The End of Core:
Should Disruptive Innovation in Telecommunications Invoke Discontinuous Regulation

PhD Dissertation

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Chapter 1: INTRODUCTION

1.1 Introduction

This research analyzes the question of how a telecommunications regulator can balance regulations with innovation at a reasonable cost. This question has gained critical importance for telecom regulators worldwide as the unregulated Internet technologies such as voice and video over Internet disrupt the regulated traditional technologies such as telephony and television *and* the historical paradigm of the regulator. The traditional paradigm for telecommunications regulation assumes a well-defined set of services, offered by a well-identified operator (or a small group of them) in a well-circumscribed geographical area. The Internet has shattered each of these foundations. Successful regulation in the modular age created by the Internet requires a radically new regulatory paradigm and approach. Consequently, this thesis describes and analyzes the new telecommunications paradigm and explores its implications for an appropriate regulatory paradigm. The explicit objective is to systematically understand regulatory objectives, constraints, and opportunities in the modular age, so that critical regulatory objectives can be met without losing the bonanza of innovation and value the Internet has brought.

This dissertation is divided into five chapters. Chapters 2, 3, and 4 are written as stand-alone papers, yet together they say a single story. These chapters are bracketed by an introduction (chapter1) and conclusion (chapter 5). Chapters 2 and 4 present the current regulatory challenge and its solution, respectively. They may be read as a sequel. Chapter 3 studies uncertainties that surround technology and industry disruption, which is an area of interest to managers and policymakers alike. The present chapter summarizes the three papers (chapters) to follow, providing a comprehensive overview of the dissertation to a casual reader.

1.2 Paper I - From Herding Sheep to Herding Cats: Can the Regulations of an Integral Age Work in a Modular Age?

1.2.1 Problem and Research Method

The existing U.S. telecommunications regulations were created in the integral age. [1] In that paradigm, each operator was vertically integrated and controlled the total functionality necessary to deliver a service; a few such operators controlled the industry; they faced low competition and were under limited pressure to adopt innovation; and consumers had limited choice. The Internet has introduced a polar opposite paradigm—the modular age. In this paradigm, each firm controls only a subset of the total functionality necessary to constitute a service; many modular firms interoperate to deliver a service; firms compete fiercely and are under great pressure to innovate; and consumers enjoy a far greater choice due to the multi-modal competition among multiple technologies. Entering the modular age raises a number of questions for telecommunications

[1] Paper 1 and 3 are targeted for an outlet such as the Telecommunications Policy Journal. While the references to appropriate literature are kept out to shorten the summaries, appropriate grounding in literature will be provided for each paper in their respective chapters.

regulation: *Can the regulatory structure designed in an integral age—in its objectives, obligations, and mechanisms—work for a modular age?* Although transitioning from an integral to a modular age dramatically flips the environment, the current regulatory response to this dramatic shift has been hesitant to shift its intellectual roots. The purpose of this paper (Chapter 2) is to examine the ongoing debate around regulation of the Internet, using the lenses of the disruptive shifts in technology, industry, and consumer experience. The analysis uses the regulation of voice communications in the United States as a representative case.

Metaphorically, this is a tale of three animals – elephant, sheep, and cats. From the time the FCC was established (in 1934) until the break up of AT&T, the telecommunications regulator was a keeper of an elephant (AT&T). The elephant was monolithic and slow, but powerful and demanding because it faced no competition. It had negotiated with its keeper a suitable confinement in the form of the 1934 Telecommunications Act.

With the break up of AT&T, the regulator became a shepherd herding a few sheep (the Baby Bells). The sheep were inherently docile – not too competitive and not too innovative. To control the sheep, the shepherd needed just a crook and a little guidance that came in the form the Telecommunications Act of 1996 and its enforcement.

