setting Spectrum Licensing Terms*, Dec. 2009.

109. *Governance as Forestry*, *supra* note 12.

110. STERMAN, *supra* note 51, at Section 2.3.4.

111. A "stock" is the amount of a business asset at a point in time, while a "flow" measures the change over a period. *See, e.g.,* Glenn Harrison *Stocks and Flows*, *in* THE NEW PALGRAVE DICTIONARY OF ECONOMICS 290 (Steven Durlauf & Lawrence Blume eds., 2nd ed. 2008).

112. Chintan Vaishnav, The End of Core: Should Disruptive Innovation in Telecom Invoke Discontinuous Regulatiory Response? (Oct. 6, 2009) (unpublished Ph.D. dissertation, Mass. Inst. of Tech.), *available at* http://web.mit.edu/chintanv/www/Publications/Chintan%20Vaishnav%20Proposal%20Abstract.pdf.

113. *See* Robert J. Lempert, *Agent-Based Modeling as Organizational and Public Policy Simulators*, 99 PROC. NAT'L ACAD. SCI. U.S. 7195 (2002); *see also* Brian J.L. Berry, L. Douglas Kiel, & Euel Elliot, *Adaptive Agents, Intelligence, and Emergent Human Organization: Capturing Complexity through Agent-Based Modeling*, 99 PROC. NAT'L ACAD. SCI. U.S. 7187 (2002).

114. JOSHUA EPSTEIN & ROBERT AXTELL, GROWING ARTIFICIAL SOCIETIES: SOCIAL SCIENCE FROM THE BOTTOM UP 4 (1996).

Such a model could also be used to study issues of interests to policymakers, such as the effects of media consolidation or closure.[115]

Simulation has so far not been widely used to explore the consequences of telecommunications policy decisions. Johannes M. Bauer, however, has explored the innovation incentives of network operators and content providers by using scenario thinking and simulation models to analyze the dynamics of various network neutrality policies.[116] He offers a stylized model with subtle and nuanced qualitative discussion. Bauer and Kurt DeMaagd also used genetic programming techniques to model the co-evolution of platform operators, content providers, and consumers subject to specific policy rules governing the interactions.[117]

Research funding institutions have taken note. The Science of Science and Innovation Policy ("SciSIP") program of the National Science Foundation has taken an interest in the use of agent-based modeling in understanding how policy can affect science and engineering research.[118] Also in Europe, Objective 7.3 of the Seventh Framework Programme, "ICT for Governance & Policy Modelling," includes a focus "on advanced tools and technologies to perform large-scale societal simulations."[119]

B. Common Law Reasoning

At some point, principles have to be turned into decisions and details. Accordingly, the common law's use of fact-finding in the service of applying (and evolving) established principles is a necessary complement to a principles-based regulatory philosophy. The common law adapts to changing circumstances as well or better than any other kind of regulation and allows flexibility without vagueness. For some time now and in the face of a mountain of obsolete statutes, legal

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115. Oleg Smirnov & Allan T. Ingraham, *Social Networks and the News: An Agent-Based Model of a Media Market* (Working Paper Series, 2008) *available at* http://ssrn.com/abstract=1354142.

116. Johannes M. Bauer, *Dynamic Effects of Network Neutrality*, 1 INT'L J. COMM. 531, 531 (2007).

117. Johannes M. Bauer & Kurt DeMaagd, *Network Management Practice and Sector Performance: A Genetic Programming Approach* (Mich. St. Univ., Working Paper No. 08-02, 2008).

118. *See* Science of Science and Innovation Policy (SciSIP), NAT'L SCI. FOUND., http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501084&org=SBE (last visited July 14, 2010); *see also Award Abstract No. 0915657*, NAT'L SCI. FOUND. (2009), http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0915657&WT.z_pims_id=501084 (awarding funding for Axtell's project "Co-Evolution of Innovative Products by Purposive Agents and the Growth of Technological Complexity").

