

# Gardening the Internet/Web: A Framework for Communications Policy

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*The idea of a garden - as a place, both real and metaphorical, where nature and culture can be wedded in a way that can benefit both - may be as useful to us today as the idea of wilderness has been in the past.*

*Michael Pollan, Second Nature (1991)*

## Abstract

Technology and business shifts constantly change the context in which regulators have to make policy for the internet/web. There are also abiding policy imperatives that always need to be met: revenue, economic vitality, public safety, consumer protection, and culture and values.

Policy makers use mental models to frame policy questions and actions. However, technical change calls into question the approaches used successfully to date. This paper outlines a schema for communications regulation that reflects the nature of the internet/web. The framework is inspired by the metaphor of the garden, and is grounded in an understanding of complex adaptive social systems, of which gardens are one example.

A consideration of systems theory yield tactics (tools) and strategies (principles) that guide policy making in meeting the over-arching regulatory goals of stability and productivity. The three guiding principles are fostering experimentation, designing flexible policies, and building in resilience. These principles are implemented through tools such as encouraging diversity, keeping an open mind, delegating, setting clear boundaries, taking a holistic approach, transparency, and modeling policy choices.

The application of the framework is illustrated in a discussion of three current policy questions: video regulation, rules for internet voice services, and licensed vs. unlicensed spectrum allocation.

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## I. OVERTURE

On Monday, July 10, 1989 a tornado blew down Cathedral Pines in Cornwall, Connecticut.<sup>1</sup> It had been a magical place, an old-growth forest of white pine trees untouched since 1800, where lovers courted, couples got married, and families came for Sunday outings. After the storm it was a tangled mess of lumber.

Arguments over its future started quickly. Some were worried about the fire risk of the piles of lumber and brush. Many wanted a concerted effort to recreate the pine forest as it had been. The Nature Conservancy, its owners, believed that nature should be left to take its course.

Unfortunately there is no single course for nature to take. The notion of “forest succession,” the eternal march of untouched wilderness towards a stable “climax” community of towering old growth, is long discredited.<sup>2</sup> Left to its own devices, Cathedral Pines might regrow in a multitude of possible ways. It probably had an underlying inclination towards pine-forest succession, though chance could push it in very different directions: a severe fire could delay forest recovery for decades, or a mild one could kill oak saplings and let pine seedlings flourish; a soaring deer population might wipe out the pines and make an opening for spruce; or brambles could take over, or an exotic non-native plant. Humans, in fact, created Cathedral Pines: the site was logged by the first generation of white settlers late in the 18<sup>th</sup> century, and loggers removed hardwood trees in 1840, leaving the pines to grow unchecked. Before them, native Americans probably kept the area regularly burned to provide mixed grassland for hunting and foraging. Reconstructing it to some earlier state would require a decision about which earlier phase was the desired one.

In the end, the Nature Conservancy decided, after negotiations with adjacent property owners and the selectmen of Cornwall, to leave the fallen trees untouched, except for a fifty-foot clear-cut firebreak around the perimeter. Human interests were taken into account, but only insofar as fire risk was concerned.

The story of Cathedral Pines has many morals. Nature doesn’t have a goal in mind; the contingencies of the world are endless, and consequential. Nature and culture cannot be separated; human management is unavoidable and necessary. And not least: any management process is sure to be contentious, and any result will displease some people.

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<sup>1</sup> This story is based on Pollan (1991) Ch. 10. For images of the remaining intact portion of the stand, see [http://terrasacra.com/cathedral\\_pines.asp](http://terrasacra.com/cathedral_pines.asp)

<sup>2</sup> Budiansky, Stephen “Chaos in Eden” *New Scientist* 14 October 1995. Available (subscription may be required): <http://www.newscientist.com/article/mg14819993.900-chaos-in-eden.html>

## II. INTRODUCTION

### A. Goals

Communications are at the heart of any culture. Modern communication is enormously intricate and dynamic, and everyone has a stake in its successful operation. Policy makers are held to account by their constituencies for success and failure, and thus communications policy is a given. However, the complexity of the topic means that the basis for taking regulatory action, let alone the precise policies to be deployed, is a very knotty problem. Yet, the policy maker has to take a position; even the decision to forgo intervention is a course of action.

This paper lays out an approach to deciding whether and how government actors should regulate the internet/web. It provides a framework for action that reflects the underlying system dynamics, balances conflicting interests, and maximizes social benefits.<sup>3</sup> It provides a bridge from day-to-day contingencies to policy plans by introducing principles that can guide policy making, and tools to implement the policies. While I will discuss some test cases, it will ultimately be up to policy makers themselves to apply the principles.

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. A policy maker should weigh the importance of competing interpretations, and choose the most persuasive under the circumstances. Policy making is judgment, not arithmetic. Differences will ultimately be decided as in a law court, rather than with a mechanical calculator.

### B. Need for new paradigm

We are in the middle of a dramatic, decades-long reconfiguration of the means of communication brought about by internet technologies and web entrepreneurs. The new ways of communicating often don't fit well into old regulatory structures. Communications policy makers are challenged by the opportunities presented by the internet/web<sup>4</sup>. Perennial policy questions about the public interest, economic growth and social values need to be addressed for the new media as much as for the old. How should policy makers act?

One needs to understand something before trying to act on it. The novelty and complexity of the internet/web therefore requires new mental models. The traditional metaphors of "silos" and "layers" don't work any more. Current metaphors for the

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<sup>3</sup> The approach is developed for the internet/web, but I believe it applies in general terms to any non-trivial policy problem that needs to integrate social, technical and commercial forces.

<sup>4</sup> 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.

internet (from pipes and highways to tools and places) don't fully capture its complexity, emergent behavior, or the human dimension. I propose that it is helpful to conceive of the internet as a vast garden, and communications policy as gardening on a regional scale.

### C. Document Outline

Part I sets the scene with a story about ecosystem management that has lessons for internet/web policy making. The introduction in Part II outlines the goal of the paper and motivates the need for a new paradigm. Part III discusses the enduring responsibilities of policy makers. Part IV describes the internet/web and how it is thought about; it also introduces the garden metaphor. Part V is a brief survey of complexity theory and its implications for communication policy. Part VI uses the regulation of video services to explore how this theory can be applied in practice. Part VII describes the tools and principles in general, and Part VIII applies them to the questions of internet voice service rules, and licensed vs. unlicensed spectrum allocation. Part IX discusses as opportunities for future research. Part X summarizes the conclusions of this paper. Part XII closes the paper with an argument that the approach outlined here applies to firms just as much as to regulators.

The flow of the document is illustrated in Figure 1, which indicates the degree of abstraction of each section.

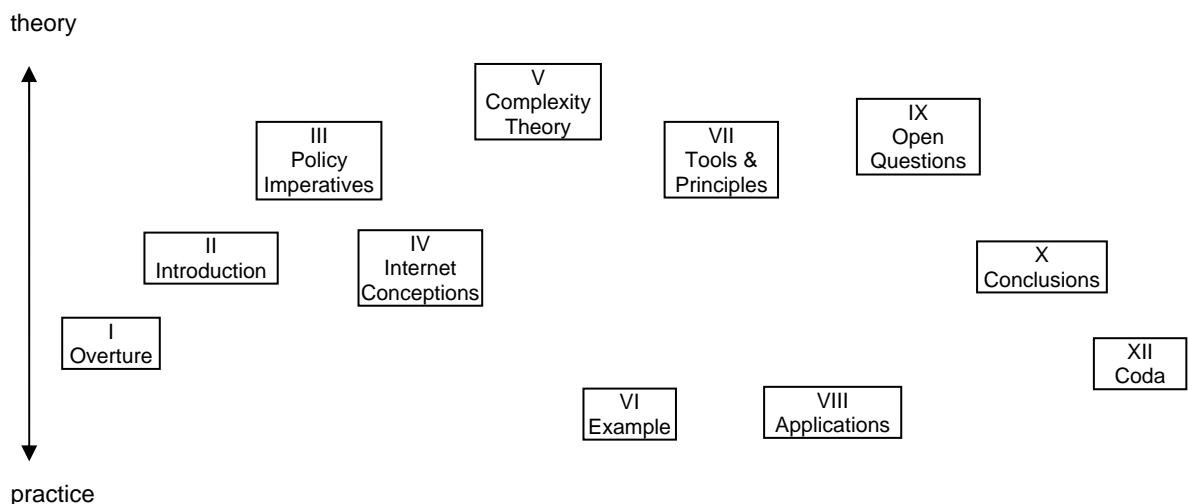


Figure 1: Outline of Argument

### III. THE UNCHANGING POLICY CONTEXT: FIVE POLICY IMPERATIVES

Societies have social and economic objectives, and regulation is one of the tools available for achieving them. The underlying goal is to increase the welfare of citizens.

Policy makers are held accountable for ensuring the delivery of public goods, which do not change amid the flux of technological and commercial innovation.

There are two broad social objectives. The first is to ensure that services necessary to public welfare are provided where economic incentives alone don't suffice; that is, public goods. The second is protecting and projecting cultural values, particularly controlling speech and content. While policy makers are not primarily focused on innovation and the economy, unless this is their specific portfolio, acting in the public interest requires attention to economic objectives, including: protecting the public from abusive practices, ensuring competitive markets and managing scarce public resources.<sup>5</sup>

One can recast these goals as five "policy imperatives": revenue, economic vitality, public safety, consumer protection, and culture and values.

**Revenue.** Money needs to be raised and spent by federal, state and local treasuries for government activities; this includes taxes, fees, levies, subsidies, tax breaks, and so on. Individual policy makers also seek funds for their own personal or political use through campaign contributions, earmarks, kickbacks, bribes, etc. Issues under this heading in telecommunications include universal service levies, registration fees for communications services, and spectrum auction revenues.

**Economic Vitality.** A vibrant market produces goods and services that citizens value, and increases their standard of living. Policy topics include fostering innovation; protecting property rights; setting up and regulating markets, facilitating market entry, and addressing market failures;<sup>6</sup> encouraging competition, interoperability and interconnection; managing public goods; and growing domestic capacity through industrial and trade policy. Internet/web issues in this category include intellectual property, allocating spectrum, national vs. international standards, market power of platform providers, interoperability, broadband build-out, and network neutrality.

**Public Safety.** Protecting citizens is a primary responsibility of government. Policy concerns in the internet/web arena include emergency services access, law enforcement surveillance, data retention, and child safety.

**Consumer Protection.** Policy makers take action across a wide range of issues when lawmakers conclude that commercial activity needs to be circumscribed in the citizen interest. Rule making may include privacy. Topics of particular interest in the communication industry include privacy, fair billing/pricing, disclosure of terms of service, access for those with disabilities, device certification, universal service, and digital inclusion.

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<sup>5</sup> The EU Framework Directive states its objectives in similar but not identical terms: to encourage competition in electronic communications markets; to improve the functioning of the internal European market; and to protect basic user interests that would not be guaranteed by market forces (<http://icttoolkit.infodev.org/en/PracticeNote.514.html>)

<sup>6</sup> Amendola & Pupillo (2007) argue that regulatory intervention should be limited to "enduring bottlenecks." Since the system is in disequilibrium, it's very hard to predict whether a bottleneck will endure. The best one can do, perhaps, is to observe for entrenchment.

**Culture and Values.** In order to protect and express a culture's values, policy makers seek to limit some kinds of speech and promote others. The internet/web touches many issues in this arena, including censorship (e.g. of subversion, hate speech, obscenity, violence), advertising rules, promoting diversity, and local content.

There is, in fact, a "sixth imperative" which is personal rather than social; the regulator's pursuit of **self-interest**. This paper will not dwell on this policy motivator, but it is clear that policy makers are not guided by purely altruistic motives. Such activities include rule-making which mainly serves to prevent criticism when something goes wrong, and rules developed to protect the regulator's job, or favor potential future employers. The self-interest includes striving to minimize recriminations for choosing policies that look foolish in hindsight.

The policy imperatives apply to different degrees in specific cases. The sometimes point in different directions; for example, economic vitality might point to a market solution, while the pressure to protect culture and values impels intervention. The Career Insurance imperative often works at cross purposes with the others, since a policy maker's personal interests may conflict with what is best for society. When imperatives are at odds, regulators should identify which one is decisive for a particular case, and overweight it relative to the others. (One cannot *a priori* put the imperatives in an ordinal list.)

#### IV. CONCEPTIONS OF THE INTERNET/WEB: CHARACTERISTICS, PARADIGMS AND METAPHORS

##### A. Characteristics

Three attributes of the internet/web are particularly relevant to the current discussion: it is modular, decentralized, and diverse.

A big change in communications systems in the last fifty years has been the conversion of centrally controlled, tightly controlled "hierarchical" systems to more open, distributed, "modular" systems. Internet /web functionality is built up out of partial, substitutable and separable pieces, known as **modules**.<sup>7</sup> They include: network

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<sup>7</sup> I define a module as an interchangeable part of a larger collection of components that delivers an ICT user experience. Modularity is the design philosophy which builds functionality out of partial, separable and substitutable components, the modules. The key attributes of modules are:

- Partial. The module is not sufficient on its own to provide a complete user experience; it's a sub-set of the entire thing. The end user needs to assemble two or more modules to create the result they seek, like combining a local and long-distance phone service provider in the US
- Separable. A module is self-contained and detachable, e.g. a web hit counter or other web plug-in can be removed without affecting functionality of the rest of the page
- Substitutable. A module can be replaced by another, equivalent one from another supplier, like replacing one web browser by another one.

connections like a wired Ethernet connection 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 functionality; an AdSense plug-in on a web page; MySpace or Facebook plug-ins; and a subscription video service via cable or satellite.

Some user-facing modules have enough heft to qualify as applications, though in a modular world they build on some modules, and host others. MySpace or Netvibes are applications, but they plug into a browser, and their functions are extended by other plug-in modules.

Many systems at a given scale may use the same sub-system at a lower scale; the topology is a web, not a tree. For example, all applications on a given machine may use the Windows OS, IE browser and DSL connectivity; or similarly, telco (DSL), cableco (cable modem) and hotspot (Wi-Fi) etc. all rely on TCP/IP etc. protocols.

Modularity has made regulation more difficult because the number of players involved is larger, and more diverse: geographically, temperamentally, culturally, technically, and politically. In the days of the Bell System, a small elite that spanned the regulatory and operational divide could quickly agree what had to be done, and how. For example, in communications surveillance telephone system engineers might cooperate with law enforcement even when the statutory situation was vague. There are many more points to monitor on the internet these days, and the engineers are not all cooperative; most of them are not even Americans. Rules that used to be unwritten now have to be codified, with all the political infighting and unintended side effects that this entails.<sup>8</sup>

A given user experience can be created out of different kinds of module, and the same module can be part of many distinct experiences. For example, web video can be consumed through a media player (iTunes), a web site (YouTube), or a video plug-in on a third party site; and a VoIP module can provide real-time voice capability for both a telephony service and a video game. It is therefore difficult to base regulation on modules, in the way that regulation can be based on industry verticals, technology architecture, or market definitions.<sup>9</sup> It's hard to use modules to define markets, since firms or consumers can mix and match the modules they use to create a service, potentially working around a provider with market power.<sup>10</sup> Cowhey, Aronson and

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Substitutability requires some public disclosure of the interface between modules. This leads to the Farrell & Weiser (2003) definition: "Modularity means organizing complements (products that work with one another) to interoperate through public, nondiscriminatory, and well-understood interfaces." Note, though, that substitutability is not a sufficient condition; it presumes that an architecture of separable and partial pieces already exists.

<sup>8</sup> Jonathan Grudin (personal communication) has pointed out that technology reveals 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 which lead to the "right" outcome when rules are "obviously" inapplicable. As technology is more deeply integrated into lives, it exposes ever more deviation.

<sup>9</sup> The "silo", "layers" and "EU" approaches, discussed further below

<sup>10</sup> My working hypothesis is that regulation should apply to the capabilities that are exposed, not the means by which they're delivered; for example, if a user experience is functionally and socially equivalent to traditional telephony, access to emergency services should be provided regardless of

Richards (manuscript) argue that this will reduce antitrust concerns on the internet/web. However, the debate around the Google/DoubleClick acquisition shows that bottlenecks could arise in the Web 2.0 world, too.

Secondly, implementation and control of the internet/web is **decentralized**. In engineering terms it is a network of networks, and thus a patchwork of autonomous institutions. Unlike circuit-switched telecommunications where there was a small number of providers, and in fact a monopolies in many countries, the number of participants is huge: Faratin et al. (2007) report over 26,000 interconnecting entities on the internet, with a growing diversity of interconnection contract types. There are 60,000 interconnection arrangements, and relationships have broadened from either peering or transit to complex blends, like paid peering and partial transit.

Content is created at the edges of the network, again by a multitude of autonomous agents. Some providers are large companies, but a huge amount of content is now created by individuals; the distinction between producers and consumers of content is blurred. For example, it is reported that uploads to YouTube reached 200,000/day at the end of 2007.<sup>11</sup> There were 10,000 Facebook applications in December 2007.<sup>12</sup> A number of video blogs approach or meet the standards of broadcast TV.<sup>13</sup>

The internet is not only decentralized; the boundaries between systems are porous, as illustrated by jurisdictional arguments that cross boundaries both physical (between countries) and conceptual (between the physical world and “cyberspace”).