But the transition from an integral age to a modular age transforms the regulator's role from that of a shepherd to a herder of cats. The cats are fiercely competitive, highly innovative, and agile. Whereas the sheep worked by consensus, the cats are highly independent. Controlling the cats requires new schemes – a net around them, a set of incentives (mice, catnip?), or something else. Control mechanisms for these species must be radically different. The previous approaches cannot control the cats. The disruptive change in the industry fabric can only be matched with disruptive change in the regulatory approach to managing the industry.

Our research approach is built upon the principles of systems analysis. The telecommunications system is viewed as one the many subsystems that interact to fulfill the objectives of the social system (the society). The dynamics of the telecommunications system emerges from the interaction of four subsystems: regulatory dynamics, corporate strategy dynamics, consumer dynamics, and technology dynamics. The regulatory objectives to be fulfilled are conceived as an emergent property of such a system of systems.

The research uses two models and a case study. The models use coupled-differential equations with feedback, and are kept minimally endogenous[2]. They capture the interactions within the telecommunications system over which the regulatory decisions take effect. The first model examines the system-level regulatory compliance as the modular age disrupts the integral age. The second model examines entrant-versus-incumbent competition as a function of the various forces, including regulation.

The case study analyzes the regulatory environment of the pre vs. post-Internet periods, both quantitatively and qualitatively. For the analysis, public comments in response to the

[2] The models will be made fully endogenous in Paper II to study the uncertainty.

Telecommunications Act of 1996 NPRM[3] are compared with those in response to the IP-Enabled Services NPRM published in 2004. These two FCC dockets form a natural experiment; the 1996 Act centers solely on the public switched telephone networks (PSTN) and mentions the term "Internet" just once, whereas the IP-Enabled Services NPRM centers on the Internet and is the first document to acknowledge the serious threat that Internet-based services pose to the existing regulations. The analysis demonstrates that the differences in the integral and modular age are indeed reflected in the regulatory record. It then further explores the nature of the regulatory environment in the modular age.

1.2.2 A Summary of Results

The appropriateness of a regulatory regime can be evaluated along three dimensions: the objectives it serves including cost & innovation outcomes, the obligations it imposes to fulfill those objectives, and the mechanisms it uses to enforce those obligations. Collectively, these dimensions determine the degree of compliance achieved and the total costs of achieving this compliance. The OBJECTIVES may be evaluated by asking the following question: are they appropriate for the telecommunications system to fulfill? The regulation of voice communications has traditionally fulfilled five objectives: three of them are social objectives (law enforcement, public safety, and equal opportunity objectives) and two are economic objectives (competition and economic development).

This paper argues that these objectives remain appropriate for the voice communications regulations to fulfill in the modular age, but they are currently being pursued at the wrong level. The debate about the regulatory objectives is currently stuck at the level of which technologies or industries (wired, wireless, internet telephony, etc.) ought to fulfill them. This seems inappropriate. For example, public safety is a societal objective that has generated emergency calling (E911) obligations for the telecommunications system. The PSTN providers have been burdened with the emergency calling obligations since 1976. However, ever since wireless telephony and Voice over Internet Protocol (VoIP) became viable competitors to the PSTN, the regulatory process has engaged in a debate as to whether and when to extend the emergency calling obligations to these new entrants. The answer ought to be clear, but it hasn't been because the public safety debate has been pursued at the level of technologies. At the societal level, the telecommunications system is one of many subsystems that facilitate public safety. If the telecommunications system as a whole fails to aid public safety because some technologies are not regulated, other subsystems—maybe non-technical ones—will have to pick up the slack. But this consideration has not been recognized in the discussion.

The OBLIGATIONS may be understood by asking the following questions: Are they appropriate for fulfilling the objective at hand? Who should bear them, and when? For the obligations to be apt, every regulatory objective must be pursued at the societal level first. Only then can the obligations for the communications system as a whole, or for the technologies or industries within it, be correctly understood. Pro-market regulatory regimes have already responded to the

[3] Precisely, the Implementation of the Local Competition Provisions in the Telecommunications Act of 1996 Notice for Proposed Rulemaking.