119. *7th Framework Programme for Research (2007-2013)*, EUROPEAN COMM. INFO. SOC'Y, http://ec.europa.eu/egovernance (last visited on Dec. 10, 2010).

scholars have proposed common law as a solution.[120] In a paper on reforming the FCC, Jonathan Sallet proposes a return to common-law reasoning. He argues that since "innovation is the cornerstone of long-term economic growth, the 21st Century common-law is advantageous because it is itself a good way of creating innovative public policies," and is also "a sensible method of adapting government oversight to changing technological and economic conditions."[121]

Congress, in enacting laws, and the FCC, in creating broad rules, should create principles that provide general guidance about the values to be protected. Decisions should then be delegated to adjudicators who apply those rules in a common law fashion, creating a body of precedent. This is a recursive process: Congress delegates the authority to work out some principles to the agency, and then the agency rule-making function delegates the detailed decision to administrative law judges ("ALJs"). If it is politically infeasible to allow the ALJs to rule, then the Commission could ask ALJs to find facts only (and not offer legal interpretations). Ideally, however, the ALJs should be given the task of both finding the facts and recommending the legal analysis to the FCC.

CONCLUSIONS

This paper argues that the Internet/Web is a complex adaptive system. Insights from the theory and practice of managing such systems, particularly managing natural ecosystems, provide useful guidance for policymakers. An analysis of the Internet/Web in terms of managed complex adaptive systems suggests a new framework for understanding the current transformation of ICT and its regulation.

Well-known attributes of the Internet/Web support its characterization as a complex adaptive system. For example, the transformations observed in ICT resemble the cycles and transitions of adaptive systems: modularity, convergence, and decentralization are cyclical changes, and the rise of the "third sector," faster tempo, and increased scale are step changes. Three other key characteristics of such systems are also observed on the Internet/Web: incomplete knowledge, hierarchy and cross-linking, and novelty and surprise.

Ecosystem management theory has had to reconcile complex

120. GRANT GILMORE, THE AGES OF AMERICAN LAW (1979); GUIDO CALABRESI, A COMMON LAW FOR THE AGE OF STATUTES (1985); Edward J. Imwinkelreid, *A More Modest Proposal than "A Common Law for the Age of Statutes": Greater Reliance in Statutory Interpretation on the Concept of Interpretative Intention*, ALB. L. REV. (forthcoming) *available at* http://ssrn.com/abstract=684251.

121. Jonathan Sallet, "New Products At Every Stage" – The Application of Common-Law Reasoning in an Age of Innovation (2009) (unpublished manuscript), *available at* http://fcc-reform.org/response/new-products-every-stage-application-common-law-reasoning-age-innovation.

biological dynamics with relentless political intervention and is thus a fruitful source of lessons for Internet/Web policy. The findings of systems theory and ecosystem management are encapsulated in four "Resilience Principles" that can help Internet/Web policymakers balance competing demands for stability and innovation. These are (1) flexibility (determine ends not means), (2) delegation (give markets and society the first shot at solving problems), (3) big picture (take a holistic view of the problem), and (4) diversity (encourage competition and market entry).

The fundamental assumption of this approach is that stasis is impossible, but resilience is achievable. These principles foster resilience in the following ways:

> 1. **Diversity**. A variety of participants ensures that a local collapse leads to a rapid restart of system function by facilitating entry of newcomers in times of disruption. If there is a monopoly, particularly at a variety of system scales, then a failure is likely to cause widespread disruption.[122]
>
> 2. **Flexibility**. Technology- and business model-neutral policy will stimulate diversity, which will improve resilience. Incorporating the possibility of unexpected events into regulatory frames, rather than simply optimizing for a single scenario, will lead to more robust policies.
>
> 3. **Delegation**. Allowing sub-systems to evolve at their own pace allows different parts of the system to be at different stages of maturity. If surrounding parts of the value chain are stable when one is disrupted, the overall system will continue to function. Clear goals focus participants on long-term outcomes and sustain momentum through periods of creative collapse and renewal. Policy expiration dates remove unused regulations and reduce the possibilities of unexpected interactions.

122. Diversity, both social and ecological, is an important determinant of ecological resilience in rangelands, which are regions between deserts and agricultural zones where people make their living from pastoralism. Examples include: the juxtaposition of soils with differing abilities to accept and store rainfall enables vegetation on some soils to survive through periods of sparse rainfall and on others to grow well under conditions of higher rainfall; plant communities with high species richness with functional types (groups) of species ensure a variety of responses to different environmental disturbances; mixed grazer and browser animal populations increase forage and marketing options, reduce drought risk, and slow shrub encroachment; diverse enterprises linked to different markets and requiring different weather conditions reduce risk; a range of energy sources (human labor, horses, oxen, fossil fuels) widens resource-use opportunities; a relatively large workforce with a mix of ages and sexes expands adaptive opportunities; having access to a region with spatially variable climate enables survival through mobility; having access to diverse land systems at regional scales offers a range of opportunities in time and space. Walker & Abel, *supra* note 51, at 309-12.