Thirdly, the decentralization of the internet/web increases its **diversity**. There are many uses and stakeholders, e.g. commercial, academic, civic, governmental, which leads to conflict. Geographic diversity is particularly troublesome: even though the network crosses borders, states want to impose their own norms on their citizens. The internet/web is also diverse in its nature: it is both infrastructure and experience; both network and conversation; both a marketplace and a community; and simultaneously a medium, a tool, a place, a conversation, a system, and a mirror.

There are two further attributes which are very striking at the moment, but which are probably temporary. The internet/web is in **flux**. It is a relatively new phenomenon,

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implementation. Matters are complicated, though, because the context in which a capability is delivered makes a difference; for example, a voice chat on X-Box Live during a game is different from voice communications module embedded into an employee’s work desktop. Modules further complicate matters when an end-user builds up an experience by using modules from different providers. For example, imagine a visually disabled person builds a portal on Netvibes with newsfeeds from various web sites, an IM plug-in from one player, and a voice module from another – who’s responsible for delivering accessibility functions?

<sup>11</sup> YouTube Editors , February 16, 2006, <http://www.youtube.com/blog?entry=jNOXAC9IVRw>. Reuters, July 16, 2006, [http://www.usatoday.com/tech/news/2006-07-16-youtube-views\\_x.htm](http://www.usatoday.com/tech/news/2006-07-16-youtube-views_x.htm). A blog post in November 2007 reports 200,000 uploads per day: [http://blogs.pcworld.com/communityvoices/archives/2007/11/when\\_will\\_youtu.html](http://blogs.pcworld.com/communityvoices/archives/2007/11/when_will_youtu.html)

<sup>12</sup> <http://facereviews.com/2007/12/05/facebook-applications-break-10000/>

<sup>13</sup> For example: rocketboom, this week in tech, geekbrief.tv, mobuzz; for more see <http://www.digg.com/podcasts>

with many characteristics still unsettled. Business models, governance, usage patterns, usage norms etc. are all rapidly changing. It is nowhere near equilibrium. Many parts of the industry are changing much faster than the regulatory process. However, it's growing up. The flux will subside, though at different rates for different attributes.

It is also **contested**. As a consequence of the internet/web's adolescence, many questions are unsettled, e.g. network neutrality, the value and protection of intellectual property, norms about archiving personal information and the decades-along consequences of its revelation, who controls which aspects of its operation, etc. Ten years from now, internet/web policy will be as exciting as broadcast regulation - not much to raise the blood pressure beyond the occasional wardrobe or vocabulary malfunction.

Ervin Lazslo (1996:17) contrasts the traditional reductionist goal of finding commonality in *substance*, with the systems theory goal of seeking universality in *organization*. The diversity of the internet/web means that there's little or no common substance, but there is commonality in organization at various layers: different connected networks use similar protocols; social networks organize themselves in similar ways using different media; communications are of widely different types (IM, VOIP, email). A systems approach is thus better suited to analyzing the internet/web than a reductionist one, which posits that reality can be reduced to a number of indivisible basic elements, that phenomena at higher levels can be fully explained in terms of ones at lower levels, and that qualitative properties can be reduced to quantitative ones (Skyttner 2001:13).

### ***B. Regulatory Paradigms***

Telecommunications policy in the 20<sup>th</sup> century was organized around a division between service categories.<sup>14</sup> These categories, often called "silos," include wireline telephony, radio communications including over-the-air television, and cable television. A service is a combination of delivery medium, implementing technologies, user experiences, business model, and market. Historically the services were distinct from each other on all counts. A classification by any of these criteria served to distinguish between the others. Services mapped well to categories that combined all these aspects.

The internet broke down the distinctions between categories that were already frail, such as in the case of television. Transport facilities that were classified differently because of the analog services associated with them could carry the same digital service: for example, internet access can be offered over cable, wireline telephony, or cellular plant.

The challenge was taken up in the late 90s in a Green Paper by the European Commission (1997). In examining options for future regulation, the Green Paper noted that one of leading alternatives to the then-current approach was "to shift away from a vertical model of sectoral regulation and towards a horizontal approach which seeks to distinguish between the network or transmission layer within converging sectors and the services carried over those networks". The EU Framework Directive (European Parliament 2002) which followed set out to address competition and user interests in a

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<sup>14</sup> See Werbach (2002) for an overview of the US situation

consistent manner across all kinds of infrastructure in a consistent way.<sup>15</sup> To this end, it creates technology neutral categories: Electronic Communications Networks (transmission infrastructure), Electronic Communications Services (conveying traffic; content services are excluded), and Associated Facilities (a grab-bag of enabling technologies). There is a presumption that companies do not have significant market power will bear minimal regulation.

The alternative approach that emerged in United States also addressed the convergence of transport technologies, but went further to create a “layer model” that urged policy makers to reformulate communications policy around the technical architecture of the internet (Werbach 2002, Solum & Chung 2003, Whitt 2004). Industry-based distinctions would give way to different treatment for layers corresponding to the internet’s implementation of packet-switched networking. The layers model has been criticized for not being technology neutral, for understating the importance of market power analysis, for difficulties in demarcating layers, and for inhibiting price discrimination (Marcus 2006, Odlyzko not dated).

The silo and layer models are attractive because they’re one-dimensional: a single parameter serves to distinguish between categories. In the silo model, the parameter is end-user service (broadcast TV, telephony, satellite communications, etc.); in the layer model, it’s the degree of network abstraction between the physical transmission of data and the end user experience. However, since both end user experience and technical architecture are useful distinctions, neither silos nor layers are sufficient on their own. Near to the physical layer, networking architecture dominates, and end-user experiences can be largely ignored; but from the user perspective, watching video is different from voice communications even if both are implemented via packet switching. Layers are helpful low in the stack, but the particular public interest mandates applied to TV are different from those on telephony, and so service silos can’t be ignored. The argument is at its most complex in the middle, where the two blur into each other.

### *C. Current Metaphors*

Metaphors use a familiar domain to explain a less familiar one. Conceptual metaphors make systematic use of the structure of one conceptual domain to reason about another one. Lakoff and Johnson (1980) introduced conceptual metaphors to a broad public. Science often advances by working out the implications of a metaphor mapping. Mary Hesse (1966) has explored the role of metaphor in physics in great depth, and historians of economic thought have argued that classical physics lies at the heart of neoclassical economics (Mirowski 1989, Klamer & Leonard 1994). A great deal of metaphorical thinking is also found in the law (Schlag 2002, Winter 2003).

Since the internet/web is a relatively new phenomenon, metaphors to help us think about it abound. In a fascinating paper, Susan Crawford (2007) contrasts the very different ways that “Engineers,” “Telcos,” and “Netheads” define the Internet; each has their own metaphor. The founding engineers see the internet as a logical architecture. The

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<sup>15</sup> See <http://icttoolkit.infodev.org/en/PracticeNote.514.html> for a summary.

incumbents (telcos) see it as privately-owned pipes that connect consumers to content. The internet futurists conceptualize it as standards and relationships that give rise to persistent social worlds.

A slashdot discussion during April 2007 about a defining the Internet gave many technical definitions, but there were also many metaphors: highways, trains, telephones, the mail.<sup>16</sup> The metaphor of systems and networks was very common, and there were a few references its social aspects. Anthropomorphism was pervasive: computers talking to each other, sending messages, sharing information with each other, etc.

A web search<sup>17</sup> to find ways of describing the internet/web yielded a similar set of terms. Communications infrastructure is the most common overarching category: highway, medium, network, or pipe. This concept also informed one-off metaphors like ‘post office’. Transport came into play in the vehicle metaphors, like ‘car’. The other common thread was that the internet/web is like a place of some kind. There was quite a lot of ‘information repository’ language, particularly ‘library’, but also references to repositories and databases. A repository is a tool, and one might say that this is the third common theme: the internet/web as a means to an end. There were a few references to the commercial aspects, e.g. market, way to make money. Other less-frequent but not uncommon images were the internet/web as a social activity (e.g. a conversation), as a mirror of society, and as a system.

The three ways of thinking about the internet in Crawford 2007 can be seen as views of the same thing at different resolutions:

- logical architecture (the view of the founding engineers) focuses on the protocol scale
- privately-owned pipes that connect consumers to content (the view of the incumbent network operators) focuses on the network scale
- the web as relationships that lead to society (the view of the “netheads”) focuses on the human scale

This nesting also partially explains the wide diversity of metaphors for the internet/web. For example, the “internet/web as communications infrastructure” metaphor focuses on the network and protocol scales, and the “internet/web as place” and “internet/web as tool” metaphors focus on the tool scale.

Steven Berlin Johnson likened the web to a rain forest.<sup>18</sup> He argues that the difference between Web 2.0 and previous technology generations is equivalent to the

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<sup>16</sup> <http://ask.slashdot.org/article.pl?sid=07/04/26/0535200>

<sup>17</sup> Google searches for “internet is a”, “internet is like a”, “the web is a”, and “the web is like a”. I used “the web is...” since simply searching for “web is a ...” throws up many results for the semantic web, which is a specialization I want to ignore in this case. Terms that occurred more than twice in the first ten pages of search results were considered. The internet was described as highway, library, marketplace, medium, mirror, network, pipe, place, repository, social activity, system, tool, and vehicle. The list for the web was largely the same, though the metaphors ‘network’ and ‘pipe’, often used for the internet, did not appear. The ‘graph’ metaphor, which wasn’t used for the internet, was used quite often for the web.

<sup>18</sup> [http://www.stevenberlinjohnson.com/2005/10/why\\_the\\_web\\_is\\_.html](http://www.stevenberlinjohnson.com/2005/10/why_the_web_is_.html)

difference between a rain forest and a desert. Information absorption efficiency of Web 2.0 dramatically higher, just as 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.

Johnson's rain forest metaphor is related to the industrial ecology metaphor. Industrial ecology sees industrial systems as being part of the biosphere, and focuses on finding solutions to ecological problems.<sup>19</sup> The ecosystem analogy has been taken up as a model for business, separate from ecological concerns, particularly in the information technology industry.<sup>20</sup>

Metaphors of business as ecosystem generally do not treat policy making as a component of the system, but focus rather on interacting firms as a web of organisms in a "state of nature". However, they demonstrate the value of thinking about the web in terms of familiar biological images. That takes us to a metaphor that illustrates how regulation, commerce and technology intersect on the internet/web: the garden.

#### ***D. The Garden Metaphor***

A garden is neither pure nature, nor pure culture; it is nature in the service of culture. A garden more than just an ecosystem, defined as a community of organisms functioning as a unit. Human agency plays a special role. While the gardener is technically an organism like all the others, she has a conscious, forward-looking agenda that is qualitatively different. The existence and form of the garden is the result of intentional human action. In the same way, the internet/web is more than just a market-culture complex, where companies, customers and citizens interact. It is shaped by governance decisions that attempt to influence market and culture.

Gardens, particularly large ones like forest systems and commercial farms, are therefore an attractive metaphor for the internet/web. A garden is nature put to human use, and the internet/web is technology put to social use. The "nature" of the internet/web discourse is its technology and commerce, separate from the "culture" of politics and policy.

The communications market place, left to its own devices, will not automatically provide all needed social goods, any more than nature, left to its own devices, will necessarily rebuild a flattened forest as an idyllic stand of pines rather than an overgrown bramble brush patch. Just as in a garden metaphor, humans have to take guiding decisions about the internet (and about business in general).

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<sup>19</sup> For a brief history of the field, see <http://www.is4ie.org/history.html>. See also [http://en.wikipedia.org/wiki/Industrial\\_ecology](http://en.wikipedia.org/wiki/Industrial_ecology). On the other hand, ecologist John Harte argues that the ecological sustainability practices under the banner of "industrial ecology" are worthy and important, but that they do not mimic the way natural ecosystems work; see "Business as a Living System: The Value of Industrial Ecology A Roundtable Discussion," *California Management Review* (Spring 2001).

<sup>20</sup> Notably in Iansiti, Marco and Roy Levien, *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability*, Harvard Business School Press, 2004.

One needs to think of gardening broadly to represent the sweep of internet/web policy, particularly at a national and international scale: it is not a personal garden or small-holding – which is roughly the equivalent of a local area network – but rather a commercial farm, a watershed, a national park system, or even a planet. The act of making policy is not just gardening, but rather farming or forestry.

The mapping from gardening to internet policy is straightforward. Just like a garden, the internet/web has a life of its own through the actions of producers and consumers, but it is shaped at a global level by policy decisions. The policy makers and regulators are the gardeners; while they have a crucial role and great responsibilities, their reach is limited.

There are many kinds of gardens. They vary in scale from window-sill planters to national forests, and in governance from personal to public to commercial. Some gardening objectives are utilitarian, and others aesthetic: some see gardens as primarily productive and others cultivate them for pleasure. In the same way, some parts of the internet/web are public, and others are private; objectives range from personal and organizational productivity, to frivolous entertainment and idealistic political movements.

While most of the work in a garden is done automatically by the plants and other providers of ecosystem services, humans impose their desires regarding outcomes. Similarly, internet/web innovation is driven by entrepreneurs and technologists according to their own agendas, though governments try to impose their will on the outcomes.

Just like the internet/web, managing a garden is often a futile matter; one can never know precisely how things will turn out. Plants that thrive in one part of the garden inexplicably fail in another. Plagues of pests and disease appear unexpectedly; unexpected consequences abound.<sup>21</sup>

Birds, squirrels, slugs, and seeds don't respect boundaries. A garden is embedded in a larger regional system, and its borders are porous. While every gardener can and should shape the garden to their preferences, there is a limit to their independence. The openness brings both plant-friendly bees and bird-chasing cats. Tension with neighbors is inevitable, and has to be managed. There is management at many scales, from a gardener's decision about what variety of tomato to plant for next year, to state-wide prohibitions on planting noxious weeds.

Different gardens have different sets of rules. By the same token, different spheres of the web will need different rules. There are clashes about cross-border jurisdiction in both gardens and web.<sup>22</sup>

The old silos of traditional communications regulation are like commercial farming. There are a limited number of well-defined fields, each with its own crop: corn, wheat, beans, vegetables, and so on. It's clear who's responsible for the farm, and the

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<sup>21</sup> For example, using imidacloprid to control grubs in lawns may be causing the collapse of bee hives across North America. See [http://www.aroundmaine.com/Around\\_Town/features/garden/07\\_08\\_31.asp](http://www.aroundmaine.com/Around_Town/features/garden/07_08_31.asp)

<sup>22</sup> In the web case “cross-border” refers to both geography and functionality, e.g. between what people do in synthetic worlds and games, vs. content posted on Youtube, vs. stuff that's done in email.

measures of success, like bushels per acre per dollar of inputs, are well defined. Today's internet/web is more like a patchwork of wilderness, forests and wilderness parks that straddle borders, and making internet policy is like public forestry. Control is decentralized, and there is a great deal of variety. There are many competing uses and users, from logging to pleasure to ecosystem services. Given this pluralism, success metrics are ambiguous at best.

The gardener is largely irrelevant and invisible to the plants, animals, bugs, microbes that do the work in a garden. They experience the gardener as part of their context, and often as a force to be contested or co-opted. However, if one generalizes the definition of "gardener" to be any organism that attempts to shape outcomes in its environment in order to further its own agenda, then every plant and animal – and groups of them acting in concert – are gardeners each at their own scale. For example: mature forests moderate local climate to their own advantage; some trees poison other plants around them; and earthworm casts change the make-up of soil, improving the situation for themselves and others. There are many gardeners, not just at various scales, but also at a given scale. Competing organisms contend towards contradictory ends. In human gardening this is most obvious at the regional management level, where there are many agencies with overlapping briefs that are responsible for the same geography.

In the same way on the internet/web, every sub-net, every service, and every applet work to further their own agenda; they garden their local environment. Each competes strenuously with its peers. Policy makers are ignored if possible, and tolerated if necessary. Governance decisions will be contested. Participants have different interests, and will thus want different governance outcomes.

Gardeners in the general sense, i.e. system actors, can be differentiated by the reach of their action in time and/or space, their power to affect the system ("keystone" species are more influential than others at the same scale), and the sophistication of the calculus they engage in. Humans are outliers on all three axes. Their ability to plan, that is to simulate action without actually acting, affects the quality and reach of their decisions power. Similarly, there are policy makers at all scales of the internet. One noteworthy difference between the internet and a garden is that internet/web has human actors at many scales, all with foresight and intentionality; this is not the case for all organisms in an ecosystem.

Who supervises the gardener? The answer is that the garden keeps the gardener honest. It sets the constraints of what will grow and what will not, and reminds the gardener of his or her limitations, often mercilessly.

The analogy of the internet/web to a garden is of course incomplete, like any analogy. Different perspectives of the internet will each reveal truths regarding that system that are neither entirely independent nor entirely compatible. The garden metaphor, though, captures the web's complex system dynamics in a familiar way. It fits in the tradition of other place-based metaphors for the web (as a building, market, library, or public venue). There is a resonance with tool metaphors, since gardens are as a means to an end, whether pleasure or production. The link to the "internet as communications infrastructure" metaphor is less direct, but they don't contradict each other. Finally, it's worth recalling that the concept of "systems" in general and "ecosystems" in particular, is only a metaphor. An ecosystem, and even more a managed ecosystem, is a human

construct imposed on multifarious and slippery reality. It's a just a model; and all models are incomplete.