"who" and "when" questions with incremental regulation. Incremental regulation can take two forms: partial regulation, where the regulatory scope permanently excludes certain types of firms or technologies from regulation; or delayed regulation, where the regulatory scope temporarily excludes certain types of firms or technologies but includes them later. Significant uncertainty in the early stages of technology disruption has been the driving force for use of incremental regulation in periods of technological disruption. Managing incremental regulation necessarily involves decisions about the regulatory scope and timing.

This paper argues that incremental regulation is futile in the modular age. Limiting regulatory scope in a modular architecture creates perverse incentives. At the industry level, it provides incentives to the regulated firms to flee to the unregulated technology segments. At the global level, it ignites competition in laxity between nation-states trying to lure both consumers and firms with lighter regulatory burdens.

As for the timing of incremental regulation, the far higher dynamic complexity of the modular age renders impractical any hope for effectiveness in the timing-related decisions. First, the regulator struggles to determine if the regulation is too-early or too-late, because many competing factors mediate the rate of technology and industry disruption, making it virtually impossible to predict how rapidly an unregulated segment might erode existing regulatory compliance. Next, the regulator cannot be sure of the outcome post-regulation, because the modular age offers far higher flexibility to consumers, firms, and technologists to strategically manipulate the competitive outcome, the dynamics of which the regulator often does not fully comprehend and cannot fully anticipate. So, to understand the appropriate scope or timing of regulation, the dynamic complexity of the modular age must be understood as well as possible. Paper 2 focuses on further understanding the dynamic complexity.

The ENFORCEMENT MECHANISMS may be evaluated by asking whether they are effective for the system to be regulated? The enforcement mechanism for traditional telecommunications regulation has been command-and-control. This mechanism worked because in the integral age the industrial interests were concentrated, which made it possible for the regulator to know whom to command and where to control. The regulatory fights were easier to identify and address. Also, as a firm possessed full functional control over a service, it could easily develop and deploy compliance mechanisms post-regulation.

The modular age completely changes the rules of the game. The modular forces blunt the mechanisms of command-and-control. First, the regulator finds it difficult to determine where a command-and-control mechanism ought to focus, because the post-Internet era has multiple players in the value chain, including consumers, each a capable interest group with a distinct viewpoint on regulatory mechanisms and objectives. Next, command-and-control mechanisms are ill-suited for building consensus around regulatory issues, which is imperative for meeting critical societal objectives, as the lack of consensus inflicts a high coordination cost that could prevent meeting regulatory objectives altogether. The modular structure shifts the center of gravity of control from a single dominant interest to multiple, from the center of the network to its edges, and from the corporations to corporations-plus-consumers. This is a tectonic shift that demands completely different enforcement mechanisms.

This paper concludes that for the aforementioned reasons, the regulatory modes of the integral age cannot work for the modular era, in their objectives, obligations, and enforcement mechanisms. To design regulations that are appropriate and practical for the modular era, the following combination must occur: the regulatory debate around objectives must be pursued at the societal level; the necessary obligations must follow from the objectives construed at the societal level; the incremental regulation being utilized for imposing obligations must be abandoned; and new enforcement mechanisms, conscious of the dynamic complexity of the modular age, must be designed. Paper 3 discusses how to achieve such an outcome.

