Information Theory as a Basis for Rationalizing Regulation of the Communications Industry

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This paper is dedicated to my long-suffering spouse, who has inspired, supported and believed in my work.

EXECUTIVE SUMMARY

This paper proposes a new analytical framework for thinking about regulation of the communications industry in light of the rapid evolution taking place within firms and among industry groups in that sector. A call for some such framework was sounded by the Clinton administration in late 1993:

> *The regulatory framework that the Administration seeks to create is designed to adjust to the technological and market changes that have undermined the regulatory regime created by Communications Act... The Administration's lodestars in these efforts are flexibility, adaptability and fairness... similarly situated services should be subject to the same regulatory requirements.*[1]

All segments of the industry have also called for what they refer to as a "level playing field." The current regulatory scheme is widely perceived as unfair and unpredictable by business, government and consumers. A call for a more rational basis for differing treatment of communications industries is certainly not new and has been made by a wide variety of policy makers and commentators since the Supreme Court accorded lower constitutional protection to broadcasters than had given to the print media.

The current regulatory framework was set up to make the first question in any analysis "Is it a duck?" For example, if "it" is identified as a broadcast service the analysis goes one way and if it is a newspaper or a telephone service it goes in other directions. This is fine as long as you can really tell a duck from a goose. But the ongoing trend toward industry "convergence" makes it increasingly difficult to apply these rules. Firms who now look more like ducks are still being treated like geese and this makes it difficult for them to compete with other ducks.

As one route for reaching the goals of flexibility, adaptability and fairness, this paper suggests that the regulatory system respond by undertaking an evolutionary process of its own. The ultimate goal of this process would be a system that is organized around the "basics" of the communication process, the things that always stay put and do not get blown away by the winds of change. To find these basics we turn to the science that is the basis for the explosion in telecommunications and computer technology because, in order to develop that technology, it was necessary to go back to the bedrock of all communications systems.

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[1] From a press handout at a speech given by Vice President Gore to the Television Academy at UCLA on January 11, 1994.

Information theory was developed to help shoot down enemy planes and became the basis for the binary digital computer languages that lead us directly to the "digitization" of the communications industry. This theory breaks down all communication into basic parts: senders, receivers, coding, channels and noise. This is true for communication between cells in our bodies as well as the most sophisticated telecommunications systems currently envisioned (and even systems that no one has even dreamed of yet).

For example, if regulation is applied to the activities of all people or firms acting as senders and/or channels (whether they are speakers, publishers, broadcasters, telcos, cable, etc.) it can be applied fairly and with flexibility and adaptability in the light of new technology. A beginning of this approach can already be seen in the regulations adopted for a new service called "video dialtone."

This framework does not dictate the outcome of any current or future policy debate. It does not dictate that policy makers in all jurisdictions make the same choices. But it does create some common ground on which those political, technological and economic debates can take place. At the very least it can help courts and policy makers think about the larger context in which they make decisions.

This paper does not attempt to suggest the direction of regulation or the policy goals that should be pursued. Those judgements have deliberately been left to other papers, other authors and, ultimately, to the political system.

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I. INTRODUCTION

This paper proposes a new conceptual framework for communications regulation. It proposes that the current system, which bases regulation on static definitions of service, be phased out and a new system based on the common elements of all communication be gradually put in its place.

This conceptual framework rests on information theory, the scientific basis of the modern communications revolution. Since this theory reduces the communication process to its basic elements it is not technology specific, allowing statements made about one communications channel to be made for all. A review of the need for this rationalization of communications regulation is presented in Part II. Information theory is explained in Part III.

Part IV applies the theory to redefine the communications industry by identifying all the relevant components of the process: senders, receivers, channels, etc., and suggests how these components could become the basis for public policy initiatives as well as the rationalization of current regulatory mandates and structures.

Because the paper aims at policy makers who are not all lawyers or engineers it strives to avoid jargon and to explain certain concepts that may be unfamiliar to persons who are not professionals in this area.

II. WHY A NEW POLICY FRAMEWORK FOR COMMUNICATIONS?[1]

There can no longer be much doubt that the various players known collectively as the communications industry are about to undergo profound changes and that these changes will have an impact on virtually every other human enterprise. There is also little doubt that the regulation of these formerly discrete industries must change as they combine and metamorphose into new entities.

As in any important or pervasive change we can be sure that new words will creep into our conversations to express things or ideas that we have never experienced before. This seems to be especially true in areas of changing technology. For example, the merger of computers with communication technology is being referred to as "compunications."[2] If a telephone company merges with a cable company is it a cablephone company? If a movie studio merges with a magazine publisher is it a movazine company? What if a cablephone company merges with a movazine company? What if there are no mergers and the telephone company just starts acting like a cable company by delivering news and entertainment via video?

These questions are neither frivolous nor far-fetched and their importance goes beyond linguistics. A wave of mergers is beginning to reorganize the communications industry both in the US and internationally.[3] In the much-touted "Information Age" new products and services will defy old distinctions between the various parts of the communications industry. But the prevalent practice is to analyze legal and policy questions by asking where a service falls with regard to the currently established regulatory boxes.[4] In other words, the first task of any public policy analysis amounts

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[1] The views expressed in this article owe much to the work of many people, but especially that of Claude Shannon, Anthony G. Oettinger, Ithiel de Sola Pool, M. Ethan Katsh and John R. Pierce, all of whom have seen communication as larger than any particular technology.