**Table 1: The internet/garden metaphor map**

<b>Garden</b>	<b>Internet/web</b>
garden	part of the internet/web
gardener	policy maker
plants animals and other organisms	firms, users, citizens
cultural expectations and human actions shaping a garden	Social pressures and policy decisions
personal garden	home network
global collection of large managed ecosystems including cross-border parks and watersheds	the internet/web
biological and physical processes	technology, engineering, commerce, user activities
Fences	borders
major crops and fields in large farms	old silos of traditional communications
wilderness, forests and parks that straddle borders	contemporary internet/web

## V. INSIGHTS FROM COMPLEXITY THEORY

While gardening lore can inform internet/web policy, there is fortunately a deeper theory to draw on: managed ecologies in particular and complex adaptive systems in general. It should not be surprising that the gardening metaphor makes sense, since both gardens and the internet/web can be modeled as complex adaptive systems.

A system is an organized collection of elements that acts over time to perform some function. There are many schools of system thinking.<sup>23</sup> Systems thinking shifts the emphasis from an analysis of the working of individual parts to their organization, and from static analysis and description to dynamic activities and processes. There is a web of relationships linking all the elements in a system. Each element affects the whole, and the whole influences the behavior of the parts. The parts cannot be understood by studying the whole, and the whole has properties not inherent in any of the parts. Systems organize themselves, and their characteristic structural and behavioral patterns are mainly a result of interaction between the subsystems.

A complex adaptive system is a collection of interacting adaptive agents.<sup>24</sup> The term is often associated with a research field that developed in the 1980's at the Santa Fe Institute by workers including Kenneth Arrow, Doyne Farmer, Murray Gell-Mann, John H. Holland, and Stuart Kauffman. Attributes that distinguish complex adaptive systems from other collections of agents include self-similarity, complexity, emergence and self-organization. Complex systems show multiple, nonlinear interactions among components at different levels of aggregation. Such systems are not decomposable into sub-processes – say, economic, technological, political – that can be understood and managed in isolation, and the results aggregated to explain the whole. Complex systems typically have a nested hierarchical structure, with interactions across the levels (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; and components adapt to disturbances.<sup>25</sup>

Carlson and Doyle (1999) focus on systems that have self-dissimilar internal configurations; this contrasts with the self-similarity which is the basis for a great deal of the earlier literature. These highly organized yet non-generic structures are models for many systems, from biological organisms to technological artifacts.<sup>26</sup> Carlson & Doyle argue that such complexity, which they call “highly organized tolerance,” necessarily emerges when systems are engineered (or evolve) to operate in a wide variety of situations. Unfortunately, this complexity can also lead to catastrophic failure; they thus describe these as “robust yet fragile” systems.

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<sup>23</sup> For surveys, see Richardson (1991), Skyttner (2001) and [http://en.wikipedia.org/wiki/Systems\\_theory](http://en.wikipedia.org/wiki/Systems_theory)

<sup>24</sup> [http://en.wikipedia.org/wiki/Complex\\_adaptive\\_system](http://en.wikipedia.org/wiki/Complex_adaptive_system)

<sup>25</sup> For a discussion of these effects in a biological setting, see Walker & Abel 2001; for a commercial setting, see Sterman 2001; for applications in economics, see Beinhocker 2006

<sup>26</sup> A commercial jet aircraft is an example of a highly organized system that displays robust yet fragile behavior (Carlson & Doyle 1999). It is a complex system composed of many, diverse sub-system, each with many components. The plane is embedded in a larger network of air transportation, which includes systems for pilot training, pre-flight checks, regular maintenance, and regulatory supervision that is intended to catch failures in the plane system and prevent a catastrophic collapse. This system in turn is embedded in a larger economic and social system.<sup>26</sup> Over time the supervisory system also becomes more complex, with periodic adjustments and simplifications. The risk of cross-scale failure increases as systems at different resolutions sync up; this might happen in the airline business if slowing growth at Boeing and Airbus prompts them to get into the pilot training and plane maintenance businesses in a big way.

There are four attributes of complex systems, in particular, that inform the policy tools and principles that are proposed later on: conflicting explanations, hierarchy, cycles and multiple equilibriums, and surprise and novelty.

### ***A. Conflicting explanations***

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 (Skyttner 2001:92). In other words, there are many, non-overlapping but equally valid descriptions for a complex system. Any given model under-represents the system. This means that conflict in policy making is unavoidable – as soon as people have different perspectives, they will have different assessments of the situation, and valuations of desirable outcomes.

Any model that purports to capture the behavior of a system necessarily under represents it (Bankes 2002). It is not possible to set up analytical models for complex systems. No model less complex than the system itself can exactly, and in detail, forecast their behavior. It’s a trade-off: analytical tools work for complicated systems that are relatively predictable, and for simple systems that are uncertain, but not for complex, uncertain systems.<sup>27</sup>

Conflicting explanations compound a deeper issue: the lack of agreement on the problem at hand. Many policy debates entail deep uncertainty, defined by Lempert et al. (2002, 2004, following Kenneth Arrow) as the condition where the decision maker does not 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. Deep uncertainty resembles Knightian uncertainty, where randomness cannot be expressed in terms of specific mathematical probabilities. Rittel and Webber (1973) 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 for an enumerable set of potential solutions.

The many models used to describe the internet/web are instances of the complementary law at work.<sup>28</sup> They include the many metaphors discussed above, as well as the variety of current and proposed regulatory frameworks, such as the industry/technology segmentation of titles in the US communications statutes, the technology neutral approach of the EU Framework Directive, and the various layer models.

### ***B. Hierarchy***

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<sup>27</sup> There are, though, pockets of predictability in complex adaptive systems – see Andersen & Sornette 2005.

<sup>28</sup> This means that the approach of this paper is also necessarily incomplete and doesn’t replace others.

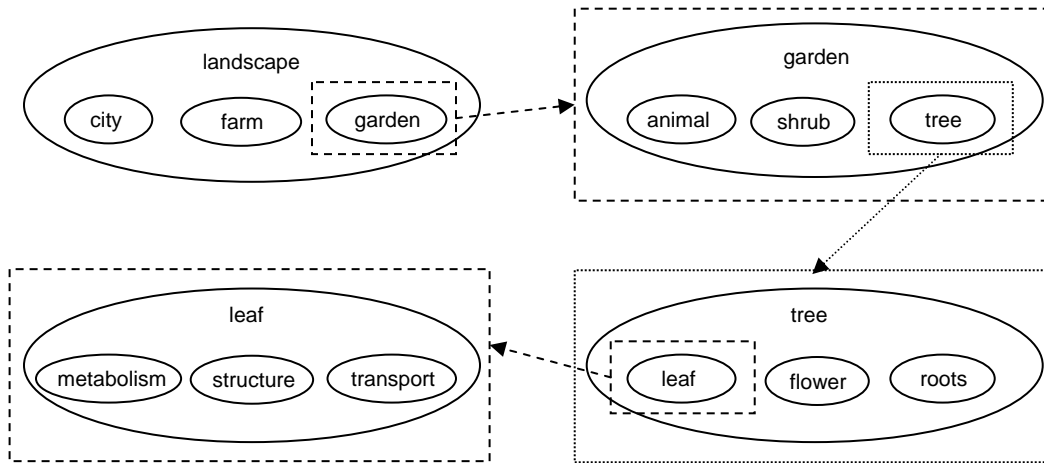
Systems consist of nested subsystems with linked dynamics at different scales. As a system grows, its complexity increases and a hierarchy emerges. Each level is made up of several systems, which can be decomposed at a lower level. The higher levels control certain aspects of the lower level subsystems: less complex systems control more complex ones (Skyttner 2001:60).

Panarchy theory (see e.g. Gunderson & Holling 2001), describes how hierarchies turn into dynamic structures in a biological setting. Natural systems have a variety of time/space scales. Growth and collapse cycles operate at different rates at each scale. Individual levels of the hierarchy have non-linear multi-stable properties which can be stabilized or destabilized through critical connections between levels. 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're vulnerable, e.g. 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 the accumulated seed bank and soil nutrients to regrow. In the late part of the growth phase at a given scale, three things are happening simultaneously: the system's potential for novelty is increasing, its connectedness and self-regulation are increasing, but its overall resilience is falling. At this point, a sudden event can trigger the collapse of the whole ecosystem.

Resilient systems have good connectivity, but not too much – over-connecting leads to fragility. Thomas Homer-Dixon (2006) 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.

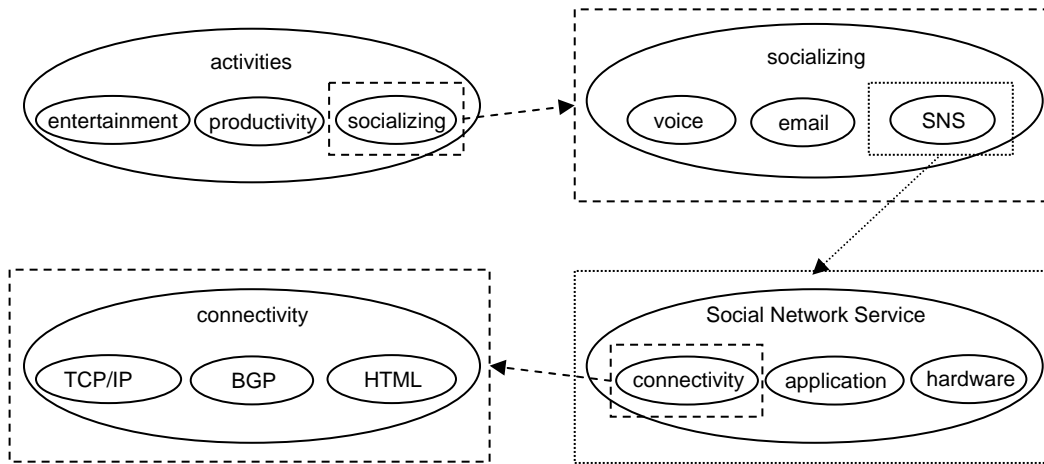
Figure 2 shows drills down into one particular cut through the system/subsystem nesting for gardening. Note that each layer is the unpacking of a super-system at the

immediately preceding scale: think nesting matryushka dolls, not a layer cake.



**Figure 2: A garden as a set of hierarchically nested systems.** The nesting reads clockwise, starting from top left. Many levels in the hierarchy are omitted. Note that sub-systems are re-used, e.g. shrubs as well as trees have leaves, and elements of leaf structure are also found in flowers.

Figure 3 drills down into one particular cut through the system/subsystem nesting for the internet /web:



**Figure 3: The internet/web as a set of hierarchically nested systems.** The nesting reads clockwise, starting from top left. Many levels in the hierarchy are omitted. Note that sub-systems are re-used, e.g. connectivity is used by email as well as SNS.

The application scale of the internet/web seems to be in a growth phase. There is a great deal of novelty, connectedness between subsystems is increasing (cf. mash-ups), and acquisitions by large companies in the midst of continuing start-ups indicates that increasing industry complexity. The available niches are beginning to fill up. If panarchy theory is applicable, it would suggest that resilience at this scale is decreasing. In practice this might mean that the system is at risk of capture by a monopolist. This may well lead to on-going diversity; when Wintel took over computing in the 80s, the standardization at the platform layer led to a vibrant application business. The network scale, on the other hand, is relatively mature. There is still some consolidation as Ma Bell is reassembled from the pieces left by Judge Green's break-up.

The hierarchy implicit in a complex system suggests why a layers approach has some value for guiding policy: if one treats different scales of analysis as layers, then they seem self-evident. However, since the hierarchy is in fact encapsulation rather than superposition of equivalent structures, separation between layers will always turn out to be problematic in practice. For example, one can represent the four layers of Werbach (2002) or Solum & Chung (2003) as a sequential unpacking in the same way as above (Figure 4):

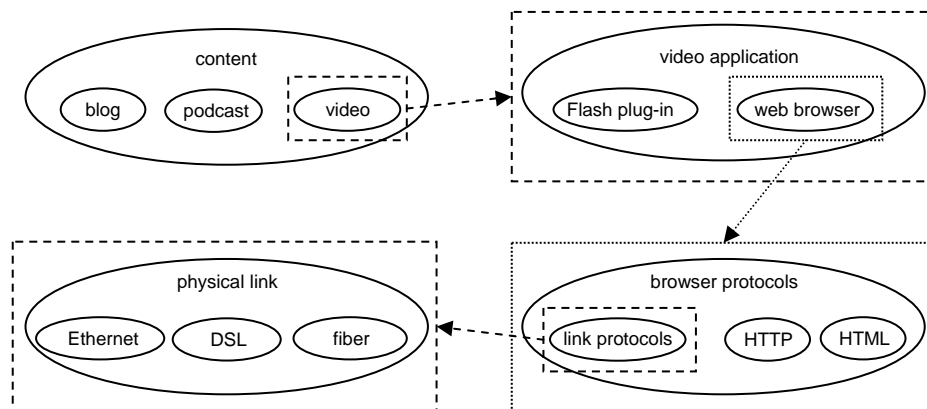


Figure 4: The layers as a set of hierarchically nested systems. The nesting reads clockwise, starting from top left.

### C. Cycles and multiple equilibriums

Complex adaptive systems can have many equilibrium states, shifting from one to another from time to time. 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.

Holling's panarchy theory (Gunderson & Holling 2001) proposes that biological systems exhibit cycles of growth, collapse, regeneration, and again growth. Such systems have a variety of spatial and temporal scales, and this adaptive cycle operates at different rates at each of them. During the *exploitation* stage of the cycle, there is rapid colonization of recently disturbed areas, for example after a forest fire or windstorm has

removed large amounts of biomass in a forest. The connectedness between organisms is low, which leads to high resilience; the loss of one doesn't lead to the loss of another. As the forest matures it moves into the *conservation* phase, 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; food chains become dense and interconnected. The conservation phase is followed by a dramatic *release* phase, triggered in a forest by fire, drought, insect pests, etc. A lot of energy is unbound, and networks are broken up. This sets the scene for the fourth phase, *reorganization*: opportunistic species, which have been suppressed by the stable configuration of the conservation phase, move in. This is a period of innovation and restructuring, laying the groundwork for a return to another exploitation phase. A system is robust if the cycles at different scales aren't in sync, e.g. a forest is relatively robust against catastrophic fire damage if its peak maturity (and thus susceptibility to fire) doesn't coincide with a temperature peak in the regional climate cycle.

Jain and Krishna explored punctuated equilibrium of biological ecosystems (Beinhocker 2006:174). They find repeated rounds of crashes in which several species get rapidly depopulated, followed by recoveries. The system starts in a "random phase," where it burbles along without much structure. An innovation suddenly sends the system into a "growth phase"; there's a innovation cascade, which eventually flattens out into an "organized phase" which is highly structured with keystone species at critical points in the interaction web. When an innovation or random change hits a keystone species, the network crashes in a wave of extinctions, leading to a restart again in the random phase.

One can map the Holling adaptive cycle to phases in industry. When technology or some other disturbance opens up a new market, there is an *exploitation* phase where economic connectivity is low; supply chains are rudimentary.<sup>29</sup> Consolidation follows: a *conservation* phase where revenues grow steadily and everybody finds their niche and stops competing at the margins. Innovation begins to decline. There follows a *release* phase where some disruptor breaks the reigning industry model, and a lot of money is lost.<sup>30</sup> 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.

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<sup>29</sup> Even though economic connectivity may be low, social networks may be rich. Peter Haynes points out (pers. comm.) that the most innovation takes place in geographical concentrations where there is very high inter-personal connectivity and quick cycle speed. Dependencies remain low, though; the failure of one start-up doesn't lead to the failure of a series of others.

<sup>30</sup> 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. The 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, or antitrust attack.

Many if not all commodity markets show booms and busts (Sterman 2000, Ch. 20). Economies show all the characteristics of complex adaptive systems.<sup>31</sup> One can be confident that such phenomena occur in the communications industry too.

One can see the adaptive cycles of panarchy theory at work at various scales of the ICT industry.<sup>32</sup> For example, in the early days of mainframes, there were few applications. The numbers grew as the customer base expanded, though most apps were developed in-house by hardware vendors. The introduction of the PC disrupted this pattern, leading to a decline in the relative importance of mainframe applications. At first there were few PC apps, but then VisiCalc provided the breakthrough that led to the explosion of PC apps in the early 90s. The interconnection between apps was low at first, but grew (cf. OLE, and application suites). The advent of the web in the mid-90s decimated the PC app business: we've gone from whole retail stores devoted to software to a single aisle at Circuit City. Egghead was founded in 1984, and closed its retail operations in 1998.

At a deeper nesting in the hierarchy, consider communications services. 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, which have now decreased again to a handful in the early 2000s.<sup>33</sup> In data communications, North American ISPs grew from 1,400 in 1996 to 4,000 in 1997, and then consolidation set in again.