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1.3 Paper II - Anticipating Uncertainty in Telecommunications Regulation, Competition, and Innovation

1.3.1 Problem and Research Method

Decision making under the constant threat of disruption is a difficult task whether you are a policymaker, manager, consumer, or technologist.[4] Difficulties arise from the bewildering array of uncertainties that surround the disruption phenomenon. This paper examines: *How can regulators and managers improve decisions taken amidst the uncertainty that surrounds the disruption of an integrated technology and industry by a modular one?* The purpose of this paper is to understand these uncertainties from the perspective of dynamic complexity in feedback systems. The paper attempts to improve our current understanding of the technology and industry disruption phenomenon at three levels. First, the paper maps the existing theories in technology and industry disruption into a single, dynamic model to explore the structure of influences that drives the various possible industry and technology trajectories. Second, the model makes endogenous key parameters that the existing theories have considered exogenous. By doing so, the model can address not only what the various scenarios of uncertainty and their outcomes are, but also when each scenario arises in the first place and how it may persist. Finally, the paper includes consideration of the strategic behaviors of firms (derived from unstructured interviews) to explain how different actors may change the game. With the help of these features, the paper discusses the impact of the various uncertainties—technological, market, organizational, regulatory, or that of the industry structure—at two levels. First, at a theoretical level, it discusses the conditions under which a disruption may or may not take place, thereby discussing the assumptions and limits of two disruption theories; namely: Clayton Christensen's work on technology disruption[5], and Charles Fine's work on industry disruption and clockspeed[6]. Next, it discusses broadly how policymakers, managers, consumers, and technologists can anticipate the behavior of a number of parameters of practical importance.

The research starts with a qualitative case study to investigate the following question: do potentially disruptive technologies always displace the existing industrial order? This is an important question to start with, because the loose and opportunistic use of the term "disruptive technology" today, by the media and experts alike, can mislead decision makers every time a new technology appears on the horizon. The case research uses a combination of content analysis and industrial statistics. First, it analyzes several important media publications to enumerate technologies they proclaimed as "disruptive technology" in the period between 1997, when the term was coined by Clayton Christensen, and August 2008. Next, with the help of the Global Industry Classification Standards, it ties these technologies to the industries they were expected to disrupt. Finally, it studies the industrial order of the industries threatened with disruption for the years 2001 and 2007. The analysis shows that in the communications industry alone, where changes ought to be easier to visualize because of its rapid rate of change, a potentially

[4] Paper 2 is targeted for either the Journal of Industrial and Corporate Change, or the Journal of Innovation and Product Management.
[5] More famously, "disruptive technology," in Ref. Innovator's Dilemma
[6] Ref. Clockspeed

disruptive technology often does not succeed (i.e., no technology disruption). Further, it finds that technology disruption does not always mean industry disruption; in other words, in some cases, a new technology may disrupt the old, but the industrial order does not change because the leaders of the old technology continue to lead the new market. To understand what factors explain such variation in the outcome, the research then turns to a dynamic model that more broadly captures the uncertainties involved.

The single, dynamic model in this paper situates the two models discussed in Paper 1 in the appropriate theories, and makes the parameters in those models endogenous. First, to model the dynamics of technology disruption, several parameters of the simple diffusion model, such as quality, innovation, price, and resources of the firms, are made endogenous. Next, to explain the dynamics of industry disruption, the industry-level modularity is made endogenous, which allows for understanding the level of organizational rigidity, dimensional complexity, and functional control the firms experience as one industry disrupts another. Finally, the dynamics of regulation are added to explain how the cost and resources required for regulatory compliance affects competition during technology and industry disruption; and conversely, how the disruption affects the level of regulatory compliance, and the time necessary to achieve it. The model is analyzed under market, technology, organizational, and regulatory uncertainty. The scope of this model is limited to a scenario where a *modular* technology and industry disrupts an *integrated* technology and industry, which is sufficient for studying the Internet's disruption of traditional technologies. Careful judgment is required to port the lessons of this paper to other scenarios of disruption.

1.3.2 A Summary of Results

At a theoretical level, the research discovers several limits to technology and industry disruption. The paper first discusses the limits to technology disruption, meaning conditions under which an entrant technology fails to displace the incumbent technology. It identifies two sets of conditions the lead to such a situation. First, a technology disruption is less likely when the incumbent's product or service enjoys strong network effects. The case research supports this finding. It shows that indirect network effects have prevented technology disruption in both operating systems as well as the wireless operators markets. Second, a technology disruption is less likely in markets where consumers prefer innovation in product or services far less compared to their low price, high quality, and high compatibility.