[2] Oettinger, Anthony G., "The Abundant and Versatile Digital Way," in *Mastering the Changing Information World* (Norwood, N.J. Ablex Publishing, 1993).

[3] The interested reader can find a list of this activity in late 1993 published in the *Wall Street Journal* on October 13, 1993, at page 1.

[4] For a comprehensive review of how various video communication technologies were regulated in the 1980's, see, Abeshouse, Jill, Krasnow, Erwin, G., and Senkowski, R. Michael, "The New Video Marketplace and the Search for a Coherent Regulatory Philosophy," *Catholic University Law Review*, v.32, n.3, Spring 1983, pp. 529-602.

to asking, "Is it a duck?"

Consider a business that wants to put a color printer in homes and offices to be used with a cable TV service to print out color coupons or advertisements at the request of the customer or print out magazine articles and even whole books.[5] Is this a cable service? A publishing service? Will it be subject to the laws regulating cable or the laws (or absence of laws) applicable to publishing? Will the local municipality, the state public utility commission or the Federal Communications Commission have jurisdiction? Or should these new technologies stay outside the regulatory process?[6]

The telephone company that starts delivering movies, professional wrestling, and reruns of 1960's sitcoms[7] will still look like a telephone company (they still have lines that go into the home and may also offer POTS[8] to the same customers) but they will act like a cable TV service.[9] The FCC has decided that, in this situation, telephone companies do not need to seek a local franchise (mandatory for cable) because they are not really a "cable system."[10] This may be the right decision but it does beg the question.

This is all complicated by the fact that the local cable company may soon start offering a service that looks like POTS in addition to its standard video fare.[11] In

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[5] A joint venture to deliver such a service was announced in 1993 by Hewlett Packard (a computerprinter company)and Time Warner (a movazine company). See, "The Media Business," *The New York Times*, October 12, 1993, sec. D, p. 15.

[6] This may be the best option where freedom of expression is concerned because, as Alexander Bickel has said, "Those freedoms that are neither challenged nor defined are the most secure." See, Bickel, A., "The Uninhibited, Robust and Wide-Open First Amendment," in *Where do you Draw the Line?* ed. Victor Cline (Provo Utah, Brigham Young University Press, 1974) p. 65.

[7] Joint ventures to deliver "video dialtone" service have been announced by several of the former regional Bell operating companies (known as the RBOCs).

[8] Plain Old Telephone Service.

[9] Columbia University professor Eli Noam has predicted that many current telephone and cable companies will evolve from information conduits to "systems integrators" who make use of a variety of technologies to serve their customer. Industry officials have agreed that this seems likely to occur. See, *Washington Telecom Week*, v.2, n.17, April 30, 1993.

[10] For a comprehensive discussion, see, Pettit, Robert L. and McGuire, Christopher J., "Video Dialtone: Refections on Changing Perspectives in Telecommunications Regulation." *Harvard Journal Of Law and Technology*, Vol. 6, Spring 1993, pp. 343-362.

[11] Several cable companies have begun to upgrade their systems to fiber optic cables and have announced their intentions to provide mobile point-to-point communication service via personal communication systems that will compete directly with local phone service.

one case we have a duck that has taken a second job as a goose while the other is a goose who also works as a duck. Both are starting to hang around with both ducks and geese and even hawks. Should we treat one like a duck and the other like a goose?[12]

But the problems/opportunities for traditional "media" enterprises and their telecommunications partners/competitors is only half the story. The law of "cyberspace" is virtually uncharted and scholars who have studied computer-based communications systems like INTERNET and NREN are struggling to determine which of the traditional regulatory models is most appropriate for this new bird.[13]

This massive reorganization of the communications industry has even called into question some of the fundamental legal and constitutional principles that had long been regarded as firmly settled for the traditional media. For example, what constitutional rights will be accorded to people who send or receive messages via cable or telephone wires? This apparently simple question is complicated by a structural flaw that has developed in building modern communications law: rights and responsibilities are governed not so much by what you say but how you say it or how you used to say it.[14]

Under the current system if you distribute information on paper you have the highest level of constitutional protection and very little government regulation. If you distribute the same information using the electromagnetic spectrum in an over-the-air system you have much less constitutional protection and a lot more regulation. If you use a wire-based system these issues are, well, up in the air, especially if you are both a sender of information and the owner of the channel. The current system is

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[12] One commentator suggests that this regulatory dilemma can be solved with a new framework based on competition and separate regulation for information transmission and information services. This is not inconsistent with the proposal made here. See, Grudus, James Walter, "Local Broadband Networks: A New Regulatory Philosophy," *Yale Journal of Regulation*, Vol. 10, No.1, Winter 1993, pp. 89-145.

[13] See, Johnson, David R. and Kevin A. Marks, "Mapping Electronic Data Communications onto existing Legal Metaphors: Should We Let Our Conscience (And Our Contracts) Be Our Guide?" *Villanova Law Review*, Vol. 38, No.2, 1993, pp. 487-515; Perritt, Henry H. Jr., "Tort Liability, The First Amendment, and Equal Access to Electronic Networks," *Harvard Journal of Law and Technology*, v.5, n.6, Spring 1992, pp. 65-151.