Many complex systems show alternative stable states, i.e. two (or more) equilibrium configurations of an industry or ecosystem. A favorite model of ecologists is lake turbidity, in which biological and political processes are intertwined (Scheffer 1999, Scheffer et al. 2002). The more vegetation in a lake, the clearer the water (i.e. 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.<sup>34</sup> However, once some nutrient load is exceeded, the lake-bottom plants all die off because of lack of light, and the lake flips into a high-turbidity state from which it won't recover even if nutrient loads are reduced below the critical

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<sup>31</sup> Samuelson worked on this in the 30s, and Beinhocker (2006) provides a contemporary survey.

<sup>32</sup> Perhaps the internet/web is so recent that it hasn't been around long enough to meander through enough of parameter space. It's mostly been in start-up/growth mode, and may be heading for maturity; the crashes are yet to come.

<sup>33</sup> W. A. Brock (2001) tells the story of AT&T in terms of the 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.

<sup>34</sup> 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.

point. Nutrients have to be reduced a lot, much below the critical point, to flip the lake back to the low-turbidity state. Economic analysis and political pressure tends to drive the system to be managed at the point where turbidity is low while nutrient input from agriculture is high – a point which is unstable to small variations in inputs, which can lead to a rapid tipping into high turbidity from which it is costly and politically difficult to return.

Integration and dispersal of distribution and content production seem to be two stable states in the video business. In the 80s the cablecos (e.g. TCI) used control of the pipe to get control of content producers. However, by the 1990s they'd started to spin out the media companies (e.g. Liberty Media spinning out of TCI/AT&T in 1991) and now we're back to pretty much pipe-only cablecos.<sup>35</sup> Those who worry about the power of local internet access providers argue that they may be in a position to repeat the integration of transport and content seen in cable systems.

There have been waves of consolidation of control over content in the over-the-air, cable and satellite businesses, not to mention movies. In each case the disrupter (cable vs. broadcast, satellite vs. cable) was blocked by the incumbent as it tried to gain access to content. One might predict that this will happen again on the internet/web as direct-to-PC players try to supply content. This has definitely happened with telcos trying to put together packages for their fiber plays; the Viacom/YouTube litigation may be the rerun on the web.

One learns from ecology that these disruptive cycles are unavoidable and indeed healthy since they lead to innovation – they get rid of incumbents for a while and allow new experiments. The trick is to ensure that the collapses are localized and controlled. For example, a lot of small, local forest fires keep the litter load down, and prevent massive fires that burn so hot that they essentially sterilize the soil which precludes seed germination and soil health.

#### ***D. Surprise and Novelty***

It is very difficult to discern cause and effect chains in many complex systems. The interlocking interactions of subsystems generate behavior that cannot be tied back to the isolated behavior of single components. When cause and effect can be linked, the distance (in time or space) between the events can be very large.

Even systems that have been developed to have deterministic behaviors, like biological organisms and human-engineered machines, are unexpectedly and catastrophically fragile in some rare configurations (Carlson & Doyle 2002).<sup>36</sup> Their

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<sup>35</sup> See e.g. Stephen Keating, *Cutthroat: High Stakes and Killer Moves on the Electronic Frontier* (Boulder: Johnson 1999). David Waterman & Andrew Weiss, *Vertical Integration in Cable Television* (Cambridge: MIT Press 1997). Megan Mullen, *The Rise of Cable Programming in the United States* (Austin: U of Texas Press 2003)

<sup>36</sup> Such systems are highly structured, non-generic, and have self-dissimilar internal configurations at different scales and levels of abstraction; they are not the sand piles and flocks of dumb automata so often treated in complexity theory.

external behavior is typically robust, but there's 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 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 rogue mutation can trigger a fatal cancer.

Doyle & Csete (2007) give the internet as an example of robust-yet-fragile behavior: 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. Anderson et al. (2002) point out that the proven resilience of the internet does not apply to all failure modes. They note that systems obeying the syntax of a protocol may in fact be behaving incorrectly, and remark that such failures occur with surprising regularity.

In sum, one cannot predict the outcomes of interventions in a complex adaptive system with much if any accuracy. This is true even for relatively constrained policy domains, since policy interventions almost by definition stress the system in unanticipated directions, unexpected behavior is to be expected here, too.

Further, humans have an innate tendency to overestimate their ability to predict key trends and discontinuities (Lempert et al. 2002, Taleb 2001). Surprise stems from several sources (Lempert et al. 2002): extrapolating the present even though discontinuous jumps are common shapers of the future; under- or over-estimating the extent of an anticipated event; not anticipating 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 prophecies where predictions elicit responses which counter their expectation. Human intuition is particularly prone to break down under conditions of complexity.

The upshot is that "rational policy making" is little more than inspired bets rationalized after the fact with "Just So" stories. This is revealed by unintended consequences and self-fulfilling prophecies, the two faithful companions of decision making.

Stories of unintended side effects are rife in ecology. For example, southwestern states are now struggling to eradicate buffelgrass from the Sonoran Desert. It was introduced by government officials after the Dust Bowl in an attempt to hold the soil and provide feed for cattle. It's unfortunately turned out to be an invasive weed that threatens the desert ecology, choking out native plants like the iconic saguaro cactus.<sup>37</sup> Another example of biological control gone wrong is the introduction of the cane toad into Australia in 1935 to control sugar cane pests: it did not control the insects and the Cane

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<sup>37</sup> By Faye Bowers, Faye (2007) "Goal for these desert troops? Bag the buffelgrass." *The Christian Science Monitor*, May 31, 2007. Available: <http://www.csmonitor.com/2007/0531/p01s01-usgn.html>

Toad itself became an invasive species.<sup>38</sup> Sometimes, probably more by luck than judgment, it works out; for example, the release of myxomatosis in 1950 was successful in controlling feral rabbits in Australia.<sup>39</sup>

An early example of self-fulfilling prophecy in statecraft was the rumor that led to the fall of the Tang Dynasty.<sup>40</sup> Word started spreading in the Imperial capital in 617 C.E. that someone named Li would take over the throne. Since the current emperor was a Yang, that caused some concern. Emperor Yang Guang duly started disposing of any influential players called Li, which led to a provincial governor Li Yuan rising up in revolt, since he was persuaded that it was better to rebel and seize power rather than wait to be destroyed by Yang Guang. The current dynasty was in trouble anyway, with discontent among the populace due to unpopular border wars and labor levies to build what would become the Grand Canal. It is unclear whether the dynasty would have fallen without this rumor; it's certain that Li Yuan would not have risen up without it.

John Sterman coined the term “policy resistance” to describe the tendency for interventions to be delayed, diluted or defeated by the response of the system to the intervention itself (Sterman 2000, sec. 1.1.1); one might also think of it as “policy ricochet.” There are many examples in bio-system management. The US Forest Service’s efforts to control wildfires shows fire suppression leads to a build-up in flammable material that leads to catastrophic blazes.<sup>41</sup> Pesticides and herbicides stimulate the evolution of resistant pests and weeds, and suppressing a pest leads to a flourishing of its prey – to such an extent that the pest suddenly returns in greater force than before.

At a policy level, the Telecommunications Act of 1996 was intended to increase competition in competition, but appears to have had the opposite effect (Economides 1998, Hazlett 2000).<sup>42</sup>

Conceiving of the internet/web as a complex social system rather than a deterministic economic or technical problem changes how one thinks about entrepreneurs, researchers, consumers, and policy makers. They are no longer external controllers of, or parameters in, a techno-economic system; rather, they are adaptive agents within an integrated social-economic-technical system.

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<sup>38</sup> Blatchford, John (2007) “Cane Beetles” Apr 16, 2007. Available: [http://insects.suite101.com/article.cfm/cane\\_beetles](http://insects.suite101.com/article.cfm/cane_beetles)

<sup>39</sup> Australian Government, Department of the Environment, Water, Heritage and the Arts (not dated) “Feral animals in Australia”. Available: <http://www.environment.gov.au/biodiversity/invasive/ferals/>

<sup>40</sup> Hammond, Kenneth J (2004) “Lecture 11: Sui Reunification and the Rise of the Tang,” *From Yao to Mao: 2000 Years of Chinese History*, The Teaching Company

<sup>41</sup> Fred Pearce, “Wild about fire”, *New Scientist* 11 November 2000 <need more fire references>

<sup>42</sup> Economides (1998) concludes that “more than two years after the passage of the Act, there is very little entry and competition in local exchange markets.” Hazlett (2000) finds that “[i]mprovements in competitiveness are modest by some standards but impressive when judged against the results of other legislation with the announced goal of increasing market rivalry.” He also notes that suggest that the wave of mergers was probably an unanticipated result of the Act.

## VI. AN EXAMPLE: REGULATING VIDEO SERVICES

Video programming is traditionally heavily regulated. Rules cover a wide front, including broadcast technology standards, content regulations and production quotas, access for people with disabilities, limiting the types and time of advertising, and controlling content such as sex, violence, and political speech.

Policy makers' overall objectives are productivity and resilience: there should be a large amount of high quality video content that meets consumer demand and social needs, which should continue without pause in spite of dramatic changes in technology and business models.

Rules on entertainment services such as video programming serve a variety of public interests. Most of the policy imperatives come into play. **Revenue** implications include covert subsidies to local content producers through quotas on broadcasters, and funding mechanisms for public broadcasters. **Consumer protection** measures include rules to ensure that the disabled have access to content, e.g. through closed captions and embedded audio descriptions. In the pursuit of **economic vitality**, policy makers seek to favor local over foreign producers through hidden subsidies, local/regional standards, content quotas, and industrial policy. They may also intervene if market power seems to prevent entry of new services. Many content rules are framed in terms of protecting local **cultural values**, either in kind of cultural production, or ancillary material like advertising content. However, they can be hijacked by ambitious policy makers seeking to burnish their populist credentials.

The traditional video content sector was orderly, with a limited number of participants; it looked a lot like farming. The regulator could ensure that the "right" crops were planted through subsidies and rules that applied to a well-defined and comparatively predictable arrangement. Video content on the internet is more like multiple-use forest land with its many settings and uses. There are many ways to consume television: broadcast content over the air, satellite, cable, and internet; and on-demand video via cable and internet. There is a spectrum of content quality from amateur to professional. Viewers have widely varying needs and wants, from education and entertainment to politics and building social networks.

There is a well-developed body of regulation for traditional broadcast technologies, but it is not clear how to apply it to new media. Simply re-applying old regulations to new services/technologies may suppress creativity: socially beneficial new services that don't fall in traditional categories premised on semi-monopolies and well-defined distribution channels might never appear. For example, if all internet video had been required to support video description<sup>43</sup>, there might never have been the flood of user-generated on-line video material using American Sign Language<sup>44</sup>.

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<sup>43</sup> Video description is an aural description of a program's key visual elements that is inserted during natural pauses in program dialogue. See e.g. <http://www.fcc.gov/cgb/dro/pam.html>; similar rules apply in many other countries.

<sup>44</sup> [http://www.youtube.com/results?search\\_query=ASL+vlog&search=Search](http://www.youtube.com/results?search_query=ASL+vlog&search=Search)

The new industry is not as easily controlled as the old; there are too many things going on, and too many variations. Regulators can guide outcomes in a positive direction by providing clear statements of what is required; setting up appropriate incentives and deterrents; giving individuals, civil society and the market time to meet the challenge; and finally intervening with detailed rules if voluntary action has failed. For example, the video game industry set up the Entertainment Software Rating Board (ESRB) in 1994 to assign computer and video game content ratings. The threat of Congressional action undoubtedly concentrated the minds of the industry.<sup>45</sup> Policy makers got the outcome they desired, without having to get into the details of defining ratings themselves.

Looking ahead, regulators would be well advised to let the internet/web generate local content before specifying rules that will necessarily solidify a particular way of doing things. In January 2008 Wikipedia claimed to have more than 75,000 active contributors working on some 9,000,000 articles in more than 250 languages.<sup>46</sup> This is a great deal of material that could not have been produced commercially even at the behest of a policy mandate, and that could not have been foreseen.

Internet/web content is blurring many previous classificatory boundaries. A piece of video can show up on a TV, a PC, or a phone; it can be delivered as a real-time broadcast, off-line podcast, or on-demand web video. Depending on the context and interpretation, different traditional categories might apply. Applying the most stringent rule to all cases will squelch creativity; it would be like always using the most potent insecticide once a pest is found, no matter the effects on a particular grove. Regulators should think broadly about the implications of regulation, since the highly connected nature of the internet will propagate the effects rapidly. For example, former FCC Commissioner Susan Ness (2006) argues that of the 1996 Telecommunications Act had the unintended consequence that the prolonged Digital Television transition has delayed freeing up spectrum vitally needed by first responders. At the other end of the political spectrum, the Electronic Freedom Foundation concluded that the “anti-circumvention” provisions of the Digital Millennium Copyright Act (“DMCA”) have not been used as Congress envisioned; for example, rather than focusing on pirates, many copyright owners have chosen to use the DMCA to hinder their legitimate competitors, which impeded competition and innovation.<sup>47</sup>

Consequently, policy makers should devise the least constraining rules consistent with the situation at hand, and build in time-scale to revisit them.<sup>48</sup> Since both mores and technologies evolve, a mechanism should be built into policy to allow relatively easy

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<sup>45</sup> Nichols, Peter M. “Should video game makers police themselves? The issue sparks a dispute between the industry’s titans, and a chance of legislation from Congress.” *New York Times*, Dec 17, 1993

<sup>46</sup> <http://en.wikipedia.org/wiki/Wikipedia:About>

<sup>47</sup> “Unintended Consequences: Seven Years under the DMCA”, Version 4, April, 2006. Available at: <http://www.eff.org/wp/unintended-consequences-seven-years-under-dmca>

<sup>48</sup> The end of regulatory supervision inevitably generates a great deal of angst; see e.g. [http://findarticles.com/p/articles/mi\\_m3169/is\\_14\\_39/ai\\_54301407/pg\\_1](http://findarticles.com/p/articles/mi_m3169/is_14_39/ai_54301407/pg_1) about the end of cable rate regulation in 1999. If the concerns are great enough, the end of a sunset may in fact generate new rules. <example?>

adjustment of rules (though it should not be too easy, because that would be prey to hysteria and the madness of crowds). For local content, regulators should not lock in a particular funding regime for local video content, e.g. by cloning existing rules for broadcast TV. Since the internet video is still evolving rapidly, it would be wise to see how the situation evolves. One may need a new approach for the multiple new kinds of video distribution on the internet that will only become evident as the new distribution channels mature.

At any given moment, particularly since policy making is often driven by a recent crisis, there will be a temptation to tailor rules to a particular case. This will lead policy to be optimized for a particular outcome, which will likely be moot in the near future – a failure of resilience in the system. For example, Guo (2003) relates that in the early days of Chinese television the main responsibility for broadcasting rested with local governments, under the administrative authority of the State Council. This worked while there were fewer than 30 regional stations. The exponential growth of Chinese television in the late 1970s rendered this system obsolete and ineffective, which led to four-tiered broadcasting system being introduced in 1982. Looking ahead, advertising rules tailored to commercials interspersed between segments of a show cannot be generalized to product placement; product placement rules geared to practices at a given time will be made obsolete by workarounds that industry finds.

Existing consumer protection rules that are framed for the traditional business model may not apply to new media; in fact, they may actively discourage new kinds of content, such as that funded through advertising. This may benefit incumbents, and while it might protect the industry from a painful restructuring for a while, it will only reduce the production of content and exacerbate the eventual collapse (Principle: resilience). For example, a panel of economists convened by the AEI-Brookings Center argued in 2006 that forcing new providers of video services to obtain franchises in every municipality, which is intended to protect local consumers, will discourage competitive entry.<sup>49</sup> Looking ahead, rules that encourage entry by forbearing from imposing public broadcaster rules on start-ups will generate innovation, services, and revenues. Limiting the ways in which advertising can be used to fund programming, particularly for emerging services, can reduce the diversity and vitality of content providers by putting a cap on revenue potential.

A healthy garden, forest or farm has a diverse mix of species; monocultures need debilitating amounts of fertilizer and pesticides, and are susceptible to sudden infestations. The analogy is well understood in North America and Europe, where there are periodic controversies over the dangers of the consolidation of media power in a few hands. These polemics are usually based on worries about culture and values; however, economic diversity is also important in its own right.

In summary, policy makers should focus their effort on defining what's acceptable and what's not, and providing incentives for desirable outcomes. They should reserve

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<sup>49</sup> “Economists’ Statement on U.S. Broadband Policy” (2006) *AEI-Brookings Joint Center for Regulatory Studies*, Related Publication 06-06, March 2006. Available at <http://www.aei-brookings.org/admin/authorpdfs/page.php?id=1252>

powers to penalize providers that eventually don't meet their criteria, rather than trying to specify in detail, in advance, how content should be produced and distributed.

Analyzing video services on the internet/web in the light of the garden metaphor has suggested a number of regulatory tools. In the next section I will ground these tools, and a few more, in complex systems dynamics, and derive some overarching principles that generalize them:

- Keep an open mind: Don't prejudge outcomes: unintended consequences abound. Focus on ends, not means.
- Delegate: Set up appropriate incentives and deterrents; give individuals, civil society and the market the opportunity to meet the challenge.
- Set clear boundaries: Once clear expectations have been set, intervene with detailed rules only if an unwanted result occurs. Build in a time-scale to revisit regulation.
- Holism: Think broadly about need for and context of regulation.