The paper next discusses the limits to industry disruption, meaning conditions under which a new technology displaces the old but the entrant firms do not displace the incumbent firms. Such a situation arises when the incumbent loses the market share initially, but then it regains the lost market to become a leader in the new technology. The paper identifies two sets of conditions for such a situation to occur. First, an industry disruption is less likely when the incumbent can significantly affect the switching behavior through a variety of strategies. The case research confirms this finding. It shows that the incumbents in computers and communications industries strategically utilize high switching costs to retain or regain their large consumer bases. Second, an industry disruption is less likely when incumbents are able to innovate while maintaining certain quality. Incumbents are typically stacked against natural barriers to rapid innovation such

as rigidity of their organization and high dimensional complexity of their product. Yet, there are examples of incumbents radically restructuring their products in order to innovate while offering lower than before but acceptable quality to their consumers. Third, an industry disruption is less likely when entrant struggle to offer quality due to lack of functional control or market power. Being able to offer system-level quality is easier when a firm has system-level functional control. Such a system-level functional control is present when a firm owns critical functional components involved in delivering a service, or when the interfaces are standardized and a modular firm can reliably assert control over the end-to-end service to offer quality. Modular entrants in nascent markets often lack such control. Moreover, in a situation where they cannot accumulate market power because of competitive or regulatory reasons, they may lack the ability to deliver the necessary quality, either by developing it on their own or by contracting with other firms for it.

At a practical level, the research provides guidance to practitioners on understanding uncertainty. First, it uncovers three myths about disruption that arise commonly. Incumbents often believe that disruptors cannot offer quality so there will be no technology disruption, which is a myth that leads to incumbent's response that is slower than necessary. Analysts often believe that every entrant technology is inherently superior so there is sure to be technology and industry disruption, which is a myth that creates hype around every new technology. Corporate leaders often believe that a highly agile firm will survive disruption, which is a myth that leads to disregarding other structural influences that may be more important than firm's agility. Each of these myths arises due to the misperceptions of feedback in complex systems.

Next, the research provides guidance on how to anticipate parameter behavior under uncertainty before, during, and after disruption. It discusses the system-level structural implications that arise because of how the causes and effects are arranged in the whole system. The paper explains the structural implications using two types of structural forces: reinforcing and balancing. It elaborates upon the several structures of each type that the model identifies. In reinforcing structures a change is amplified, so a growth leads to further growth and a decline to further decline. In balancing structures a change is countered, so either a growth or a decline is countered. Structural influences demonstrate why dislodging the incumbent can be so difficult. In the communications industry, the incumbent's large installed base reinforces three of its strengths – high quality, low price, and high compatibility. Hence, a potentially disruptive entrant needs a great innovation to overcome these forces. The structural forces also explain several sources of lock-in. For example, integrated structures have a tendency to remain integrated, and modular structures to remain modular. These observations argue that the small market share of a modular entrant at the time of entry is not enough reason to ignore the entrant as the reinforcing forces may help it grow rapidly. Also, once a modular structure disrupts and becomes dominant, it might persist because of the lock-in, so the disruption has real consequences.

Finally, the paper discusses the challenges of observing and measuring parameters.

1.4 Paper III - From Animal Trainer to Wildlife Conservationist: Balancing Regulation and Innovation in the Modular Age

1.4.1 Problem and Research Method

Juxtapose the social and economic objectives served by the existing telecommunications regulations, and evaluate what the modular age has done to them from the societal perspective, and you shall see a very different role emerging for the regulatory agency in the new world. The modular forces naturally promote the economic objectives such as competition and innovation, but they derail critical social objectives such as law enforcement and public safety. The regulator's new role should be to achieve the following vital combination, which we define as the *first best* (FB) outcome: regulatory compliance, innovation, and competition are maximized subject to compliance cost constraints. In other words, the necessary regulatory compliance is achieved, the high innovation and competition are preserved, and the reasonable cost of compliance is maintained. This paper asks: *How can such a balance of regulation, innovation, competition, and cost be achieved in the modular age of the Internet?*