[14] For a detailed discussion, see, "Print and Electronic Media: The Case For First Amendment Parity," Committee on Commerce, Science and Transportation, United States Senate, (US Government Printing Office, Washington DC, 1983).

based on three basic regulatory models that were built for the technology they regulated: print, broadcast and common carrier. Attempts to apply them to new technologies (and even to old ones in the face of improvements in the efficient use of spectrum) has become a nightmare for everyone involved.[15]

In his book describing the communications revolution as it is being developed in the Media Lab at MIT, Stewart Brand says that because technology always moves faster than the law, all new technologies are outlaw areas and they are all dynamite.[16] There is no doubt that communications regulation has, in fact, being overwhelmed by the changes. The regulatory agenda at the Federal Communications Commission and the state public utility commissions is beginning to surpass their resources.

But we know from Hollywood westerns that when there is an absence of rules on the frontier the big guys usually win. However, in some quarters this is thought to be bad public policy where communications are concerned.[17] And without an adequate regulatory force in the field the uncertainty of the new territory is bound to create fear. Fear by consumers is clearly evident in debates on privacy of data[18], government eavesdropping[19], and the cost of access to the new information

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[15] This problem is not really new and became apparent as soon as services like subscription television were introduced. See, pp. 27-30 below for a more detailed discussion of the issues raised as when regulators seek to put new channels in old boxes.

[16] Brand, *The Media Lab: Inventing the Future at MIT*, Penguin Books, New York, 1987, page 213.

[17] Congress and the FCC have made concerted efforts to avoid concentration of ownership by broadcasters by limiting the number of stations that can be owned in any particular market and in the country as a whole and have gone to some lengths to make it possible for minorities to own stations. 47 CFR 73.3555 and 73.4140. In the telephone business this policy is clearly evident in the Modified Final Judgement that has attempted to control the activities of the units of the former Bell system. See, Hindman. Richard A., "The Diversity Principle and the MFJ Information Services Restriction: Applying Time-Worn First Amendment Assumptions to the New Technologies," *Catholic University Law Review*, v. 38, n.2, Winter 1989, pp. 471-510.

[18] For example, many state regulators have been faced with claims of "privacy" violation with the introduction of Caller ID. For a survey of this and similar issues, see, McManus, Thomas E., "Telephone Transaction-Generated Information: Rights and Restrictions," Center for Information Policy Research, Harvard University (Cambridge, MA, 1990).

[19] The FBI met with heated resistance when it asked for special regulations that would allow them to eavesdrop on calls that have been encoded with proposed technology called a Clipper Chip. See, Wallich, Paul, "Clipper Chip Runs Aground," *Scientific American*, v.269, n.2, August, 1993, p. 116.

wonderland[20]. Fear on the part of communications companies has led to reluctance to introduce new products and invest in new infrastructure before the rules are clear.[21] This confusion in the regulatory climate has been cited as one of the major brakes on the continuing commercialization of the evolving American communications and computer technology.[22]

The way of thinking about communication systems proposed here will be familiar to policy makers in the telecommunications field because it involves exactly the same fundamental breaking down of the system that is currently discussed in terms of open network architecture and the "unbundling" of telephone service. In these regulatory initiatives, POTS is broken down into its basic parts and offered to customers in pieces (e.g., transmission offered separately from switching) so that competition can be made feasible in all aspects of this communication system.[23]

The theoretical framework proposed here may also help regulators and industry bridge some of the vast cultural differences between themselves and the new industries they are about to come in contact with. For example, telephone companies have seen themselves as "partners" with government in providing universal service and, until recently, had become accustomed to seeking regulatory for approval of even the smallest change in the ways they do business. This is absolutely antithetical to the view that newspapers have of their relationship to government and will be a serious impediment to any joint ventures or business activities between these industries in the future.

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[20] Many people, including the Clinton administration, feel that if users are charged too much for access to the New Information Highway, this will create an underclass of information "have nots" and government must step in to insure something like universal access to at least a minimum amount of information. See, "The National Information Infrastructure: Agenda for Action," National Telecommunications and Information Administration, Report # PB93-231272 (Washington DC, 1993). *But, see* Compaine, Benjamin M., "Information Gaps: Myth or Reality," in *Issues in New Information Technology*, ed. Benjamin M. Compaine (Norwood, N.J. Ablex Publishing, 1988).

[21] The new rules will be developed by legislation and by court cases that will interpret both new and existing legislation as well as the common law. It is assumed that the stakeholders will endeavor to choose the forum most likely to recognize their interests.

[22] See, "The National Information Infrastructure: Agenda For Action," National Telecommunications and Information Administration, (Washington DC, 1993); and, for an industry perspective, see National Critical Technologies Panel, *Second Biennial Report*, US Government Printing Office, January, 1993.

[23] See, "ONA: Unbundling and Competition in Interstate Access Markets," *Telecommunications Policy*, v.16, n.3, April, 1993, p. 194.

This paper does not advocate for or vilify any particular technology or the people who control any particular technology. Washington DC and the state capitols are swamped by trade associations representing newspapers, broadcasters, telephone companies, cable companies as well as all the new and/or hybrid technologies. They all attempt to lionize the contributions of their members to the American Way while painting rival technologies as the forces of evil. This approach has led to what is commonly known as regulatory gridlock, and, while it has left regulators unable to move, it has also resulted in the absence of the predictability that is so desperately needed by everyone involved. This can put many of the crucial questions facing this industry into the courts where judges must make these decisions with little to guide them except the laws that were made when ducks were ducks.[24]