## VII. POLICY TOOLS AND PRINCIPLES

Given that making policy for the internet/web is like gardening a large and complex biological system with many human stakeholders, what outcomes should a policy maker seek? And what mix of intervention and forbearance – since forbearance is as much an action as intervention – are most likely to deliver on the public policy imperatives?

The over-arching policy goals are **productivity** and **stability**. Society wants as much value from the internet garden as possible, in terms of both economic welfare and cultural benefits. Since innovation is a proven source of social welfare, policy makers need to create an environment where beneficial serendipity occurs. The policy maker also needs to ensure that productivity continues as smoothly as possible; this requires the system to be stable. However, given the susceptibility of complex systems to cycles and shocks, resilience is the best one can hope for. Values such as equity and justice are outputs of a properly productive social system.

The next task is to find ways to deliver productivity and resilience given the characteristics of complex social systems. Decisions in internet/web policy, like those in gardening or other policy debates, concern processes that exhibit surprise, self-referential/feedback loops situations, and imperfect information. Forest managers need policies that work during all phases of the biological cycle, from growth and maturity to collapse and regeneration. In the same way, communications policy needs to address both mature industries and sectors in flux. We need a policy approach that works equally well for traditional telecoms and the burgeoning web.

Since communications systems are constantly changing, a policy approach should be built on a few enduring principles that apply no matter which phase of the adaptive cycle the internet/web, and its successors, finds itself. This section explores a variety of

tools that can be used to obtain these outcomes. The tools turn out to be ways of implementing three policy principles: experimentation, flexibility, and resilience. The principles (strategies) and the tools (tactics) are a bridge from a given set of circumstances to a set of policy actions and inactions. The principles are sufficiently general to maintain their value even as technology and business models evolve, but specific enough to be a guide to action.

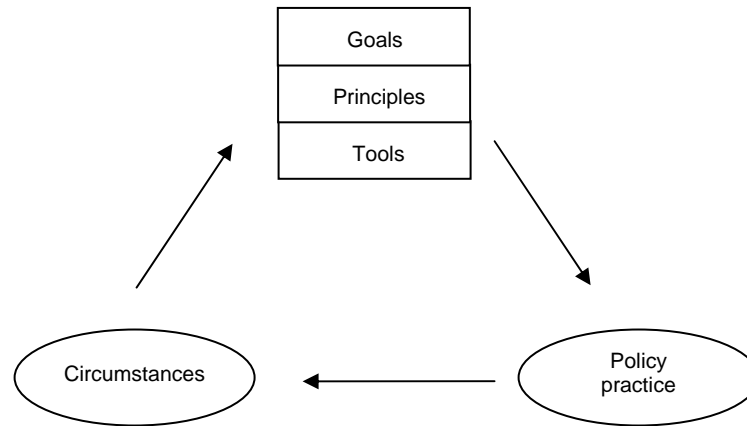


Figure 4: The Policy Cycle

## A. Tools

### 1. Diversity

Diversity: Encourage new companies and industries to enter markets.  
Act against firms that abuse significant market power

A lack of biodiversity was a contributing factor to several agricultural disasters, including the Irish Potato Famine, the European wine industry collapse in the late 1800s, and the US Southern Corn Leaf Blight epidemic of 1970. A diverse range of organisms contributes to the resilience of agricultural and natural ecosystems, their capacity to recover from environmental stress and their ability to evolve. It increases food security. Species diversity reduces external input requirements in farming by increasing nutrient availability, improving water use and soil structure, and controlling pests naturally.<sup>50</sup>

Diversity refers to a large variety of different players, with different goals and means. In an industry context, diversity entails nurturing new entrants (both new firms

<sup>50</sup> “Biological diversity in food and agriculture,” *Food and Agriculture Organization of the United Nations*, available at: <http://www.fao.org/biodiversity/index.asp>

and new industries) and allowing them time to mature. A seedling needs special care for the first few years, making sure that it has enough water and fertilizer, and is protected from being eaten by snails or deer. Once it has become established, it no longer needs protection and becomes productive. Similarly, early stage companies and industries may need protection from competition for a limited time.

Wells & Darby (2006) argue that economic diversity can bring particular benefits to society that parallel those to be found with bio-diversity including economic resilience, variegated opportunities in terms of employment choices, regenerating localities, and activities that are in harmony with the characteristics of the locality, both human and natural.

Diversity needs to be maintained. A market economy is the most efficient available way to create and allocate goods. The competition which is at the root of the success of markets, however, necessarily also provides incentives for firms to establish monopolies or cartels. These structures, if unchecked, allow firms to extract non-cost based rents, and extend their dominance into adjacent markets. While market dominance has some benefits in terms of standardization and stability, it also reduces diversity. This reduces innovation, and the robustness of the market system to unexpected shocks. It is necessary to have provisions that limit the ability of firms to abuse significant market power to the detriment of the overall health of the system.

The European approach to telecommunications regulation s described in Marcus (2002) provides a useful framework for encouraging diversity through market entry. It focuses on responding to market power. 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, any such obligations must be rolled back. The review of the EU Framework Directive indicates that European regulators continue to be mindful that diversity is 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.<sup>51</sup>

## 2. *Open Mind*

Open Mind: Don't prejudge outcomes. Do not specify the implementation in detail. Determine ends, not means. Policy should be technology and business-model neutral. Prefer *ex post* to *ex ante* action. Prepare for unexpected events.

Surprise, sometimes experienced as failure, is the normal case in complex systems; long-term prediction is impossible. Since the outcome of system evolution is so uncertain, it is unwise to pick, predict or optimize for a specific preferred outcome; this is bound to lead to disappointment at best, and many undesirable, unintended consequences at worst.

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<sup>51</sup> See e.g. [http://ec.europa.eu/information\\_society/policy/ecommm/tomorrow/reform/index\\_en.htm](http://ec.europa.eu/information_society/policy/ecommm/tomorrow/reform/index_en.htm), <http://www.ovum.com/news/euronews.asp?id=6374>

Regulators seldom if ever have sufficient knowledge and control of the system that they can drive it to a specific outcome; not only do they not have enough knowledge or control, but any path towards an outcome is made obsolete by ongoing adjustments by the system being regulated. This suggests that *ex ante* regulation is ill-advised in most cases: the problem that it is intended to solve may be misidentified due to the complexity of the situation; even if correctly identified, the problem may self-rectify without intervention; and any regulation will immediately have consequences beyond just those required to address the problem at hand. This implies *ex post* rather than *ex ante* regulation. *Ex ante* regulation may, however, be necessary in cases where there is a clear and present danger of the entrenchment of market players who already have significant market power. Action may be needed to maintain the system diversity which is required for robustness.

Ignorance of the details of how a rapidly evolving system works, combined with the likelihood of unwanted and unexpected effects of intervention, means that regulation should fix as few parameters as possible to achieve its goal.

It is important to separate outcomes from mechanisms. Policy makers have limited control over the system, and can only affect output through indirect means; even if they were to define mechanisms, they would undoubtedly be a very limited subset of what the system could come up with. They should therefore focus on ends, not means.

Regulation should therefore strive to be agnostic about technology and business models. Firms and consumers that actually generate public goods are best placed to do the detailed implementation within frameworks created by policy. The government should not, and cannot, design products. If intervention is necessary, it should set overall performance requirements, not specifications. Since the outcomes of interventions in complex adaptive systems like the internet/web are hard to predict, there should be a bias against detailed policy prescriptions that purport to achieve a specific outcome, e.g. achieving network neutrality.

Regulators have successfully used a hands-off approach in spectrum allocation, in both unlicensed and flexible-use licensed cases. For example, unlicensed allocations set limits on device characteristics, such as maximum transmission power, and prohibit harmful interference to licensed services that may share a spectrum band. Device manufacturers and service providers are free to innovate as they wish within these constraints. In the 2.4 GHz ISM band, for example, one finds a variety of technologies (e.g. a plethora of Wi-Fi standards, Bluetooth devices, and cordless telephones) and business models (e.g. free local hotspots, for-fee hotspot networks, and community networks). Flexible-use licensed spectrum has also seen dramatic shifts, e.g. from analogue to digital networks during the 1990's. These policies have gained momentum as US policy makers and scholars across a broad spectrum have concluded that "command and control" policies that manage the uses and users of spectrum in fine detail have failed to use resources efficiently.

There was a flurry of concern about interoperability between instant messaging (IM) systems in the US around 2001. Microsoft and Yahoo pushed for IM interoperability as a condition of the AOL/TW merger. They hoped to pressure AOL to make its then-dominant IM system interoperable with competitors. In August 2003 the FCC removed the requirement, imposed in early 2001 during the AOL Time Warner

merger, that AOL provide IM interoperability.<sup>52</sup> Eventually, in 2005 Microsoft and Yahoo announced that their systems would interoperate with each other; at that point, their market share was comparable to AOL's.<sup>53</sup> The shift in attention from IM to other communication modes like social network sites, as well as third party tools like Trillian<sup>54</sup> and Jabber<sup>55</sup> that allow users to connect across all the major IM services, have rendered the debate moot.

The European policy stance, as evidenced in the 2007/2008 review of the EU Framework Directive, continues to move in the direction of *ex post* regulation. The Commission proposes to remove *ex-ante* regulation from most markets in the telecoms sector, and only to maintain *ex-ante* regulation in those markets where competition is not yet effective.<sup>56</sup> The difficulty of passing network neutrality rules in the US during 2007 indicates that at least some participants there also worry about *ex ante* rules which presume that broadband providers will necessarily discriminate in harmful ways among data streams.

Policy planning should include developing contingency plans and making preparations for adverse events. Precautions should include ensuring that a regulator has the power to act, without requiring them to. The bigger the downside risk, the less one should optimize for a particular expected case. For example, since imposing telecom tariff rules on all voice communication could stifle, say, in-game voice chat, regulators should hesitate about taking this step.

### 3. *Delegation*

Delegation: Rely on players close to the action, like consumers, firms and civil society, to solve problems in the first instance; regulate only if they fail.

Both gardeners and policy makers can exert only limited control over their charges, in the first instance 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.

Even if it were possible, close management is often harmful. Managing 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 (Holling et al. 2001, Ch. 1). For example, effective flood control leads to higher human settlement

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<sup>52</sup> <http://www.techlawjournal.com/topstories/2003/20030820.asp>

<sup>53</sup> According to Radicati Group, quoted in the Register, at that time Microsoft and Yahoo! held 44% of the worldwide IM user base between them, with AOL taking 56%; see [http://www.theregister.co.uk/2005/10/12/microsoft\\_yahoo\\_im\\_interop/](http://www.theregister.co.uk/2005/10/12/microsoft_yahoo_im_interop/)

<sup>54</sup> [http://en.wikipedia.org/wiki/Trillian\\_\(instant\\_messaging\\_client\)](http://en.wikipedia.org/wiki/Trillian_(instant_messaging_client))

<sup>55</sup> <http://www.serverwatch.com/news/article.php/3641361>

<sup>56</sup> See e.g. [http://ec.europa.eu/information\\_society/policy/ecommm/tomorrow/reform/index\\_en.htm](http://ec.europa.eu/information_society/policy/ecommm/tomorrow/reform/index_en.htm), <http://www.ovum.com/news/euronews.asp?id=6374>

densities in the fertile valleys, and a large investment in vulnerable infrastructure. When a large flood eventually overwhelms the dams and dikes, the result is often a dramatic reconfiguration of the social and economic landscape along the river. Ultimately, technocratic management of single parameters leads to instability of the entire system.

Control of a system can be achieved only if the variety of the repertoire of controller is at least as great as the variety of the situation to be controlled.<sup>57</sup> 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.<sup>58</sup> These laws imply that a regulator cannot control a system directly; it needs to work through intermediaries through delegation. This accounts for the control hierarchy in communications, where Congress enacts general laws and the FCC implements regulations at the federal level, with a similar structure (legislatures and public utility commissions) at the state and local levels. Legislation and regulation at the higher level necessarily has to be general and focus on just a few parameters. There isn't enough variety or rapidity in the repertoire of, say, the FCC to match the fluid situation "in the wild." Actors closer to the action are more able to exert effective control over their part of the system, and generate change.

Decentralized, local, self-optimizing searches for consumer benefit are more efficient at finding solutions than central planning; hence, policy makers should rely on firms and civil society first, and regulate only if that fails. Allowing the market and civil society an opportunity to solve a problem without the constraints and ancillary consequences of regulatory action is likely to produce a more satisfactory solution than the regulator trying to act as a market/consumer surrogate.

In some cases, market participants may not have sufficient economic incentive to address a social problem without incentives and threats. Regulators may still be able to achieve the desired outcome without having to act simply by taking powers and/or threatening action. An exception can be made to this approach if there is a clear prospect of loss in consumer welfare through lock-in by an unregulated incumbent.

The self-regulation of video games was referred to above as a successful example of delegation with a threat of action. Another successful instance was the US Government's approach to internet governance: it delegated authority to the IETF, a technical body staffed by independent technical experts whom the USG trusted to make the "right" decisions (technology-led, market-biased) without direct supervision. The alternative was the much more old-line command and control ITU - but that was so clearly beholden to enemies of the US market-friendly approach that the IETF was the lesser of two evils (Cowhey, Aronson and Richards, in manuscript).

Looking ahead, policy makers should establish detailed surveillance technology and data retention rules only if industry does not establish voluntary cooperation procedures with law enforcement that that meets societal needs. They should not prejudge where/how data should be collected to serve law enforcement surveillance needs. Data flows on the internet different from those on circuit switched networks; the

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<sup>57</sup> Ashby's "law of requisite variety," see Skyttner 2001:92

<sup>58</sup> Aulin and Ahmavaara's "law of requisite hierarchy," see Skyttner 2001:92

most efficient tap point may not be at the most visible services, e.g. not at web service providers but at ISPs

#### 4. *Clear Boundaries*

Clear Boundaries: Provide clear goals that describe and justify the outcomes sought. Build in expiration dates. Specify glide paths for new entrants to meet policy objectives.

A gardener has a vision of the garden she wants, and intervenes at a relatively high level to bring it about. She can desire roses, and plant rose bushes, but cannot make the rose plants bloom and often struggles vainly against the various maladies that afflict them. She needs to be patient in allowing new plants to become established, but also needs to know when to cut her losses and move on. Intervention is sometimes unavoidable. Since the garden keeps changing, practices need to take time into account.

The use of the “open mind” and “delegation” tools provides the flexibility that will allow participants in the internet/web to find creative solutions that meet the policy imperatives. However, experimentation needs to be given clear boundaries that define the scope of regulation. A regulator has the responsibility to frame policy goals and create the contexts within which other participants can deliver on them.

When the time comes to draft regulation, for example when a hands-off approach has failed to deliver social goods or when there are abuses of significant market power, regulators should step carefully. Since the passage of time may invalidate assumptions, it is useful to build checkpoints into regulation, e.g. through a termination date, or “sunset”, for regulation.

A regulation may terminate at a fixed date unless there is a proven need to the contrary, or it may continue indefinitely with regular opportunities to make the case for its demise. The more detailed a regulation, the more likely it is to become obsolete in the face of social, technological and commercial innovation. This leads to graduated sunseting, that is, regulations expire more rapidly (or are revisited more frequently) the more detailed their scope. High-level policies about, say, the definition of prohibited speech change only on the scale of many decades, if at all; taxes and requirements on specific technologies, e.g. an implementation of text access for the deaf, might expire in 5-10 years.

Policy makers should also be open to experiment, both in the rules they make, and in the ways in which markets and civil society meet social policy goals. Transposing rules invented for another time and industry onto newcomers is likely to suppress diversity, and socially useful products could be stillborn. However, aspirants should operate from the start under the expectation that they will have to meet all policy imperatives eventually. Both these requirements can be met by clearly stating expectations at the start, but providing time, a “glide path”, for new services to meet these expectations.

## 5. *Holism*

Holism: Take a broad view of the potential solutions to policy problems. Where possible, use generic rather than sector-, technology-, or business-specific regulation. If there are choices among applicable regulations, start with the least onerous one.

There are many properties of the internet/web that cannot be associated directly with the performance of a particular part. For example, traffic volume depends on the amount of fiber capacity, transport and application technologies, the financial health and business arrangements of service providers, the momentary popularity of particular applications and sites, and legal initiatives. Each of these factors depends on the others; the resultant traffic volume is an emergent property.

Systems have overall properties that cannot be predicted by analysis of their sub-systems. Further, one cannot optimize the system piecewise. If each subsystem is operating with maximum efficiency, then the system as a whole will not operate with utmost efficiency (Skyttner 2001:92). Piecewise regulation ignores these emergent properties of a system, and will lead to sub-optimal results.

Consequently, policy makers should take a holistic view. This means taking an expansive view of the potential sources and nature of solutions to policy problems. For example, existing instant messaging tools offer solutions to web communications for the deaf; text-via-telephony solutions needn't necessarily be mandated. It also implies using general rather than sector-, technology-, or business-specific regulation wherever possible. A holistic approach also implies a broad view of the regulator's role: not only to regulate, but also sometimes to forbear.