> **4. Big Picture**. Seeking the health of the communication system on a broad scale rather than narrowly optimizing for the interests of particular incumbents allows for more flexibility and experimentation, attributes that enhance resilience. Ensuring that different system scales are not too tightly coupled, for example by limiting vertical integration, prevents disruption at one scale from causing a system-wide collapse.[123]

The precise formulation of the principles matters less, however, than the principle-oriented philosophy that underlies them. The same premises may lead others to different taxonomies, but a principles approach is likely to remain.

The approach proposed here leans towards *laissez faire*, but has a clear role for government. The model is not that the Internet/Web is a pristine wilderness, untouched by human hands and "red in tooth and claw." Rather, it is a managed ecosystem where societal needs and human agency contend with the self-organizing complexity of the biological system.

123. This is widely seen in political systems, where different parts of government are replaced at different rates. In the U.S., for example, federal elections are held every two years for Congress, four years for President, six years for the Senate, and federal judges have life-time appointments.

APPLYING COMPLEXITY THEORY TO POLICY MAKING: A COMMENT ON " THE RESILIENCE PRINCIPLES: A FRAMEWORK FOR NEW ICT GOVERNANCE," BY PIERRE DE VRIES

MARC BEREJKA[124]

I own a shelf-full of popular science books on complexity theory. I find them extremely enlightening in that they attempt to describe the general principles that shape the behavior of real-world, highly interactive and ultimately unpredictable systems. Our minds instinctively seek out understanding. Over the course of the centuries, we have become quite good at using our reasoning power to explain natural phenomena and at exploiting that understanding to improve our welfare. Our reasoning power, however, can disserve us when we fail to see its own limits—when we bake into our analyses assumptions about human behavior or other natural phenomena that, while convenient, are overly simplistic. At the micro and macro level, natural systems are regularly subject to multiple forces pulling them in competing directions and, so, outcomes are frequently, highly uncertain. Here is where complexity theory steps in. While it disavows predictive power, it does provide insights for understanding the nature of change, i.e., how highly interactive, adaptive systems move from periods that seem in equilibrium, through disruptions, and into new equilibria.

Many of the books on complexity available at retail also promise insights into how the theory can improve public policymaking. I have voraciously consumed these books, building up my basic understanding of complexity while anxiously awaiting the closing chapter on how the theory can help us make better policy decisions—only to be disappointed. These works make the point that, yes, complexity theory can improve our decision making, but they fail to describe how. They offer little guidance in terms of "applied complexity."

Pierre de Vries and I have been talking for several years about how complexity theory can improve policymaking, especially in the highly dynamic Internet/Web space. I applaud him for joining what seems to be a small but growing community of academics and other writers looking to develop the field of applied complexity.

This community has two branches. The larger "simulators" branch seems to be building up its capabilities and bona fides quite impressively. These are the multi-disciplinary intellectuals who are also experts in

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computer programming. They couple their programming prowess with today's massive computing capability to run thousands (if not millions) of iterations of scenarios with baked-in uncertainty in order to see what patterns and local equilibria emerge. De Vries has placed himself on the other, less well-developed branch—the one that seeks to extrapolate guiding principles for decision makers from complexity theory in realms that are too complex to simulate (at least for the foreseeable future). In fact, it is quite possible that De Vries's piece is the first, or among the first, to plumb the depths of complexity theory not just to understand the contours of highly interactive systems, but to take that awareness and, from it, articulate meta-rules for policymaking.

De Vries refers to these rules-for-making-rules as "resilience principles." Those principles urge policymakers who are attempting to shape, but not frustrate, progress in the Internet/Web space to: (1) embed ***flexibility*** in their decisions; (2) ***delegate*** the development of norms and enforcement of them, wherever possible, to more knowledgeable players who are closer to the action; (3) maintain a ***big-picture*** view of the problem set; and (4) encourage, or at least accommodate, ***diversity*** in policy solutions. For those immersing themselves in De Vries's piece, I have two suggestions—one for follow-on researchers and the other for all readers.