Of course it would be naive and probably counterproductive to expect the existing regulatory apparatus to change overnight. The slow pace of change in the law is said to be one of its strengths, especially in the face of great social or technical change. Justice Oliver Wendell Holmes put this case most succinctly when he said that, "It cannot be helped... the law is always behind the times."[25] Change is clearly necessary but precipitous change will almost certainly make the problems faced by this evolving industry even worse. However, a targeted manipulation of the system at its pressure points can help move change in the desired direction(s). It has long been acknowledged that a major function of the law is to "maintain adaptability" and redefine relations between individuals and groups as the conditions of life change.[26]

The current systems for communications regulation developed in an evolutionary way as new technologies were added to the regulatory agenda, so an evolutionary process that enables the participants to evolve and adapt to the new technological

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[24] At the same time the courts are struggling to come to grips with what the new technology will mean to the practice of law. Since the court system is based on the processing and storage of information the new technologies have challenged old systems because the need for efficiency has become a paramount concern. A system that has depended on (even revered) the written word is adapting to a new computer-based "literacy." For a comprehensive and insightful discussion of this change and its effect on the law, see, Katsh, M. Ethan, *The Electronic Media and the Transformation of the Law*, (New York, Oxford University Press, 1989).

[25] Oliver Wendell Holmes, *Collected Legal Papers*, (Boston, Little, Brown 1921) p. 231.

[26] Jenkins, Iredell, *Social Order and the Limits of the Law*, (Princeton, N.J., Princeton University Press, 1980) p. 9.

environment would seem to make more sense than one that would involve the massive amounts of bloodshed (literal as well as figurative) generally associated with revolutionary change. An evolutionary process will also allow for mid-course corrections and adaptation to circumstances that are currently unforeseeable. But policy makers are not necessarily relegated to being spectators during this process. They can focus on the things about communication that will stay put and won't be blown away by the winds of change.[27]

It is important to stress that the framework proposed here does not dictate particular outcomes for any policy question nor does it mandate that policy makers in all jurisdictions make the same choices, just as the current scheme of industry-defined "boxes" does not do so.

[27] This metaphor is not mine. It was coined by Anthony Oettinger during a lecture at Harvard University in 1994.

III. INFORMATION THEORY

A valid scientific theory seldom if ever offers the solution to the pressing problems which we repeatedly state. It seldom supplies a sensible answer to our multitudinous questions. Rather than rationalizing our ideas, it discards them entirely, or, rather it leaves them where they were. It tells us in a fresh new way what aspects of our experience can profitably be related and simply understood.

John R. Pierce

SCIENCE AS A BASIS FOR LAW

One of the hallmarks of American jurisprudence is its passion for equal justice under the law. Two cases with the same essential facts should end with the same result. Attributes of the parties themselves that are irrelevant to the issues should not, in theory, control the outcome. This also enhances the predictability of the law and allows citizens and businesses to plan their affairs. Laws that are applied differently to similar parties are condemned as discriminatory and laws that are hard to predict can distort or even paralyse economic activity in a market economy. Laws of science attempt to predict how people (and all other compilations of matter in the universe) will behave under certain conditions. Much of jurisprudence is based on the predictions of scientific disciplines known as the "social" sciences, e.g., sociology, anthropology, and political science. For example, much of the criminal justice system is based on assumptions about how people will react to the threat of imprisonment or various efforts at rehabilitation.

The so-called "hard" sciences (physics, chemistry, biology, etc.) are also used as the basis for laws and regulations where they can be used to predict the desired (or undesired) outcomes. For example, the regulation of nuclear reactors would not be useful unless it is based on nuclear physics.

But looking to science for a conceptual framework for the law in any area has little precedent. After all, science is not regarded as beneficent in all cases and popular fiction has sometimes depicted it as working against the best interests of the

human race. Dr. Frankenstein's monster and the terrible consequences of genetic engineering at a "Jurassic Park"[28] have tempered the American love affair with invention and technology.

The science discussed here is not generally taught in high schools or liberal arts colleges and many readers will not be familiar with it. It is founded on mathematical principles and is one of the foundations for the advancements in telecommunications and computers that have led us to the communications revolution. This paper uses the structure of information theory but does not discuss the underlying mathematics. Those who are interested in the mathematical basis of the theory should consult Shannon's original work.[29]

FOUNDATION OF INFORMATION THEORY

Like most theories, information theory cannot really point to a birthdate. It finds its roots in many areas, but primarily in physics and mathematics. And, like most scientific theories, it did not come to the attention of those outside academic circles until it became useful in engineering and technology, i.e., until someone could use it to make something or make something work. But because it is based in mathematics it is also applicable to many other areas and has been used to analyze subjects as diverse as physics, cybernetics, psychology and even art.[30]

The world saw information theory in action (although it was not yet identified as such) in the work of Samuel F.B. Morse. Starting in 1832, Morse pioneered the use of a coded electrical signal to send information over long distances. Since all that the system could send was a "click" to the machine at the other end of the wire, the letters of words being communicated were coded into a series of short or long pauses between the clicks which became known as Morse Code. This system illustrates all the basic features of any communication process:

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[28] See, Crichton, Michael, *Jurassic Park*, (Alfred A. Knopf, New York, 1990).

[29] See, Shannon, Claude, E., "A Mathematical Theory of Information," *Bell System Technical Journal*, v.27, 1948, pp. 379-423, 623-56; See, also, Liversidge, Anthony, "Interview, Claude Shannon," *Scientific American*, January 1990, pp. 22-22B.

[30] See, Pierce, John R., *An Introduction to Communication Theory, Symbols, Signals and Noise*, Dover Publications, Inc., New York, 1980.