Parts of the US communications industry that are regulated by different titles of the Communications Act are sometimes called "silos." Silos (i.e. sub-systems) have the advantage of being simpler than the entire system, and are thus easier to characterize and control; for example, life is simpler if one can treat broadband infrastructure and content rules separately. However, broadband speeds and limitations influence the kind of content that emerges, and content drives demand for infrastructure. One therefore needs a "no silos" approach.<sup>59</sup>

The details depend on what counts as a "silo". It is now generally accepted that internet access services should be regulated regardless of the transport medium used. Since different industries used to be defined by their transports (wireline telephony, broadcast TV, cable TV, cellular telephony, etc.), this implies that regulation should cross industry silos defined by transport medium.

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<sup>59</sup> One might take "don't regulate in silos" to mean "don't regulate by classification". This is probably impossible; regulators instinctively, and rationally, try to categorize new problems. Once you have the class, the regulatory action follows; the alternative is to go back to first principles in every case. However, in a dynamic world such as that of the internet/web, categories are constantly shifting, and categories have little lasting value. A principled approach, as advocated here, is better able to maintain its value over time.

The convergence of transport media has led to a blurring of silos defined by transport medium. The unit of regulatory analysis is now the service, defined as a user experience. Similar services offered by different industries would be considered as a group in a holistic approach; taken together they may entail sufficient diversity and choice to obviate close regulatory supervision. Regulation should be applied on a service basis, and not to components that make up a service. Similar functionality might be offered in different markets as parts of different services, e.g. real-time voice communication in the telephony and on-line game markets. Telephony regulation of real-time voice would not be transposed automatically to on-line games simply because it contains a voice communication feature.

If there are pre-existing precedents for a converged service (e.g. video) in many classification silos, and regulation is deemed to be necessary at all, then start with the weakest available regulation, not the strongest rule in the set of silos.

## 6. *Transparency*

Transparency: Allow monitoring by consumers, civil society and the market. Mandate disclosure to the public domain, particularly by regulators and firms with significant market power.

System complexity means that a decision maker has limited insight into what's going on; a gardener has to be able to read subtle signs of trouble in her garden, such as egg masses on trees in winter hinting of an infestation that's invisible when the leaves are out. In the internet/web system many of the participants are human, and so supervision can be improved by enabling them to observe what's going on. The limited capacity at the top of the control hierarchy can be complemented by distributing monitoring throughout the system.

Transparency is a useful tool for managing the volatility in complex systems. In the Beer Distribution Game, invented by Jay Forrester in the 1950s, volunteers play the roles of brewer, distributor, wholesaler and retailer; each adjusts its orders up the chain at will (Sterman 2000: 684-708). At a certain point, the demand doubles; it turns out that shipping volumes in the supply start oscillating wildly, and never stop. John Sterman found that there are two ways to dampen these cycles: reduce the time delay between placing an order up the chain and receiving inventory; and give participants more visibility on what's happening in the supply chain.

Visibility into the workings of a complex system reduces volatility and improves robustness. But in a market system with lots of players, how does the regulator get information, and how does it intervene?<sup>60</sup> Since complex systems are difficult to monitor, and since funding for monitoring by regulators is limited, it's important to allow civil society and the market to monitor players.

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<sup>60</sup> The question was raised in this form by William Lehr during a panel discussion at TPRC 2007 in Washington DC, 28-30 September 2007.

Transparency is a necessary complement the tools of delegation and keeping an open mind. This will smooth cycles, and increase system resilience. For example, one can argue that regulatory intervention like supervising players with SMP should be limited to “enduring bottlenecks” - but since the system is in disequilibrium, it’s very hard to predict whether a bottleneck exists, is coming about, or will endure. The best one can do is to observe carefully, and distribute the results quickly. In many cases the market will self-correct, but disclosure and distributed monitoring will speed up regulatory intervention should it become necessary.

Disclosure should be to the public domain; disclosure limited to cozy confidential regulator-regulatee relationships is almost useless. Internet/web technology is making information more immediately accessible, and is driving peer-to-peer disclosure and pooling of information and knowledge. The information is not centrally controlled, and purposes are not centrally determined. The pioneers like Zagat, Amazon Reviews, and Wikipedia are being supplemented “vigilante transparency” organizations monitoring civil servants, campaign contributions lobbyists, internet service providers and even nannies demonstrate the value of distributed surveillance.<sup>61</sup> Government hasn’t yet exploited these trends, and Fung et al. (2007) argue that policy makers can and should make greater use of these tools.

Since the internet/web is such a diverse system, observation of its dynamics needs to be distributed. This requires disclosure mandates, particularly on regulators and players with significant market power.

Transparency is a fashionable and increasingly common policy tool. Research by the Harvard-based Transparency Policy Project (Fung et al. 2007) has found that information provided should be understandable, and should match users’ needs at the moment when they’re making decisions; they need accurate, actionable information. Disclosers should have the means and incentive to respond to users’ choices; eventually, disclosers should come to see transparency as a business tool. There are, of course, limitations. More transparency isn’t necessarily better, and more information isn’t synonymous with full disclosure. Transparency has a cost, both in terms of an additional burden on disclosers, and in unintended consequences. Many disclosure policies don’t work; they’re the result of political compromise, and powerful interests can neuter disclosure. It is also important to require sufficient disclosure without mandating the detailed format.

Many proposals for transparency requirements are emerging in current internet/web policy debates. Atkinson & Weiser’s (2006) recommendations for a new approach to network neutrality include a transparency provision as part of effective consumer protection measures; they recommend that “all providers should state clearly to what extent content and services enjoy preferential delivery opportunities and any limitations on the ability of consumers to access the content and services of their choice.” The FCC would then monitor whether firms comply in practice with their stated policies.

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<sup>61</sup> Civil servants: <http://nyc.uncivilservants.org>. Campaign contributions: <http://fundrace.huffingtonpost.com/>. Lobbyists: <http://www.opensecrets.org/lobbyists/>. ISPs: <http://www.nnsquad.org/>. Nannies: <http://isawournanny.blogspot.com>.

Weiser (unpublished) recommends disclosure as part of a consumer protection strategy. Measures include guidance and supervision by the FTC regarding information consumers need, and accurate representations by broadband providers of the network management policies they use. PFIR launched the “Network Neutrality Squad”<sup>62</sup> in November 2007 with the stated mission of the “detection, analysis, and incident reporting of any anticompetitive, discriminatory, or other restrictive actions on the part of Internet Service Providers (ISPs) or affiliated entities, such as the blocking or disruptive manipulation of applications, protocols, transmissions, or bandwidth; or other similar behaviors not specifically requested by their customers.” There is a pending petition for rulemaking from P2P video distributor Vuze Inc, which asks the FCC to examine netops’ network management practices, and make rules to prevent them from discriminating against particular internet applications, content, or technologies.<sup>63</sup>

It is particularly important, and difficult, to monitor “slow variables.” Complex systems change simultaneously at a variety of speeds. Fast change, e.g. loss of forest stand due to fire, is easy to monitor. Slower change, e.g. the build-up over decades of an insect infestation that can lead to sudden, wide-area defoliation, is harder to monitor but more influential.<sup>64</sup> In the internet/web case, fast variables include market share, profitability, and company formation, merger and bankruptcy. An important hidden slow variable is the creation of a market bottleneck, e.g. an applications or advertising platform that creates an indispensable multi-sided market.

## 7. Modeling

Modeling: Use computer systems to simulate the consequences of regulatory choices.

Human intuition is a frail guide to action when dealing with complex systems, from gardens to the internet/web. The large number of variables exceeds our cognitive capacity, and non-linear interactions don’t match the linear models our brains tend to prefer. Long delays between causes and effects further confound our ability to understand dynamics. Complex adaptive systems typically have both slow and fast variables. People respond best to fast variables. Changes in slow variables may not be recognized because they’re imperceptible, or because they do not fit into the mental models of observers; yet, they often tip a system into a new state. Even when they’re recognized, the fact that collective action is needed to address slow variables constrains responses. This leads to

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<sup>62</sup> <http://www.nnsquad.org/>

<sup>63</sup> Filing 14 November 2007: [http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native\\_or\\_pdf=pdf&id\\_document=6519811711](http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519811711). eWeek story: <http://www.eweek.com/article2/0,1895,2217747,00.asp>.)

<sup>64</sup> Ludwig, Jones and Holling (1978) showed that slow increases in spruce budworm infestation can lead to sudden forest collapse. When a forest is young and sparse, bird predation controls budworm numbers. As the forest matures, it becomes harder for birds to find the worms, which eventually leads to explosive growth in budworm numbers, and thus collapse of the forest. For more, see <http://www.geog.mcgill.ca/faculty/peterson/susfut/resilience/rBudworm.html> and <http://www.na.fs.fed.us/spfo/pubs/fidls/sbw/budworm.htm>.

emphasis on short-term welfare that is counter-productive in the long run (Walker & Abel 2001).

However, these systems can be modeled, and policy makers can experiment with the consequences of regulatory choices *in vitro*. Simulations of the internet/web will help to make their behavior more familiar to policy makers, and experimentation may help find solutions to the collective action dilemma.

The emerging discipline of systems dynamics (Sterman 2002) seeks to understand the behavior of complex systems through simulating the many interlocking, sometimes time-delayed, relationships among its components. It focuses on stocks and flows, with feedback loops among participants. A number of social scientists have turned to agent-based modeling and simulation to examine social phenomena (Sackler Colloquium 2002). Agent-based modeling simulates the interactions of many autonomous individuals on a network (Epstein and Axtell 1996). Bankes (2002) and Lempert (2002) make the case that robust policy strategies can only be developed by reasoning over an ensemble of policy scenarios. Inductive reasoning over large ensembles of computational experiments, known as Massive Scenario Generation (Davis et al. 2007), make possible systematic comparison of alternative policy options using models of complex systems. Davis et al. argue that these tools provide a way to address deep uncertainty, a situation where the system model and the input parameters to the system model are not known or widely agreed on by the stakeholders to the decision. Lempert et al. (2002) define the regret<sup>65</sup> of a strategy in any future is defined as the difference between the performance of that strategy and the performance of the best strategy in that future.

Simulation has been used rarely, if at all, to explore the consequences of telecommunications policy decision. There is an opportunity to apply the techniques developed for business modeling (Sterman 2002) and long-term policy analysis (Lempert et al. 2003) to the internet/web. For example, agent-based simulations of the internet access subsystem of the US telecoms industry could provide insight into the dynamics of network neutrality regulation. It would be instructive to explore whether the resulting system has multiple stable states, as one might expect from a complex adaptive system. There might be two (or more) stable industry structures in the provision of consumer broadband at a given revenue level – which, since costs are largely fixed, is approximately also the profit level – for internet access providers. One state has a high degree of network neutrality and a low media concentration (i.e. high diversity of content providers), and the other has more differential pricing and a higher media concentration (lower diversity of content providers). As access provider revenue increases, content provider concentration increases in both states because the network operators are extracting more value from the system. There is a limit to the revenue possible for the high neutrality state, though, because most/all revenue is derived from consumers, who have a limit to what they're willing to pay. Revenue can only be increased by flipping to the low neutrality state, where access providers can extract additional revenue from

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<sup>65</sup> Regret theory provides a basis for choosing between policy strategies, explaining some decision behaviors; see e.g. <http://www.investopedia.com/terms/r/regrettheory.asp> and Loomes, G. and R. Sugden. (1982) "Regret Theory: An Alternative Theory of Rational Choice Under Uncertainty" *The Economic Journal*, 92, 805-824

content providers. This toy model is a simple-minded transposition of Scheffer's model of eutrophication of shallow lakes (see Scheffer 1999 for a survey and references). Once such a model is in place, one can extend it to do resilience analyses, and factor in political power (Scheffer et al. 2002).

Such dynamics could be discerned by simulation of models with software agents representing access providers, content providers, consumers and advertisers. Bauer 2007 explored the innovation incentives, based on their revenues, of netops and content providers. He uses scenario thinking and simulation models to develop an understanding of the dynamics of different policy approaches to network neutrality. Bauer concludes that a strategy of monitoring combined with the willingness to intervene if necessary, perhaps backed by appropriate authority for the FCC, seems to be the most adequate immediate way forward. He offers a stylized model with subtle and nuanced qualitative discussion, but no simulation results are offered or described. Shapira's 2004 MBA thesis integrate several pieces of relatively simple dynamics simulations into a full blown system dynamics simulation of the telecom industry, using MATLAB. He was able to reach conclusions about the convexity of risk/return tradeoff in R&D investment under severe network externalities, as well as substitution as a matching device for innovation clockspeed in competing industries. However, while he examined network externalities, investment strategies, regulation, standardization of products, and behavior of consumer welfare, he did not directly address network neutrality.

## ***B. Principles***

The tools I have described are tactics for managing a complex system. When viewed from a broader perspective they accrue to three principles which provide the strategic framework for this approach: fostering experimentation, designing flexible policies, and building resilience into a system.

The three principles interlock, each reinforcing the other. Fostering experimentation allows flexible policy making to work because it stimulates many ways to address social needs, and it increases resilience by generating diversity. Flexible policies increase resilience by allowing the system to bend rather than break in adverse situations, and they foster experimentation by not limiting implementation choices. Finally, increasing the internet/web's resilience allows experimentation to proceed without the risk of causing catastrophic failure, and it supports flexible policies by providing a stable base for development.

### ***1. Foster Experimentation***

Foster experimentation: Give participants the leeway to find solutions. Simulate various policy options before choosing one.
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One of the over-arching goals of policy makers is productivity, of both economic and social goods. Just as gardens are smarter about the details of producing fruit than gardeners, the participants that make up the internet/web know more about making it work than regulators. Policy makers should therefore give them adequate leeway to find solutions.

Complex systems are problem-solving machines. They show perpetual novelty, with the components and their interactions constantly adapting to whatever situation they face. For example, farmers are constantly fighting weeds that mimic crops; some crops, like rye and oats, evolved out of weeds competing with wheat.<sup>66</sup> Weeds are continually evolving to match crops, including developing herbicide resistance. Techno-social systems like the internet/web have the gift possessed by the heroes of Horace Walpole's fairy tale *The Three Princes of Serendip* (1754): the ability to make useful discoveries by accident, known as "serendipity." For example, peer-to-peer (P2P) file distribution started as a hacker tool mostly used to circumvent copyright, but is now increasingly being used by commercial firms. In September, NBC announced in September 2007 that it would use P2P delivery to enable viewers to watch TV shows as ad-supported downloads.<sup>67</sup>

The experimentation principle has two aspects: policies that encourage the discovery of new opportunities by internet/web participants, and experiments in the policy making by regulators. Allowing participants to experiment is vital for a productive internet/web, and exploration of policy options in setting where mistakes can do limited harm will lead to a more resilient as well as productive system.

It is wise to experiment with rules before applying them across the board; once they're widely implemented, the ecosystem will adjust to them, and there's no way back.

Each of the tools described above can help implement this principle:

- **Diversity:** A regular influx of new market participants generates innovation. Since incumbents can suppress competitive innovation to protect their position, careful monitoring to prevent abuse of market power can increase novelty.
- **Open Mind:** Allowing to participants to experiment with new technical and commercial arrangements may obviate the need for regulation, yielding the desired results without limiting innovation. Prejudging the implementation, which would necessarily be given in terms of existing technology, will limit innovation.
- **Delegation:** The system should be allowed to find solutions in preference to policy makers trying to be smarter than the aggregate talent of the internet/web.
- **Clear Boundaries:** Novel solutions will appear if the regulator clearly specifies the social goods that need to be delivered, and provides incentives. A glide slope that allows new entrants time to conform to expectations for delivering social goods will lead to more diversity, and more solutions.

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<sup>66</sup> [http://en.wikipedia.org/wiki/Vavilovian\\_mimicry](http://en.wikipedia.org/wiki/Vavilovian_mimicry)

<sup>67</sup> [http://blog.streamingmedia.com/the\\_business\\_of\\_online\\_vi/2007/11/nbc-direct-to-u.html](http://blog.streamingmedia.com/the_business_of_online_vi/2007/11/nbc-direct-to-u.html)

- **Holism:** Casting a wide net for solutions to problems is most likely to find good answers. Generic regulation is more likely to foster experimentation than narrow sector-, technology-, or business-specific rules.
- **Transparency:** Ideas stimulate more ideas. Awareness of problems as well as opportunities will inspire invention.
- **Modeling:** Since internet/web policy making takes place under conditions of deep uncertainty, modeling is indispensable in informing policy makers' intuition, and testing which courses of action are most productive (Sterman 2002). An ensemble of plausible models, rather than any single model, may best represent the available information about the future, and is a better basis for decisions than a single model. (Lempert 2002b).

## 2. *Design Flexible Policies*

Design Flexible Policies: Fix as few parameters as possible; design in the ability to change course.

The internet/web is constantly evolving. Innovation constantly adjusts the products on offer, the needs and wants of citizens, and the situation that confronts the policy maker. Fostering experimentation is a necessary first step in allowing the internet/web system to find solutions to problems rather than intervening to devise solutions “by hand.” However, it is also important for the policies themselves to adapt to change.