In terms of follow-on research, I hope the nascent applied-complexity community can look back at real-life policy challenges for lessons that either shore up, add nuance to, or challenge De Vries's work. For instance, those policymakers in the United States Government who, for more than a decade now, have been in a position to shape the rules of the road for the domain name system seem to have been generally, albeit unwittingly, following Resilience Principles. Over a decade ago, the United States Government officially *delegated* the governance role for the DNS to ICANN, and more recently, ICANN rearticulated its own commitment to constantly incorporate stakeholder views into its policies—moving the policymaking process even closer to those most affected by ICANN decisions. Moreover, it is clear that the relationship between the USG and ICANN, and with other stakeholders, has manifested *flexibility* and a *big-picture* perspective over the course of time. And ICANN has long aspired to accommodate a *diversity* of global needs in managing the DNS subject, of course, to the paramount interest in maintaining DNS stability. I am optimistic that a fuller examination of the Internet/Web realm will yield other examples of how resilience-oriented policymaking has yielded positive results.

For the general audience, De Vries recaps the attributes of complex adaptive systems, and he mentions "emergence of order" as one of those properties. To me, the emergence of order is one of the most fascinating and important attributes of complex adaptive systems. The notion is that despite life's many conflicting tensions, order does emerge on a regular basis. How order will emerge is impossible to predict, but from within the tumult of our existence and notwithstanding the constancy of change, we rarely find ourselves living in true chaos.

In the social realm, we consciously develop law or other formal rules to foster order. More frequently, in the interstices between law and the vast unregulatable space of normal life, behavioral norms emerge. These norms can be beneficial, they can be annoying or harmful, or they can present a mixed picture. For example, the invention of spam as an online marketing tool has spawned a bundle of norms, *de facto* and *de jure*, that now shape the business of e-mailing millions of messages to Internet users. They include a range of technical measures aimed at limiting spam's impact, expectations for a tolerable level of spam in your in-box, devious efforts to evade anti-spam measures, as well as attempts to govern commercial e-mail by law. I think it is fair to say that after a tumultuous period of years, we now live in a new state of commercial e-mail equilibrium bounded by this bundle of norms. The state-of-affairs of this new order may not be ideal, but it is tolerable for most consumers, and certainly the situation is not perfectible.

So for me, one of the key take-aways from De Vries's work is that it provides those of us in the policymaking realm with guidance on how we might assist the complex adaptive system we know as the Internet/Web to evolve towards more salutary equilibria. How can policymakers assist in the development of positive norms as new manifestations of order emerge?

I use the word "assist" deliberately. The Resilience Principles have baked into them the notion that prescriptive, technology-specific regulations are likely to do more harm than good. The ambitions of policymakers should be more modest, to nudge along an inherently dynamic process in a mostly beneficial direction. As a corollary, the Resilience Principles provide guidance to what De Vries calls "the third sector" on how to avoid overly constraining regulation. Corporations, NGOs, and the like can assist the policymaking process by consciously developing and promoting adoption of salutary norms that are part of a new order and that, in turn, obviate the need for more cumbersome governmental intervention.

Ultimately, I am drawn to complexity theory and the Resilience Principles, and I hope other readers are too, because of my concern that traditional mechanisms of government intervention are simply not resilient enough for the dynamism of the Internet/Web. The traditional means, be they new laws or regulations, are like the hammer, and those wielding the hammer may at times feel they have no option but to see a social problem on the Internet/Web as a nail. The only question is when to strike the hammer to the nail head. Of course, the Internet/Web requires a much more sophisticated policymaking approach. The Resilience Principles offer a path for how we might describe and promote that approach.

A COMMENT ON "THE RESILIENCE PRINCIPLES: A FRAMEWORK FOR NEW ICT GOVERNANCE," BY PIERRE DE VRIES

BRAD BERNTHAL[125]

"The Resilience Principles" article's focus upon system dynamics—and, more specifically, complex adaptive systems—dislocates the existing paradigm of telecommunications regulation. While other scholars and thinkers have observed systems-like aspects of the *object* of regulation (*e.g.*, the Internet "ecosystem"), few have gone as far as Pierre de Vries in diagramming what *management* of systems might suggest for regulatory agents and the institutions that they work within.

A critical question is whether the article is correct in its premise that the object of regulation, Information Communications Technology, is a "complex adaptive system" akin to complex systems in the natural world. The suggested connection between ICT and natural systems may be understood in at least three different ways: (1) definitional; (2) metaphorical; and (3) literal. To a certain degree the article posits that ICT and natural systems are alike along each of these three dimensions. As a definitional matter, the question is not particularly interesting, as it formally turns on socially constructed definitions. The metaphorical and literal dimensions, however, are more interesting to unpack.