Sender: The person who is attempting to send a message to another person. (In this case, the person who wants to send the telegram.)

Receiver: The person who perceives the message, whether or not they are the intended receiver. (The person to whom the telegraph is addressed.)

Encoder: The person or device that changes the code of the message so that it can use a particular channel. (The person who changes the words into dots and dashes.)

Sending device: A machine that puts the coded message into the channel. (The key pressed by the operator to open and close the electrical circuit, creating the clicks at the other end.)

Receiving device: A machine that takes the coded message out of the channel. (The sounder at the other end that makes the clicks.)

Decoder: A person or machine that changes the code of the message back to the original. (The operator at the other end to translates the dots and dashes into the language of the receiver.)

Channel: The medium or process through which the message travels. (The line through which the electrical current flows.)

Message: The changes or variations in what is going through the channel. (The breaks in the current that are moving through the wire.)

Noise: Other messages or signals in the channel that make it difficult to sort out the one you want to receive. (Extraneous static or breaks in the signal caused by forces other than the telegraph operator.

Of course in the case of the telegraph there are at least three communication processes going on. The sender (customer) communicates with the telegraph operator, that operator communicates with the operator at the other end, and the receiving operator communicates with the person for whom the message is intended. If that receiver decides to send a responsive message the process takes place in reverse, with the receivers becoming senders. (See Figure 1)

Every communication process can be broken down to a very basic model. All of the basic elements of the model are present in each process and may be present on multiple levels or at multiple stages of the process. (See Figure 2)

In some cases the message is "stored" during or between communications

transactions. For example, messages are stored in books, on computer discs and, of course, in human brains. Communications has also been broken down into "substance, process and format."[31] These concepts are not inconsistent with the Shannon model but are ways to describe various ways the parts of the model work together. For example, "format" describes how coding and the channel work together (e.g., a book is coded into a written language then printed on paper as its channel). All modern complex communication systems are refinements or elaborations on these concepts including radio, television, satellite communication, cable, and wireless phones and computers.

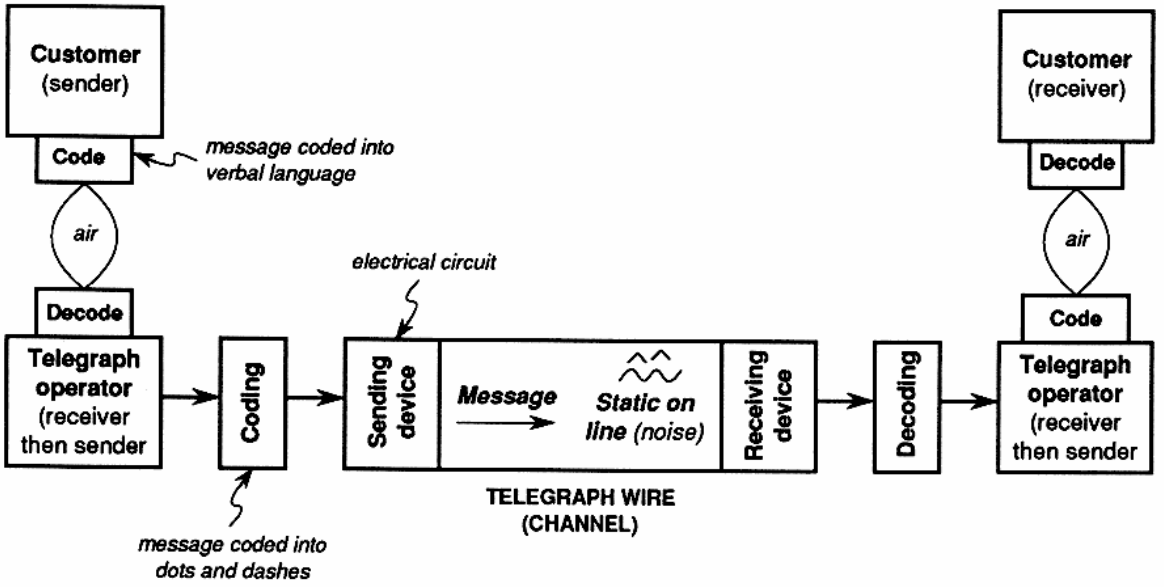

Figure 1

Model of Telegraph Communications

[31] See Oettinger, at note 2, p. 103-104.

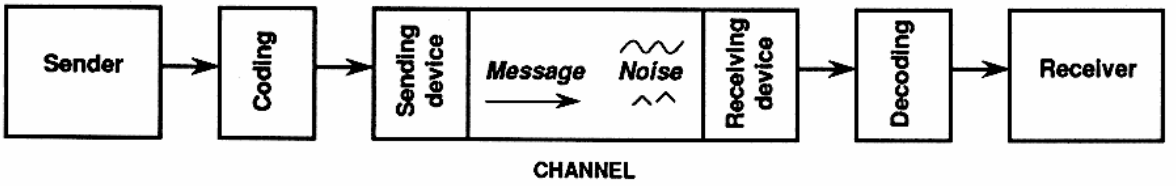

Figure 2

General Model of Communications

The technology of communication improved steadily during the first half of the 20th century but the foundations (i.e., the mathematics) upon which it was based remained essentially unexamined until the Second World War when it became critical to find a way to predict the position of moving airplanes and ships in order to deliver ordnance. This required that messages received by radar devices be used to predict the position of an enemy craft that were detected. This predictive function was developed by applying mathematics. The problem was solved independently in Russia by A.N. Kolmogoroff and in the United States by Norbert Wiener. They devised a system to separate out the extraneous "noise" received by the radar from the signal made by the movement of the vessel in order to plot its most likely course.[32] At about the same time, mathematician Claude E. Shannon was developing theories that would become the foundation for the binary digit computer language (1's and 0's) that is the basis for modern digital communication.