The internet/web adapts around policies as they are introduced. The system changes faster than the regulatory process. This demands regulatory humility: policies should be flexible enough to adapt to developments, becoming stronger or weaker as the situation requires. One mechanism is to avoid setting industry parameters by legislation, and rather delegating managing them to a regulatory agency. Policy makers should be ready to act in case something goes wrong, e.g. by having the authority to impose regulations *ex post*. Policy should be flexible enough to remain viable as the industry moves through phases of its development cycle. A policy framework which recognizes that there are times to encourage innovation and times to allow mature incumbents to deliver the benefits of scale provides a basis for adjusting the balance of intervention and forbearance at different times in different parts of the communication system. We've seen quite a few cycles in communications technology: the rise of the telegraph, then broadcasting, then the internet (each with its own epicycles). Carlota Perez's analysis (2002) of 40-year technology innovation cycles provides a longer-scale context.

Unfortunately regulators do not have the luxury of having two policy regimes, one for stability and another for change, since different parts of their systems may be in different phases at the same time. The diversity may be geographical (internet access is mature in the US, but booming in Asia), in industry (messaging services are mature, but online content is changing rapidly), or in scale/hierarchy (data transport is mature, but social networking applications are in flux).

Considering the tools in the light of the flexibility principle yields:

1. **Diversity:** A healthy mix of market participants allow a system to respond to change. A sunset regime on a policy, or experimentation in geographical regions, will allow policy makers to compare different policy solutions and select the most effective.
2. **Open Mind:** *Ex post* is preferable to *ex ante* regulation since it allows policy makers to respond to problems that actually arise, rather than locking them into hypothetical scenarios. The more specific the regulation, the longer it takes to change since it enshrines scores of hard-fought trade-offs. Neutral, open-ended policies are more likely to be flexible enough to cope with changing situations.
3. **Delegation:** Empowering agents closer to the action allows for more flexible policy, since regulators do not have to lock in all the parameters of a solution in advance.
4. **Clear Boundaries:** A call for flexibility may wrongly be taken as a license for ambiguity. On the contrary: well-defined desiderata and check-points will allow all participants to measure progress and adjust as necessary, leading to more effective flexible policy.
5. **Holism:** Generic regulation is more adaptable, since it is not bound by the peculiarities of a particular industry or technology.
6. **Transparency:** An abundant flow of information about the health of a system give a regulator the information needed to adjust policy if necessary. Of course, policy flexibility does not presuppose regulatory intervention; a policy can be designed to flex on its own as the situation changes. However, visibility into both the situation and the policy's performance allows a regulator to learn, and adjust if necessary.
7. **Modeling:** Exploring the consequences of policy choices in simulation can identify which courses of action are most robust under a variety of possible outcomes.

### 3. *Build in Resilience*

Build in Resilience: Encourage diversity of participants; keep away from economically optimal but vulnerable regimes; limit tight coupling between layers; don't pick outcomes; develop contingency plans; analyze the robustness of chosen strategies against a multiplicity of plausible futures.

Occasional catastrophic failures cannot be designed out of a complex adaptive system. They're a consequence of its ability to operate under a variety of circumstances (Carlson & Doyle 1999). Even without such unpleasant surprises, unexpected behavior and perpetual novelty is an important attribute of complex systems.

Collapse and renewal are, in fact, essential to long-term productivity and stability (Gunderson & Holling 2001). In politics, the periodic replacement of political leadership is essential for the health of society by flushing out corruption and gaining new insights, even though a price is paid in the loss of expertise. Striving for constancy sets up the conditions for a catastrophic collapse; for example, the intensive use of lawn chemicals leads to superficial health, but force-feeds the grass while denuding the soil of organisms. That leads to feeble grass that is vulnerable to diseases and weeds.<sup>68</sup>

During the exploitation and conservation phases of an adaptive cycle, a forest or an industry is stable and produces many apparently secure jobs (and happy voters). Gains from scale lead to consolidation, and those not directly competing with the major players benefit from standardization and the creation of a product platform. However, the situation is fragile, because the majors represent a single point of failure.<sup>69</sup> When they do fail, damage can be limited if the sector is still growing in other areas, e.g. internationally or in other parts of the value chain.

Policy for the internet/web should therefore not only prepare for collapses; it should build in the conditions that allow periodic small collapses and minimize the likelihood of rare catastrophes.

There are two aspects to resilience: policies that lead to resilient systems, and policies that are themselves resilient to changes in external circumstances.

A resilient system is one that can maintain its structure and function in spite of experiencing disturbances (Holling & Gunderson 2002). In cases where there is uncertainty about outcomes – usually the case for complex systems – it is better to choose robustness rather than optimality. A robust strategy is one that performs reasonably well, compared to the alternatives, over a wide range of plausible scenarios (Lempert et al. 2002). Optimality would select the strategy that performs best in the most plausible scenario.

System resilience can be improved by: allowing a diversity of participants, and facilitating entry of newcomers particularly in times of disruption; favoring robustness over efficiency by not operating the system in a regime that is vulnerable to shocks, even if that were the most economically efficient<sup>70</sup>; and ensuring that different system scales are not too tightly coupled, so that disruption at one scale doesn't cause a system-wide collapse<sup>71</sup>.

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<sup>68</sup> “Greener lawn care” ColoradoSprings.com, June 27, 2007. Available at: <http://www.springshomeandgarden.com/fullStory.jsp?id=6019>

<sup>69</sup> Cross-scale consolidation isn't evident in the internet/web at the moment, but presents a threat to robustness should it occur. One scenario is that consolidating netops use this power to consolidate in the content business, entraining the applications level of the systems hierarchy to the network layer, in the way that cable companies used their market power to take stakes in content providers (cf. TCI growing into Liberty Media).

<sup>70</sup> The bigger the downside risk, the less one should optimize for a particular expected case.

<sup>71</sup> This is widely seen in political systems, where different parts of government are replaced at different rates. In the US, for example, elections at the federal level are held every two years for Congress, four years for President, six years for the Senate, and federal judges have life-time appointments.

Resilient policies comprise strategies that perform well, compared to the alternatives, over a wide range of plausible scenarios. Resilience is defined in relation to the desired purpose of the system; this is implicit in the notion of the system “performing well”. The various stakeholders may have different ideas about what constitutes success. Resilient policies will therefore also perform reasonably well when judged against the many value systems held by different parties to the decision (Lempert 2003, Walker & Abel 2001).

A variety of techniques increase the resilience of policies: 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; and analyzing the robustness of chosen strategies against a multiplicity of plausible futures.

Loose coupling between internet/web sub-systems at different hierarchical scales improves system robustness. Aspects of the “layers” approach can therefore be justified in terms of achieving system resilience. Government should not take action that encourages vertical integration. However, breaking up vertical integration after the fact should be approached very cautiously, since one cannot predict the consequences for the entire system.

The policy tools help to improve resilience in various ways:

1. **Diversity:** A variety of participants ensures that a local collapse leads to a rapid restart of system function. If there is a monopoly, particularly at a variety of system scales, then a failure is likely to cause widespread disruption.<sup>72</sup>
2. **Open Mind:** 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 operate at their own pace without a uniform regime imposed by a central regulator allows different parts of the system to be at different stages of maturity. If surrounding parts of the

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<sup>72</sup> 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, taken from Walker & Abel (2001), 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

value chain are stable when one is disrupted, the overall system will continue to function.

4. **Clear Boundaries:** Lucid 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.
5. **Holism:** 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, which enhances resilience.
6. **Transparency:** It is important for system participants to learn about changes and failures rapidly so that they can adapt and benefit from them, thus maintaining overall system stability.
7. **Modeling:** Policy simulation allows decision makers to “sweat in training rather than bleed in combat”. They can eliminate policy choices that are brittle and work in only a narrow set of circumstances, leading to more resilient final measures.

## VIII. APPLICATIONS OF THE PRINCIPLES AND TOOLS

### A. *Rules for internet voice services*

Internet voice conversations pose a significant challenge to policy making since some, but not all, aspects of these applications overlap with a substantial body of regulation that has developed over a long period of time for traditional voice telephony (“Plain Old Telephony Service” or POTS). These rules emerged in the context of monopoly service providers, and it has proven difficult to disentangle provisions that address antitrust concerns, meet other social needs as a condition of monopoly (e.g. cross subsidies, universal service), and speak to social interests unrelated to market structure (e.g. public safety).

There are many aspects to this regulatory field. I will consider fees, access to emergency services, and disabled access.

#### 1. *Policy Imperatives in Play*

Revenue generation is an important policy focus in telephony regulation. Regulators need to continue to generate tax income for existing programs such as universal service even as the revenue base of traditional industries shrinks. There are calls to spread the tax base to new services (e.g. cellular telephony and internet voice communications), since the old ones (e.g. wireline long-distance) are dying.

Universal service indicates another policy imperative: the consumer protection interest of providing access to various disadvantaged populations in cases where markets would otherwise fail to do so. Public safety may require disabled access to emergency services; this is high profile subset of the larger consumer protection question.

Fees are often presented as way to raise funds for emergency services, thus invoking the public safety imperative. The “sixth imperative” of self-interest comes into play when policy makers seek to score political points by supporting first responders, or when they advantage incumbents with an eye to future sinecures.

Public safety is the ostensible motivation for questions about access to emergency services. However, policy is actually driven by a combination of revenues, economic interests and self-interest. Policy makers are reluctant to take a chance on the failure of public safety access, since it represents a public relations nightmare; for example, headlines in Texas and Florida prompted a 4-0 FCC vote in 2005 to require some voice-over-Internet Protocol (VoIP) services to interconnect with public safety access points.<sup>73</sup> It does not have to be this way: the British regulator Ofcom seems to have taken a more data-driven approach in their rules, invoking market research that indicated that as many as 78% of VoIP users who cannot use their service to call 999 thought they could, or did not know whether they could.<sup>74</sup>

## 2. *Applying the Tools and Principles*

The voice communications business is like a forest where a lot of big trees have been blown down after being weakened by age and shifting climate. The reassuring old food web in which every organism had its place has gone; in its place is a buzzing confusion with many new species contending for their share of sunlight, and the promise of a new community better suited to new circumstances.

### a) *Fees*

One cannot expect the welcome newcomers in this incipient wood to behave just like their defunct predecessors; they cannot bear the weight yet, and their specialties may be different (Principles: experimentation, resilience). One should therefore not put the burden of legacy taxes and regulations on new services, particularly since these measures shape the commercial design of a system (Tool: diversity). Existing rules bias the system in a specific direction, and are likely to prevent innovation that is likely to generate more services, more revenues, and more taxes eventually (Principle: experimentation; Tool: open mind). *Ex ante* rules, necessarily based on precedents established with traditional services, will lock in existing industry structures (Tool: open mind). This reduces diversity and innovation which would otherwise generate social surplus, and also increases the robustness of the system (Principle: resilience; Tool: diversity). For example, a policymaker could assert that it would impose 911 rules on VoIP if industry does not adopt a voluntary solution that is transparent to users and solves the underlying problem within a set period of time (Tool: clear boundaries).

The funding of emergency service infrastructure such as public safety access points is based on the structure of traditional telephony; imposing fees and

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<sup>73</sup> [http://mrtmag.com/mag/radio\\_public\\_safety\\_gets/](http://mrtmag.com/mag/radio_public_safety_gets/)

<sup>74</sup> [http://www.ofcom.org.uk/media/news/2007/07/nr\\_20070726](http://www.ofcom.org.uk/media/news/2007/07/nr_20070726)

interconnection requirements on new service entrants creates a significant burden of entry (Principle: resilience; Tool: diversity).

Sometimes fires destroy forests. If they are suppressed for too long, increases in leaf and branch litter can lead to catastrophic burns.<sup>75</sup> The soil structure and large trees around which forest communities are built survive through medium-sized fires, allowing rapid rebuilding; in big fires, the soil is sterilized and large trees are felled. Similarly, while occasional disruptions in industry revenue arrangements is uncomfortable for vocal incumbents and painful for entrants, it prevents wrenching restructuring later on (Principle: resilience). The inflexibility and regulatory capture that results from industry-specific rules can limit competition and valuable innovation, e.g. by protecting rural telephone companies from wireless competition (Tool: diversity).

If there is a need for revenue, it should be raised by the most general available means, rather than from levies on specific technologies that keep changing (Principle: flexibility; Tool: holism).<sup>76</sup> All similar services should bear the same burden. However, there is a countervailing consideration: taxing newcomers like PC-to-PC voice communications can reduce economic vitality, since it may limit the growth of new entrants to a point where they can compete with incumbents without government protection (Tool: diversity). When a forester tries to encourage regrowth with diverse native species, he may need to protect the seedlings from being eaten by local wildlife. The goal is to have the same expectations on all when they are able to meet them, but not to impose the old mechanisms on the new entrants (Principle: flexibility; Tool: open mind).

Once a practice is established – whether it is allowing noisy All-Terrain Vehicles in the wilderness, or imposing a communications tax – it is very hard to change. For example, an excise tax on long-distance calls imposed in 1898 by the US government to help pay for the Spanish-American War was not abolished until 2006.<sup>77</sup> Policy makers should therefore hesitate to impose new fees/rules on new entrants. This will allow them to respond to developments (Principle: flexibility). Since one aims to manage to outcomes, see if/how the new services can deliver the social benefits sought; don't assume that they have to do it in the same way as existing services (Tool: delegation, open mind).

#### *b) Disability access*

Struggles over providing support for the hearing-impaired on the web provide a good argument that there should be flexibility in rules over time.

Regulation should provide clarity on the requirements that society has for supporting hearing-disabled citizens, but leave it up to industry and civil society to find

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<sup>75</sup> “Effects of Fire Suppression”, Forest Encyclopedia Network,  
<http://www.forestencyclopedia.net/p/p4/p142/p165/p167/p170> <need more, better references>

<sup>76</sup> It is also a truism in economics that taxes are most efficiently levied over the broadest range of incomes.

<sup>77</sup> [http://en.wikipedia.org/wiki/Federal\\_telephone\\_excise\\_tax](http://en.wikipedia.org/wiki/Federal_telephone_excise_tax),  
[http://www.usatoday.com/money/industries/telecom/2006-05-25-phone-tax\\_x.htm](http://www.usatoday.com/money/industries/telecom/2006-05-25-phone-tax_x.htm)

solutions (Principles: experimentation, flexibility; Tools: delegation, open mind). Since disability access serves only a small percentage of customers, firms may not provide such features. Allowing differential pricing is one way to make it more commercially attractive, but is unlikely to be sufficient. Clear goals and support for voluntary action should be complemented by incentives/penalties as well as long enough lead times to allow manufacturers to get products into the pipeline (Tool: clear boundaries). Mandated disclosure of product accessibility can help manufacturers market their products as well as assist the disabled in finding the best solution (Tool: transparency).

Locking in TDD<sup>78</sup> technology helps only a small number of legacy manufacturers, to the potential detriment of a new generation of users who could benefit from innovation (Principle: experimentation). Premature regulation will stifle the invention of better-than-traditional access solutions on new platforms (Tool: open mind). However, users who depend on TDD should be given ample opportunity to transition, or continue to use their TDD equipment with transcoding to new technologies (Principle: resilience; Tool: diversity). It's better to adapt the small legacy base of TDD to new technologies than shoehorning new technologies into a Sixties mold. A sunset on TDD technology can be tied to meeting needs for emerging services; this provides an incentive for firms to meet their social obligations (Tool: clear boundaries).

No ecosystem scientist would presume to micro-manage forest succession; not only is it too complex and subtle, but human intervention will not be able to respond to the subtle changes in environment that distinguish a new forest from a predecessor (Principles: experimentation, flexibility). In the same way, if industry and citizens are allowed to innovate, they may well find better ways to meet the needs of the disabled than rigid, pre-cooked regulations (Tool: delegation). Innovations include not only technology but also business models; there may be situations where disabled would be best served by a range of offerings at a variety of prices. Regulators should encourage market entrants to provide new products, and only regulate if they don't do so (Tool: diversity). Legacy feature sets and requirements should not be imposed unthinkingly on new services, e.g. mandating TDD/TTY for web services (Tool: open mind).

*c) Access to emergency services*

New forest communities have new ways of doing things; species arriving from outside fill old niches, and create new ones (Principle: experimentation). Regulators should not stifle new services by forcing them to conform to old rules – a new service may not need a 911 mandate, even though it contains voice conversation as a feature (Tool: open mind). If users eventually want it, then apply rules if the market hasn't provided it - don't try to create expectation ahead of time.

Providing access to emergency services on new internet/web services reveals an apparent contradiction in applying the gardening/complex systems metaphor. On the one hand, thinking holistically about the system suggests that all providers of

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<sup>78</sup> “Telecommunications Device for the Deaf,” also known as TTY, textphone, or minicom, is a technology used by the hearing impaired to communicate over the phone. See e.g. [http://en.wikipedia.org/wiki/Telecommunications\\_devices\\_for\\_the\\_deaf](http://en.wikipedia.org/wiki/Telecommunications_devices_for_the_deaf)

communications services should be treated equally, and that everybody, new entrants included, should provide access. On the other hand, fostering creativity through allowing experimentation and increasing robustness by encouraging new entrants implies that newcomers should be given time to meet access requirements; different rules should apply to old and new.