As a metaphor, the analogue has appeal. There are certainly elements of ICT that are *like* and *resemble* natural systems. Highlighting these resemblances suggests useful understandings. The article's Section II ("Insights from Managing Complex Adaptive Systems") provides a stimulating set of ideas. Awareness of complex and chaotic contexts, mathematical tools for modeling systems, and the four resilience principles are potentially helpful management tools that regulators could adopt and adapt. Such management techniques suggested by an adaptive systems approach could easily have utility in communications regulation. Such utility does not necessarily hinge on literal connections between ICT and the natural world.

A stronger view of literal parallels between complex adaptive systems in ICT and the natural world, however, is more difficult to embrace. One is reminded of Benjamin Cardozo's admonition that metaphors in law can be useful, but that they should "be narrowly watched, for starting out as devices to liberate thought, they end often by enslaving it."[126] Fundamentally, the construct of a *complex adaptive system*

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126. Berkey v. Third Ave. Ry. Co., 155 N.E. 58, 61 (N.Y. 1926). For a similar comment by Justice Frankfurter, *see* Tiller v. Atlantic Coast Line R.R. Co., 318 U.S. 54, 68 (1943).

is itself, of course, a mental model. The fact that this mental model is capacious enough to suggest characteristics common to two systems should not go further and overlook notable differences between the underlying phenomena in each system. For example, the nature of "collapse" of a natural ecosystem through catastrophic fire is different than the "collapse" of ICT through, say, disruptive innovation. In a natural fire, the physical substance of the biological ecosystem is altered; in ICT, the nature of the "collapse" is more conceptual (viz., a "market" is disrupted) than it is biological (viz., the physical substance may be rendered less valuable, but it is not physically altered). Failing to keep track of such differences could lead to importing principles of complex adaptive system in instances where they could be unhelpful or even pernicious.

The strength of de Vries's article is precisely the way that it dislocates familiar paradigms for communications regulation. Liberated thinking often emerges when a qualitatively different approach is suggested. *The Resilience Principles* accomplishes this by jarring loose familiar assumptions and frameworks and, into the breach, proposes a vocabulary and mental model of *regulation as systems management*, which is novel and challenging. It is a fresh perspective that works best when understood as a policymaking metaphor which suggests a set of management tools that are underexplored today.

COMMON LAW FOR UNCOMMON RESULTS: A COMMENT ON "THE RESILIENCE PRINCIPLES: A FRAMEWORK FOR NEW ICT GOVERNANCE," BY PIERRE DE VRIES

JONATHAN SALLET[127]

Near the mid-point of his paper on the Resilience Principles, Pierre de Vries offers the following thought: ". . . [T]he best response to an uncertain and ever-changing situation is to accept it and aim at resilience rather than efficiency. Any diagnosis and prescription should always be provisional and made with the knowledge that it will have to be changed."[128]

That assertion is both true and fundamental. It is true not merely on a transcendental level, but as a hard-nosed understanding of the reality in which governance decisions affecting the Internet are being made. The challenge, in my view, is to incorporate common-law reasoning as a critical part of the process of "resiliency"; a process that requires additional consideration of two important questions: What would be the source of common-law principles to be used when such a system commences, and who will play the role of a common-law "judge?"

Answering those questions requires an appraisal of the context in which regulatory principles are being constructed. In earlier times, regulation did not need to move at the speed of light because the underlying technologies of regulated industries were relatively stable. In the first sixty years of significant railroad competition in the United States, technological innovations were adopted (like the substitution of steel for iron rails), but the changes were, more than anything else, designed to squeeze additional efficiency out of an established system.[129] Copper telephone wires, first used for long-distance telephony in 1884,[130] remained the basic technology used for connecting homes to the telephone network through the end of the 20th century, and the copper loop remains the technology that continues to support DSL-based Internet access.

Of course, great changes occurred in these long periods of time, but the pace was, by today's standards, slow. Conversely, in the last decade

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128. *Supra* p. 159.

129. Steven Usselman, *Running the Machine: The Management of Technological Change on American Railroads, 1850-1910*, 17 BUS. & ECON. HIST. 213 (1988).

130. *Long Distance Telephone History*, CYBERTELECOM, http://www.cybertelecom.org/notes/long_distance.htm (last visited July 14, 2010).

the nature of technologies that contribute to the Internet experience has evolved rapidly, from the deployment of fiber-based and wireless broadband networks through the creation of many new forms of devices (like the iPod/iPad and netbook computers) to the creation of new forms of "cloud"-based computing to the invention of countless applications (and almost as many home-made videos posted on YouTube).