These two theories are used to build communication systems that can encode messages from known patterns and transmit them accurately and swiftly in the presence of noise. Greater accuracy and speed allows more messages to be sent in the same amount of time thus increasing the efficiency of both the human and mechanical inputs into the communication process. This is generally discussed in terms of "bandwidth." For non-techojunkies this can be understood as a measure of how large

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[32] Wiener's most famous work, *Cybernetics*, was published in 1948 and deals with communication and control. (Technology Press, Cambridge, MA, 1948).

the channel is and how fast communication can move in the channel, as in water flowing through a pipe: the bigger the pipe the more water will flow through it per second. For example, if a traditional phone line constructed of paired copper wire and using analog technology can transmit X amount of information per second, and a line constructed of fiber optic cable and using digital technology can transmit a million times X amount of information in the same amount of time, the later system is said to have greater bandwidth.[33]

As more communication systems become digital the basic similarities among communications technologies will become more apparent and it will become difficult to posit a relevant difference between a message delivered over a coaxial cable, a fiber optic cable or a satellite. A byte is a byte is a byte.

Information theory should not be confused with "Information Policy" (at least at this point) which has recently been applied to broad range of issues that include privacy and intellectual property rights. It should also not be confused with a social science discipline known as "communication theory" which is somewhat related in subject matter. That communication theory literature contains a wide variety of definitions for the terms used here due to the many uses to which communication models are put.[34]

The choice of information theory and its terms is the result of some thought about their utility in the regulatory process but they are not the only possible or only reasonable definitions. They are deliberately simple in order to allow this analysis to proceed at a broad level of applicability but it is anticipated that they will be enlarged, refined and perhaps redefined as they are applied to real-life problems. They contain

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[33] The term originates from the fact that over the air communication is sent using stretches of the electromagnetic "spectrum" called "bands." Technologies that transmit more information per second generally require a larger portion of the spectrum. One could think of the spectrum as a tape measure that has been rolled out and space along this band of tape must be allocated to distinct communicators so that they do not interfere with each other. Some communicators will take fewer inches than others because of the technology they are using. For example, radio transmitters will take few inches than television transmitters because television must send enough information in its signal to bring video as well as audio to receivers. A wire based system does not use air waves so the technology used will, in effect, determine how long the tape is and, therefore, how much information can be sent per second.

[34] See, e.g., Schramm, Wilbur, "The Unique Perspective of Communication: A Retrospective View," in *Journal of Communication* 33 (3) 1983, pp. 6-17; and, Hardt, Hanno, *Communication History and Theory in America*, (New York, Routledge, 1992).

all the essential elements of the communication process but their ultimate shape is unknowable, at least at this point in the evolution of the industry. Indeed, to make any predictions at all in this field seems foolhardy.

It is also important at this juncture to define what is meant by "regulation" for purposes of this discussion. We will apply that term to any government limitation on the choices of persons who control any of the various components of the communication process.[35] The term applies equally to limitations imposed by the judicial, legislative or administrative branch of government at any level, from the Supreme Court of the United States to the regulatory bureaucracy of a city or small town. Under the current regulatory scheme it is not always immediately clear which part of the communication process is being regulated and, in many cases governments have attempted to classify regulation in a way to make it more politically or constitutionally palatable. But it is possible in all cases to determine what is being regulated by asking which of the elements is being limited in some way. For example, a regulation of violence on television may be characterized as a regulation of the channel (i.e., the airwaves) but is, in fact, a regulation of the sender because the channel itself is not limited by the regulation, only the activities and choices of senders are circumscribed.

Several more definitional issues must be dealt with before we proceed. First, it should be noted that the terms "media" and "medium" have been avoided where possible. In communications regulatory circles these terms are generally applied to businesses that are both senders of messages and have some control over of the channel(s) through which their messages are sent, i.e., broadcast and cable. Webster defines "medium" as (inter alia)

> "...2. A substance through which a force acts or an effect is transmitted; as, air is the common medium of sound; surrounding or enveloping substance or element; environment; also, the condition on which any event or action occurs; necessary means of motion or action. 3. That through or by which anything is accomplished, conveyed or carried on; and intermediate means or channel; instrumentality; as,

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[35] Certainly "regulation is a much broader concept that includes government created rights as well as restrictions, but we have chosen to limit it in the current discussion in order to simplify concepts for those without legal training.

an advertising medium."[36]

All of these definitions contain the concept of "channel" (i.e., the thing or process that enables a message to get from the sender to the receiver) but some also contain elements of coding and/or message. Therefore, we have not used these terms in order to keep these concepts separate for purposes of this discussion.

We have also avoided, at least for the present level of analysis, the definitional boundaries between communication and computation. This battle has been fought (apparently to a stalemate) in the FCC proceedings known as *Computer I, II and III*.[37] Computers can be used for many things in the communication process including the manipulation of messages for the purpose of changing them, using them to make new messages, and to encode them. In some respects computation can be used to increase the speed or efficiency of any part of the communication process except (at least as far as we know now) the humans who are the ultimate senders and receivers. Because they have become so closely intertwined it has become extremely difficult to separate computer ducks from communications geese. There are a lot of deese and gucks. The only reason anyone has tried to solve this taxonomic riddle in the past is because a piece of the regulatory system (i.e., the FCC) is charged with regulating communication and not computation. But for our purposes, we will assume that, at this point in the evolutionary process communication and computation are inextricably intertwined and that computation can be used at any point in the communication process and vice versa, like a heartbeat or digestive system, either can be a part of ducks or geese or birds that we don't know about yet.