The research begins with analyzing regulatory compliance, innovation, competition, and compliance cost as emergent behaviors of the systems model developed through papers 1 and 2. It then proceeds in three stages. In the first stage, we investigate whether the FB can be achieved *using the currently-known policy levers* such as the scope and timing of regulation. For this investigation, we subject the model to a set of optimization exercises. In each exercise, the desired objective function needs to be achieved by varying the scope and timing of regulation. The optimization exercises are organized in an increasing order of complexity. They show that partial and delayed regulations cannot achieve the FB, and that balancing the four attributes involves tradeoffs.

Hence, in the second stage, we carry out policy analysis on the systems model *to seek levers that are capable of achieving the desired balance, but that have not been exploited by the policymakers yet.* Once we find such policy levers that would, in theory, achieve the desired balance, in the third stage of the research, we discuss how the objectives, obligations, and enforcement mechanisms might be devised to implement the policies it in the practical sense, and from the systems perspective. For the third stage, we extend the Pre- vs. Post-Internet Regulation Case Research, already introduced in Paper 1.

1.4.2 A Summary of Results

The first optimization exercise demonstrates that if the regulatory compliance alone had to be maximized, the policy of comprehensive regulation, where all market entrants are regulated at the time of entry, achieves the necessary regulatory compliance, but it does so at the cost of innovation and competition. Here, unless the entrant enjoys a giant price and performance advantage over the incumbents that cannot be dwarfed by their regulation, the regulation creates a barrier to entry. This exercise shows that there is indeed a tradeoff in increasing compliance versus innovation and competition.

The second optimization exercise shows that if compliance had to be balanced with just innovation and competition but not cost, the regulator can do better if they accept a delayed regulation of the entrant; meaning, they give up regulation at the time of entry so as to let the modular entrant enter. Such a finding validates the regulatory tendency to leave nascent entrants unregulated; for example, the exclusions of the Internet from the 1996 Act. In theory, delayed regulation may work if entrant can be regulated as soon as it has a sufficiently large consumer base but no later, as such careful management of the timing of regulation provides the best possible payoff in terms of both regulation and innovation. Unfortunately, however, there are several undesirable effects. First, the average compliance only reaches a level that can be achieved in a fully modular structure, which may be inadequate for the objective at hand. Next, as discussed in Paper 1, such a management of the timing of regulation is too difficult in the post-Internet environment because of the dynamic complexities. Finally, such improvement in compliance and innovation, achieved using delayed regulation, comes at a disproportionately large compliance cost due to the inordinate coordination cost of fully regulating the modular value chain.

The third optimization exercise shows that if all four – compliance, innovation, competition, and cost – had to be balanced; the regulator can do better if in addition to the delayed regulation, they accept partial regulation of modular value chain, where the regulatory scope includes only those firms that can easily comply with regulation, thereby reducing the coordination cost. Such a finding validates the regulatory tendency for leaving out the difficult to regulate technologies; for example, the partial regulation of IP-Enabled services such as VoIP. However, we know from Paper 1 that such partial regulation is unsustainable as it provides perverse incentives for the regulated firms at the industry as well as global level in a dynamic environment. But more importantly, even after accepting both partial and delayed regulation, the average compliance remains inadequate for fulfilling the critical regulatory objectives.

The first stage of research above concludes that the existing arrows in the regulatory quiver are blunt. Nonetheless, the above analysis does illuminate the theoretical conditions that must be met if the compliance, innovation, competition, and cost had to be balanced. These conditions are as follows: the modular structure must disrupt and win (i.e., regulation must not act as a barrier to entry); the modular structure must remain modular even after gaining market power (i.e., regulation must prevent significant accumulation of market power to maintain competitive pressure); and the modular structure must have the ability to comply with regulations at low cost (i.e., regulation must ensure that the coordination costs remain low). The policy analysis in the second stage of research explores which new policy levers must be pulled to achieve such an outcome.