The paradox is resolved by requiring new services to provide access, but not mandating that they use traditional methods (Principle: experimentation; Tool: open mind). The requirement to provide service is also graduated, allowing time for entrants to arrive at the level of service offered by long-standing competitors (Tool: clear boundaries). Not imposing the full burden immediately allows novices to develop their competence (Tool: diversity); it may turn out that the service fails for other reasons, and one will not be left with legacy rules that will deter future entrants. Conditioning mandates on interconnection with the PSTN is a politically expedient fix that will eventually fail, and will have to be replaced, as more communications bypass traditional voice networks. However, simply imposing all legacy rules -- many of them developed for monopoly markets -- on aspirant providers is equally inappropriate (Principle: resilience; Tool: diversity). The PSTN interconnect condition is an expedient proxy for a glide path. It gives the same result, but the PSTN condition obscures the market dynamics and need for a holistic approach that also enables diversity and experimentation.

## ***B. Licensed vs. unlicensed spectrum allocation***

The relative merits of allocating spectrum via licenses obtained at auction, or via unlicensed access open to all devices that comply with given performance specifications has been one of the most contentious questions in spectrum policy in recent years.<sup>79</sup>

### ***1. Policy Imperatives in Play***

Revenue gets the headlines in the spectrum allocation debate: license auctions represent a ready source of cash for legislators. However, auctions are simply an up-front tax on the provision of spectrum access; the cost is passed on to consumers by auction winners, and a too-heavy burden can delay build-out.<sup>80</sup> Another argument goes to the economic vitality engendered by the supposedly novel forms of innovation that come from unlicensed uses. However, either form of allocation is as likely as the other to benefit from technological progress, and both generate innovation, though of different kinds.

The appropriate focus for regulatory concern is the best way to maximize the social benefits of this resource. Auctions clearly play a role, but diversity of regulatory modes and alternative sources of innovation indicate that unlicensed allocations should

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<sup>79</sup> See for example Hazlett (2005) and Lehr (2004)

<sup>80</sup> "Air supremacy: America's wireless-spectrum auction avoids the pitfalls of Europe's" *The Economist*, Sep 7th 2006. Available at:

[http://www.economist.com/business/displaystory.cfm?story\\_id=E1\\_SRRSJVT](http://www.economist.com/business/displaystory.cfm?story_id=E1_SRRSJVT)

also be used. Unlicensed uses also generate tax revenues: on the sale of unlicensed devices and services, and on the increased economic activity that they engender.

Self-interest plays an important role in this debate, since spectrum incumbents who oppose unlicensed have a substantial regulatory influence, through their accumulated expertise, long-standing relationships with legislators and regulators, and through the prospect of jobs and sinecures for policy makers.

## **2. *Applying the Tools and Principles***

The principles of flexibility and experimentation suggest that regulators should be agnostic about the business uses and implementations of technologies in a given spectrum band, since this gives innovators most scope to find the optimal solution, and change their mind about their implementations. Spectrum allocation by markets in transferable flexible-use licenses allows regulators to avoid having to predict or shape technology developments (Principle: flexibility; Tools: open mind, delegation).<sup>81</sup> Given the rapid evolution of wireless technology and services, regulators should only intervene, e.g. to allocate by command-and-control or license-exemption (unlicensed), if there are clear unwanted results.

Allocating everything by auction might appear to be the most economically efficient approach, but it is not resilient against the eventuality where spectrum scarcity is unexpectedly low (Principle: resilience). If technology development outstrips user need, spectrum could turn out to be relatively abundant; in this case, commons use is more efficient since it doesn't have the transaction costs inherent in creating and running markets. Therefore, a mix of licensed and unlicensed is more robust (Tool: diversity).

The decentralized coordination required for unlicensed use is less spectrally efficient, but the lower cost of entry for device manufacturers leads to more rapid and diverse innovation.<sup>82</sup> A mix of regulatory modes therefore leads to more innovation; policy makers shouldn't preclude unlicensed innovation by auctioning off all spectrum (Principle: experimentation; Tools: diversity, holism).

## **IX. OPEN QUESTIONS**

The approach outlined in this paper raises many questions that have not been addressed here. This section notes some opportunities for on-going research.

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<sup>81</sup> The FCC has made the running in creating flexible use rights (FCC Docket WT 00-230, "Elimination of Barriers to Development of Secondary Markets), and the UK regulator Ofcom has taken a lead in directly specifying the emissions that a license holder may transmit in neighboring bands or locations, rather than protect neighboring users against harmful interference indirectly by specifying or assuming a certain application or technology, and imposing technical limitations, based on the interference effect that the technology or application is likely to cause to neighboring applications or technologies, which are likewise specified or assumed (Ofcom 2006).

<sup>82</sup> See e.g. Tonge & De Vries (2007), De Vries (2006).

### **A. Testing the Metaphor**

The garden metaphor needs to prove its worth by generating new research questions, and novel solutions. Ideally it should make falsifiable predictions. Topics in ecology that are ripe for transposition to internet/web policy include: bi-stable states in the internet/web industry; confirming/explicating the adaptive cycle; providing metrics/dimensions for cycle (discussed in more detail below).

This paper illustrates the applicability of its method by examining a few cases at a high level. To prove its worth, the approach needs to be applied in detail to a complex policy question, such as network neutrality, in order to properly explore its utility.

The predictions and prescriptions of this approach needs to be compared and contrasted with that of the leading policy frameworks, such as the architecture-as-policy and free-market approaches.

The policy recommendations in this paper lean towards a *laissez faire* “Anglo-American” approach: skepticism about the ability of government to intervene effectively through central planning, a bias towards light-handed regulation, and empowering the market and individuals to solve problems. Is this a necessary consequence of a systems approach, or could the same premises in different hands have led to *dirigiste* “European” prescriptions: a belief in the need for government to manage markets, a willingness to regulate, and a social democratic rather than capitalist world view? If any set of principles and policy tools can be derived equally plausibly from the premise that the internet/web is complex adaptive system, then the approach has little descriptive, predictive or normative value.

### **B. Guiding Policy Making**

One of the difficulties of the European approach to communications regulation, and with antitrust rules in general, is the definition of a market. Any definition necessarily draws an artificial boundary around a system in constant flux, a particularly difficult task during periods of rapid innovation. Can complex system theory cast light on ways to define markets that take dynamics into account?

One of the requirements of flexible policy is that it should work equally well in times of growth, maturity, collapse, and renewal. Can the management of macro-economic cycles in the financial sector inform the regulation of communications?

This paper proposes ways to deal with policy problems, which it takes as given. However, policy makers need to diagnose and characterize problems before they can address them. Can a complex systems thinking help policy makers to know where the problem lies?

### **C. Applications to the Internet/Web**

If the internet/web is a complex adaptive social system that resembles a managed ecology, then many of the techniques developed in that field should be applicable.

Can one simplify the complexity of the internet/web by identifying the key processes, and a limited number of variables that control them, at a variety of scales in a hierarchical structure?

Panarchy theory suggests that variables operating at different speeds are important to adaptive cycles; for example, the key variables in forest-pest dynamics are insects (fastest), foliage (slower), and trees (slowest).<sup>83</sup> Are there similar dynamics in the internet/web? Can one diagnose which part of the cycle sub-systems at various scales of the communication system find themselves in?

What are suitable metrics for tracking the overall (emergent) performance of the internet/web? Are there metrics for overall “quality” of the internet/web that relate to emergent properties?

Complex system theory suggests that the internet/web industry should contain bi-stable states. The paper suggests that this was the case for video production and distribution, but the claim needs to be validated by a detailed econometric analysis. Are there other cases? It is also necessary to analyze boom/bust cycles in the ICT industry in the light of adaptive cycles. Candidates include the music publishing industry<sup>84</sup>, telephone company revenue streams<sup>85</sup>, and theatrical entertainment<sup>86</sup>.

Any systems analysis requires one to draw boundaries around sub-systems. On the other hand, the flux of the current internet/web makes classifications protean, and borders fuzzy.<sup>87</sup> Clark et al. (2005), for example, recommend that internet system design should be modularized along “tussle boundaries”. How does this relate to a layers analysis? How does it interact with the classificatory instinct of regulators?

#### ***D. The Broader Context***

Transposing Rawls’s principles of justice into communications policy (below) seems to imply light-touch regulation and protecting new entrants from companies with significant market power; that is, the principles of Experimentation and Flexibility, and tools like Diversity, Delegation, and Open Mind. Can other policy tools and principles be derived?

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<sup>83</sup> See e.g. Gunderson & Holling (2001:69) Table 3-1

<sup>84</sup> The labels are seeing a collapse in CD sales. Prior booms and busts in the music industry may include the introduction of sheet music undermining the power of performers while helping composers and publishers, and the introduction of recordings putting a dent in concert hall revenues.

<sup>85</sup> Telcos have seen (and will continue to see) their voice revenue collapse, and data revenues have not kicked in yet. A similar transition happened from telegraphy to voice traffic.

<sup>86</sup> Waves of technology have swept through “theatrical” entertainment, including film, radio, television, and the internet.

<sup>87</sup> Frieden (2007) contends that the old dichotomy between regulated “telecom services” and unregulated “information services” is no longer sustainable. Technological convergence and innovations calls into question whether Congress can create categories that the FCC can use to determine the scope of government oversight, and the FCC itself has exacerbated the confusion with some of its rulings.

This paper has focused on internet/web policy, but the approach applies equally well to any complex policy question, including finance, energy, and transportation. Not only will applying the method there test the approach, but it will also surely provide new insights to the internet/web.

## X. CONCLUSIONS

Technology and business shifts constantly change the context in which regulators have to make policy for the internet/web. There are also abiding policy imperatives that always need to be met.

Policy makers use mental models to frame policy questions and action. However, technical change calls into question some approaches used successfully to date.

The garden, that is, a biological system for which people are responsible, is a productive and stable metaphor that can be used in developing policy for the internet/web. Such policy can be grounded in an understanding of complex adaptive systems, of which gardens are one example.

Systems theory can yield tactics (the tools) and strategies (the principles) that can guide policy making to meet the over-arching regulatory goals of stability and productivity.

The principles are:

1. **Foster Experimentation:** Give participants the leeway to find solutions. Simulate various policy options before choosing one.
2. **Design Flexible Policies:** Fix as few parameters as possible, design in the ability to change course
3. **Build in Resilience:** Encourage diversity of participants; keep away from economically optimal but vulnerable regimes; limit tight coupling between layers; don't pick outcomes; develop contingency plans; analyze the robustness of chosen strategies against a multiplicity of plausible futures

The tools are:

1. **Diversity:** Encourage new companies and industries to enter markets. Act against firms that abuse significant market power
2. **Keeping an Open Mind.** Don't prejudge outcomes. Do not specify the implementation in detail. Determine ends, not means. Policy should be technology and business-model neutral. Prefer ex post to ex ante action. Prepare for unexpected events.
3. **Delegation:** Rely on players close to the action, like consumers, firms and civil society, to solve problems in the first instance; regulate only if they fail.
4. **Setting Clear Boundaries:** Provide clear goals that describe and justify the outcomes sought. Build in expiration dates. Specify glide paths for new entrants to meet policy objectives.

5. **Holism:** Take a broad view of the potential solutions to policy problems. Where possible, use generic rather than sector-, technology-, or business-specific regulation. If there are choices among applicable regulations, start with the least onerous one.
6. **Transparency:** Allow monitoring by consumers, civil society and the market. Mandate disclosure to the public domain, particularly by regulators and firms with significant market power.
7. **Modeling:** Use computer systems to simulate the consequences of regulatory choices.

## XI. CODA: STRATEGIC DISINTEREST, OR WHY COMPANIES SHOULD TAKE THE LONG VIEW

The aim of this paper is to show that gardening, or rather complex systems thinking, provides policy makers with a usable framework for analyzing the internet/web. I believe that this mindset is in fact appropriate to all internet/web players, particularly companies and consumer advocates. (I will refer to just companies in the sequel for simplicity.)

Commercial firms may resist a principles-based approach such as this, since in many cases the recommended policy position will contain elements that are at odds with their perceived interests. Companies will judge policy recommendations by whether they give the “right answers”. Rightness will be probably judged on the basis of tactical, short-term self-interest. However, following one’s short-term self-interest is an unsafe strategy when operating in complex adaptive system like the internet/web, since the unpredictability of such a system means that non-one can be sure what their situation, and thus their interests, will be in the future.

Companies frequently have “Oh, never mind” moments that reflect changes of mind triggered by changes in their situation. For example, in the late 90s, AOL lobbied to require cable networks to give ISPs the right to offer services via cable networks. After TW and AOL announced their merger in 2000, Case retreated and the AOL lobbyists had to eat their words.<sup>88</sup>

Another example is the cellular industry’s about-face on local number portability (LNP). Mobile phone companies had argued strenuously before the FCC that requiring

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<sup>88</sup> Perine, Keith (2000) “You’ve got scrutiny” *The Industry Standard*, March 13, 2000. Available: <http://theindustrystandard.com/article/0,1902,12594,00.html>. “Before the merger was announced in January, Case was the self-described Paul Revere of mandated open access, championing federal legislation before congressional committees to force cable companies to let ISPs use their broadband networks. AOL actively lobbied for such rules, retreating only after it decided to buy the opposition. Last week, Case was forced to backpedal. He told both Senate committees that he always preferred voluntary open access by the cable industry, and only if that didn’t occur would a “light touch” of federal law be needed. Case pointed to the new memo as proof that the industry - namely Time Warner and its chief cable rival, ATT - is committed to open access. . . . Several senators on both committees were openly skeptical of the open-access pledge, which is not legally binding.”

them to allow customers to keep their numbers when they changed carriers was technically impossible, and even if it were possible, it would be ruinously expensive to implement. The real reason, of course, was that everyone was terrified that LNP would increase churn and reduce profit. However, once Verizon broke with the pack, everybody else in the industry came around.

Finally, telephone companies have argued that television delivered over Internet Protocol (IPTV) wasn't an internet service, because they were seeking franchise relief that would allow them to deploy it without network neutrality mandates. However, because they wanted minimal regulation, they also ended up arguing that IPTV wasn't cable service, either.

Surprisingly, moral philosophy can help one think about formulating principles of governance when one's specific future interests are unknown. John Rawls's analysis leading to his *Theory of Justice* (1999) offers one path.<sup>89</sup> The goal of Rawls's theory of justice is to establish a procedure whereby one could establish principles of social morality.<sup>90</sup> Similarly, our goal is to establish principles for communications regulation. Rawls wants to establish a universally recognized theory; likewise, we're trying to establish principles that everyone can agree to. He posits a thought experiment in which people decide the principles from behind a "veil of ignorance," that is, before they have any knowledge of what social position they'll have, what their natural talents will be, or what life goals they will have. This ensures that the principles become a collective best choice among alternatives, rather than a negotiation between parties all acting in their narrow self-interest. By analogy, principles of communications regulation should be agreed by parties without reference to their market power, competitive differentiation, or business strategy.

Why should players in the regulatory game accept the veil of ignorance? Because in complex systems, the veil of ignorance reflects the actual situation players find themselves in; it is not just a thought experiment. One cannot predict outcomes with any certainty in a complex system; they are sensitive to initial conditions, conscious agents in the system constantly push back against changes, and surprise is inevitable. While one might be able to predict many small, near-term variations, the high-impact large changes

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<sup>89</sup> See for example "Original Position", *Stanford Encyclopedia of Philosophy*. At: <http://plato.stanford.edu/entries/original-position/>

<sup>90</sup> Rawls argues that this starting position yields two principles of justice. First: each person is to have an equal right to the most extensive scheme of equal basic liberties compatible with a similar scheme of liberties for others. Second: social and economic inequalities are to be arranged so that (a) offices and positions must be open to everyone under conditions of fair equality of opportunity; (b) they are to be of the greatest benefit to the least-advantaged members of society (the difference principle). The application of these principles to those entities subject to communications regulation seems straightforward. The first principle can be interpreted as freedom of companies and citizens to enter into contracts as they choose, engage in speech, and follow the business strategy of their choice, as long as it doesn't abridge the rights of others. Principle 2(a) can be analogized to market entry opportunities. The Difference Principle, 2(b), is the most interesting: it suggests that regulation be made with the particular interests of the weakest companies and citizens in mind. This aligns with the conclusion that the resilience of a communications system depends on diversity, and that diversity requires some protection of emerging players against incumbents with significant market power.

are not predictable. This means that decisions based on calculations of self-interest may be wildly wrong, since the company's interest may turn out to be completely counter to what was originally anticipated.

Short-term calculations of self-interest remain vital to tactical competition. However, nothing is lost if a player decides strategic rules of the game like regulatory frameworks from behind the veil of ignorance. This is true not only for companies: it holds for anyone taking a strategic view of the interests of their constituency, from governments and politicians to consumer advocacy groups and NGOs.

Assuming the veil of ignorance does not mean that participants will agree, however – *contra* Rawls. He assumed that the parties are acting rationally in their self-interest with complete information, and that there is one universally accepted definition of reason. This assumption fails since reasonable people disagree on important social premises. Even if there were agreement on the problem, different models of the situation would generate different results. Finally, research in behavioral economics shows that we're not even rational by traditional criteria (Mullainathan & Thaler 2000). This means that there will be disagreement and negotiation even behind the veil of ignorance.<sup>91</sup> Neither Rawls's principles nor the approach I advocate here is a deterministic machine that generates a unique, uncontested answer. However, a principled approach such as this offers a relatively rational basis for argument that will be relatively robust against unexpected outcomes.

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<sup>91</sup> This points towards Hayek: people's incompatible preferences cannot be resolved rationally, but they can coexist in a market-based society with private property.

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