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[36] *Webster's New International Dictionary of the English Language*, 2nd Edition, G&C Merriam Company, Springfield MA, 1961).

[37] See, Sikes, Alfred, "After Computer III: Picking up the Pieces at the FCC," *Public Utilities Fortnightly*, v.126, n.4, August 1990.

IV. APPLYING AN INFORMATION THEORY FRAMEWORK TO COMMUNICATION POLICY ISSUES

SENDERS

It is not necessary to be human to send a message (e.g., a neutron star sends us a special signal that announces its presence and the type of star it is, and a dog barking at the back door is communicating its desire to go out) but for purposes of this discussion we will assume that senders are persons, either natural or corporate.[38] Senders are the ultimate source of the message, the people whose actions started the communication. It is not necessary for these actions to be purposeful. Indeed, we all send thousands of unintentional messages everyday: how we dress, walk and the expression on our faces convey important information. However, in most cases message senders exercise some choice. According to information theory, if senders do not have any choice their messages would convey no meaning because the message would be absolutely predictable. For example, if I always send only one message (e.g., "wolf") my receiver(s) will soon not perceive any information coming from me because they are certain what I will say. Any restriction on the choices of the sender will thus increase the certainty (and decrease the uncertainty) by the receiver and the amount of real substance sent in any message will be diminished. This concept is called entropy[39] and is useful in any discussion of the regulation of senders and/or the coding used for the communication.

Government regulation of senders in the United States is extremely rare because most restrictions on the choices of senders strike at the very heart of the freedom of expression guaranteed by the US Constitution. Ever since the landmark case of *Near v. Minnesota*[40] the government has been constrained by constitutional principles that limit its ability to prohibit or punish the sending of any particular message. However,

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[38] An interesting problem will arise with the development of artificial intelligence and computer generated messages that are not specifically designed by human intelligence. For an accessible review of this area, see, Crevier, Daniel, *AI: The Tumultuous History of the Search for Artificial Intelligence*, New York, Basic Books, 1993.

[39] See, Pierce, *An Introduction to Information Theory*, at note 30, especially Chapter V.

[40] 283 US 697, 75 L.Ed. 1357, 51 S. Ct. 625 (1930).

as we will see, the same end can be accomplished by regulating the channel or the coding of the message which are generally subjected to a lower form of constitutional scrutiny when they are characterized as regulation of the "time, place and manner" of sending a message.[41]

A regulation of senders might single out a group of persons and limit them by prohibiting them from using a communications channel (including the human voice or sign language) to send certain messages. This is generally known as censorship and its application can vary by the channel used. For example, for several years certain messages judged to be "indecent" could only be sent at certain times of the day in a broadcast channel but could be distributed at any time via print.[42] This type of regulation is said to protect children (one group of potential receivers) by restricting the message but is, in fact, a restriction on the choices of senders and receivers (adults as well as children). Other government regulation of senders include restrictions on advertising[43] and on persons with knowledge of certain national security matters.[44]

Over the years, some have urged that senders should have a First Amendment right of access to channels and that the owner of the channel should not be able to "censor" that access. This argument has been specifically rejected by the Supreme Court with regard to newspapers but accepted to a limited extent for broadcast.[45] Indeed, nondiscrimination of access is one of the hallmarks of the channels known as common carrier systems (e.g., telephone companies).[46] But telephone companies

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[41] See, Tribe, Laurence, *American Constitutional Law*, Second Edition, Chapter 12, Sec. 12-23, New York, Foundation Press, 1988.

[42] See, Lipshultz, Jeremy, "Conceptual Problems of Broadcast Indecency Policy and Application," *Communications and the Law*, v.14, n.2, June, 1992, pp. 3-29.

[43] See, e.g., Collins, Ronald K.L., and David M Skover, "Commerce and Communication," *Texas Law Review*, v.71, n.4, pp. 697-746, March, 1993; and, Geyh, Charles G., "The Regulation of Speech Incident to the Sale or Promotion of Goods and Services: A Multifactor Approach," *University of Pittsburgh Law Review*, v.52, n.1, Fall 1990, pp. 1-73.

[44] See, e.g., Sobel, David L., "Free Speech and National Security," *Bill of Rights Journal*, v.20, December 1987, p. 5.

[45] See, Baron, Jerome A., "The Telco, the Common Carrier Model and the First Amendment," *Rutgers Computer & Technology Law Journal*, Vol. 19, No. 2, 1993, pp. 371-404.

[46] 47 USC 202(a) (1988).

have been allowed to deny access to "900" services (caller pays toll) that are "adult entertainment" messages because these were held not to be common carrier services. Is the telephone company more than a channel in 900 services? Clearly, it is the choices of senders and receivers that are being limited in such cases, but since a phone company is not the government it cannot "regulate" or violate anyone's First Amendment rights.[47] In this case the telephone company has taken on the functions of both an intermediary sender and a channel, in much the same way that a newspaper does when it publishes "letters to the editor."