The policy analysis on the systems model contends that the highest leverage regulatory solution for meeting the above-listed theoretical conditions is a combination of two policies: to guard against the build up of significant market power, and to lower the coordination cost in modular industries by building consensus around the regulatory issues. The following logic drives this recommendation. When a modular industry disrupts an integrated one, there is a great lack of consensus among firms around the regulatory issues. This lack of consensus causes two problems: it increases the time required to build compliance mechanisms, and it inflicts a large

coordination cost that inflates the total cost of compliance, both of which reduce the overall compliance. Further, the coordination costs pose entry barriers for the nascent entrants. Since meeting regulatory requirements in a modular industry necessitates that all firms coordinate, such increase in coordination cost is inevitable. For example, when devices, applications, and access networks involved in delivering a single service are provisioned by separate parties, they must necessarily coordinate actions to comply with public safety or law enforcement requirements. Additionally, as the modular components compete fiercely over territories in a modular value chain, there will be a constant disagreement over who should bear the coordination cost. One market-based solution for reducing coordination cost is to let the modular firms integrate, but such integration comes at the cost of consolidation of market power, less standard interfaces, and lower pressure for innovation adoption. Hence, the coordination cost and the modularity of the industry structure, together, play a central role in balancing the compliance, innovation, competition, and cost, and the regulator is the best suited to balance these attributes by controlling the coordination costs and the level of integration in the industry structure. Controlling the coordination cost and the level of integration require the regulator to use two policy levers: building broad-based consensus around regulatory issues, and limiting the consolidation of market power in the communications industry. These levers allows the regulator to increase compliance levels by containing the time and cost of developing compliance mechanisms, and to keep the innovation and competition high by reducing the barrier to entry as well as by maintaining the competitive pressure to innovate and adopt innovations.

Limiting the consolidation of market power and building broad based consensus may be a nice theoretical solution, but are the regulators equipped to achieve it at the practical level? As established in Paper 1, to design regulations that are appropriate for the modular age in a practical sense, the following combination must occur: the regulatory debate around objectives must be pursued at the societal level; the necessary obligations must follow from the objectives construed at the societal level; the incremental regulation being utilized for imposing obligations must be abandoned; and a new enforcement mechanism conscious of the dynamic complexity of the modular age must be designed.

This paper argues that to be able to address the objectives at the societal level, the FCC must be empowered to, and in fact must take a philosophical position on regulatory objectives, and thereby on the resulting obligations. While the dynamic complexity of the environment may complicate the enforcement of regulations, it does not obscure what the philosophical position on each objective ought to be. For example, the FCC must clearly state that objectives such as law enforcement and public safety cannot be compromised, and technologies that aspire to substitute existing channels of voice communications will be required to find a way to comply with the necessary obligations. Similarly, the FCC must clearly state that it considers promoting multi-modal competition and innovation to be of critical importance. Therefore, the interconnection obligations will be considered across any two technologies, not just within a single mode such as PSTN. Similarly, universal service obligations may be fulfilled by any acceptable substitute, not just PSTN.

Taking a clear philosophical stance on issues like these will help in several ways. First, it will prevent the entrenched interests from defocusing the regulatory debates. The analysis of the public comments, posted in response to the 2004 IP-Enabled Services NPRM, shows how the

absence of a clear position on the objectives allows the political economy of entrenched interests to hijack the regulatory debate away from being objective-centered. For example, the state vs. federal, or local vs. long-distance service interests currently overwhelm the debate about the access charges, which ought to be centered around how to achieve the objective of high competition. Similarly, interests trying to preserve the compensations that currently benefit them monopolize the debate about universal service, which ought to be centered on how socio-economic benefit may be brought to remote areas through new technologies. As a result, today, the regulatory proceedings spend enormous energy on appeasing the entrenched interests, which ultimately does not achieve the goal.