This is not to confuse cause and effect. Of course, new technologies have significant ripple effects on society. The introduction of railroads in the 19th century had large impacts on the nation, from the way we tell time to the organization of corporations. But, as Pierre rightly emphasizes, the Internet today is a complex adaptive system in which the inputs to the consumer experience necessarily involve hardware, software, applications, devices, server farms, and more. Change is rapid, the variables in solving any single "equation" of consumer value are shifting, and the future is, therefore, shrouded in deep uncertainty. It is as if the Heisenberg uncertainty principle, which limits our ability to predict the position and movement of even a single particle, were being applied simultaneously to many particles in an attempt to map the position and predict the trajectories of each of them separately and simultaneously as they move and interact.

What to do? Are we caught in the cross-fire between certainty of future outcomes, favored by people who want to know how to adjust their behavior and expectations to follow the rules, and *ad hoc* decision making, which provides maximum flexibility but little guidance?

I have suggested the use of common-law reasoning as a solution to the seeming dilemma; an approach that focuses on finding the facts, asking whether they are same or different from the factual basis of previous rulings, recognizing the larger principle that has arisen from prior rulings and, of course, deciding whether such a principle requires modification in light of the newly-adjudicated facts.[131]

But the two issues noted above must be addressed for common-law reasoning to be successfully employed: What would be the source of common-law principles to be used when such a system commences, and who would play the role of a common-law "judge?" Both are important, of course, because effective answers to both must be in place for a system of governance to have the "resilience" that Pierre de Vries rightly recommends. Let me briefly address each issue:

First, the quest for the balance between certainty and flexibility is to be found in the balance between principles (which can also be characterized as "norms") and case-by-case adjudication, leavened by the use of "sunset" provisions. Consider, for example, the protection of

131. Sallet, *supra* note 121.

speech in the United States Constitution. "Congress shall make no law," it says, "abridging the freedom of speech, or of the press."[132] That is a fundamental principle whose interpretation over the last two hundred years has sparked questions that include: What is speech? When is speech nonetheless "action" that Congress can regulate? What speech, if any, is not within the scope of the principle? Whose speech is protected? What does it mean to say that Congress can make "no law?"

Here, the principle embodied in the First Amendment provides fundamental guidance. The case law applies that principle both to unresolved issues and to forms of communication, like the Internet, that did not exist at the time of the ratification of the Constitution.

In the world of Internet governance, two obvious sources for the creation of principles come to mind. An expert body can "borrow" from prior precedent. So, for example, in the world of competition policy, future decisions could be based on past adjudications under Section 5 of the Federal Trade Commission Act. Or, Congress could enact a new legal standard, much in the manner that the program-access rules were designed to apply competition-policy principles to a particular set of vertical relationships. Either way, it is important that the "first principles" come first and that they be expressly adopted with debate and discussion of their purpose and potential application. Of course, and this is in keeping with the nature of uncertainty described above, the principles should avoid regulatory "lock-in" that could spawn unexpected side effects or render them as quickly obsolete. Indeed, obsolescence is the reason that such legislation should be subject to a "sunset" provision of, say, five years. So that Congress can return, examine the case-by-case results, and determine whether amendment of the first principles is needed.

Second, we need effective administrative processes to implement the common-law approach.[133] That may seem like an oxymoron to some, but there are effective ways to improve and apply current practices. One example of a robust administrative system designed to find facts can be found in the Federal Trade Commission. A system to be used effectively in pursuit of effective Internet governance should, it seems to me, (i) gather data from informed sources, including technical expert bodies of the kind used in standards-setting processes, (ii) use administrative law judges to conduct rigorous factual proceedings, (iii) move quickly, (iv) permit the issuance of effective short-term injunctive orders, and (v) consider the use of private processes, such as arbitrations, in order to gain

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132. U.S. CONST. amend. I.

133. I have written about this at slightly greater length in *Principles for Governmental Action in a Broadband World* (Econ. Policy Inst., Working Paper No. 273, 2005), *available at* http://www.epi.org/publications/entry/wp273.

greater efficiency.

Of course, both of these points are worthy of greater analysis, but the purpose of the exercise seems clear. At a time of great change when we need governance principles to develop an uncommon ability to be simultaneously principled and clear, and fact-based and flexible, the common law offers an important way forward.