The second advantage of taking a clear position is that it reduces the regulatory uncertainty, and thereby makes both incumbents and entrants less risk averse. Firms do not risk investment in differentiating themselves from the competition when there is uncertainty about regulations that may neutralize the advantage. A clear position on the objectives makes it clear for the firm if they should expect to be regulated. And guaranteed regulation is often better than a threat of regulation.

The third advantage of taking a clear position is that the obligations that follow will eliminate misalignment that currently exists between opportunities, objectives, obligations, and capabilities. The obligations that follow from public safety, equal opportunity, and universal service objectives would then more aggressively leverage the new technologies that offer improved ways to achieve these objectives. The obligations that follow from critical areas such as law enforcement would not be partial or delayed. And, the obligations would not burden only parts of the value chain when the capacity to meet the obligation has moved to the other parts as a result of the movement in the functional control.

Of course, simply taking a philosophical position will not be sufficient. To fulfill the objectives at the societal level, the government institutions, more broadly, and the FCC itself, more specifically, will have to organize differently. The fragmentation of government and the regulatory agency does not currently empower any party to be responsible for understanding and achieving the objectives at the societal level. While the full exploration of how to reorganize the government or the FCC is beyond the scope of this thesis, here is an example.

We know from our analysis that a merger between two firms can potentially compromise two objectives: promoting multi-modal competition and innovation experienced by an average consumer. Yet, no merger in telecommunications industry to date has evaluated competition between multiple technologies, nor has any been viewed as a precursor to the impending loss of innovation. The reason clearly is the fragmented organizations sharing responsibility for evaluating a merger. The FCC is organized in technology-specific silos such as wireline, wireless, and media. bureau. Despite that fact that large telecommunications firms today are invested in all technologies, every merger evaluation is assigned only to one of the FCC bureaus. Hence, the multimodal competition perspective could easily fall between the cracks. The FCC evaluates a merger from only the "public interest" perspective. It is the Department of Justice (DoJ) that assesses if the merger will "substantially lessen" the competition, but the DoJ does not have the technological perspective, let alone that of multi-modal technology. FCC's "public interest" is also inadequate. It only involves the analysis of how the merger affects the consumer

welfare, and does not recognize that with a merger, the industry integrates, product interfaces may go from standardized to proprietary, and the industry may turn from one that was innovation-focused to the one that is quality-focused.

Apart from taking a position on objectives and reorganizing the agency as appropriate, to be able to build broad-based consensus, a whole new set of capabilities and processes will have to be added to the enforcement bureau. Broad-based consensus may be built in two ways: by bringing all stakeholders to the negotiation table, or via the process of standards. The enforcement bureau has never included negotiators, nor have they participated in standard body meetings. It may need to acquire both of these skills. Their paradigm has been command-and-control, which only uses fines and punishment. Unfortunately, the modular age renders the current enforcement paradigm of command-and-control ineffective because of the enormous dynamic complexity. Today, the firms cannot easily comply with regulation because of the inordinate coordination cost due to the heterogeneity of architectures and competitive interests. The regulator must focus on reducing the firm's effort required to comply, so the firms can focus on their core competencies. Being able to negotiate a broad-based consensus around regulatory issues will allow the FCC to reduce the burden of compliance on modular firms, so that these firms can comply with regulation and innovation at the same time.

Metaphorically, in the modular age, the role of the regulatory agency has gone from that of an animal trainer to a wildlife conservationist. The animal trainer cared only about compliance, but the wildlife conservationist cares also cares about the survival of species. The trainer, like a policeman, curtailed unwanted activity, whereas the conservationist, like a parent, is interest in a balance, where animals are playful but also grow into responsible citizens of the jungle.