The responsibilities of both primary and intermediary senders for libel and violation of laws such as copyright when using new channels are far from settled and some predictability in these areas will be necessary for the development of new information services.[48]

In some cases the government has taken it upon itself to force senders who also own or control the channel to send particular messages to receivers who have not specifically requested them. It has required broadcasters to send certain messages intended for children,[49] to send the advertising messages of congressional candidates,[50] and responsive messages by unendorsed candidates.[51] These regulations are inconsistent with the rule that (at least for oral and print communication) the First Amendment does not allow government to force anyone to speak[52] but have been justified on the grounds that broadcasting is done via access to

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[47] The constitution only prohibits infringement on free speech by government. Private firms and individuals are not covered by it although their activities that affect speech may be limited by other laws.

[48] See Perritt, H., at note 13.

[49] Congress has set limits on the amount of advertising contained in programming aimed primarily at children of not more than 10.5 minutes per hour on weekends and not more than 12 minutes per hour on weekdays. In addition, the renewal of television broadcast licenses are dependant on a showing that the licensee has "served the educational and informational needs of children." 47 USC 303a and 303b.

[50] FCC regulations require broadcasters to sell advertising time to candidates at their "lowest unit cost" and forbids them from altering the advertising even if it will offend many of their viewers or contains indecent or libelous material. 47 USC 315.

[51] If a station endorses a candidate for office it must allow all other candidates for that office to respond at no charge. 47 C.F.R. 73.1930.

[52] See, *West Virginia State Board of Education v. Barnette*, 319 U.S. 241 (1943) (mandatory flag salutes by school children prohibited); *Miami Herald v. Tornillo* 418 U.S. 241 (1974) (forced publication on public issues by newspapers prohibited); *Pacific Gas and Electric v. P.U.C. of California*, 475 U.S. 1 (1986) (forced publication of

the limited electromagnetic spectrum and therefore government can demand certain speech in return for the privilege of the license to broadcast.[53]

These same rules are applied to cable television (which is not limited by the spectrum since it uses a wire technology) under the fiction that there is a physical limit on the number of lines that could come into a home or office and, therefore, local government must ration this limited public resource, giving them the right to make demands on the owners of the channel and the senders in the channel. At least one commentator has suggested that candidates for office must be given similar access to computer-based communications networks.[54] All of these regulations limit the choices of senders who own/control channels by requiring them to use part of their resources for the benefit of government or receivers.[55]

RECEIVERS

A receiver is an identifiable entity that becomes aware of a message. As in the case of senders, it is not necessary that receivers be human beings. A dog will become aware of a message when scolded by its owner and will "learn" from this message to change its behavior. But for present purposes we will assume that receivers are people or legal entities. Just like sending, the act of receiving need not be purposeful. Human beings and corporations become aware of messages not intended for them and for which they had no intention of receiving. But overhearing a conversation in the employee cafeteria is, nevertheless, a message received even if the receiver had taken affirmative steps not to hear it by moving away from the speakers.

Direct regulation of receivers is rare because it would require laws that put

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consumer information in utility newsletter prohibited).

[53] In *Red Lion v. FCC*, 395 U.S. 367 (1969) the Supreme Court used this rationale to uphold the Fairness Doctrine which required broadcasters to air information on both sides of issues of public importance and to give free time for response to those attacked in the coverage of controversial issues. It has subsequently been repealed. See, Hazlett, Thomas W., "The Rationality of U.S. Regulation of the Broadcast Spectrum," *Journal of Law and Economics*, v.33, n.1, pp. 133-175, April 1990.

[54] Campbell, Angela J., "Political Campaigning in the Information Age: A Proposal for Protecting Political Candidate's Use of On-Line Computer Services," *Villanova Law Review*, Vol. 38, No. 2, 1993, pp. 517-553.

[55] For an overview of the compelled speech doctrine, See, Ogden, David W., "Is There a First Amendment Right to Remain Silent?" *Federal Bar News & Journal*, Vol. 40, No. 6, July 1993, pp. 368-373.

physical limits on a person's ability to perceive. In addition to being technologically difficult it, like regulation of senders, strikes directly at the heart of freedom of expression. There is however, an interesting line of cases that seems to give individuals rights *not* to receive messages. For example, in one case the United States Supreme Court has held that Americans have a right not to have their children receive messages that are indecent (at least not via public communications channels).[56] Some cases have upheld laws that forbid sending *any* message through a particular channel (e.g., the use of sound trucks in residential neighborhoods) in order to protect receivers from communication that they perceive as "noise."[57] An interesting example of this may emerge in the form of regulation of "junk FAX" where the receiver actually has to pay for the unwanted message.

On the other hand, some cases give receivers the right to receive certain messages. For example, adults have the right to receive indecent messages if they choose to do so.[58] However, receivers do not generally have the right to demand that certain messages be sent by a particular sender absent some contractual obligation agreed to by the sender. For example, radio listeners who enjoy classical music can not demand that a particular broadcaster provide or retain that programming.[59]

The "rights" of receivers are also discussed with regard to public access to a given channel or level of information. Unlike the laws that force broadcasters to send certain information because it is "good for" receivers, the proposals in this area appear to mandate that certain channels or information be available to receivers at low or no cost if they *choose* to receive it. However, these regulations generally demand that some or all of the suppliers in the system (senders, channels, encoders etc.) use some of their resources to insure that this access is available. We meet this issue again in the discussion of channels.

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[56] *FCC v. Pacifica Foundation*, 438 U.S. 726 (1978) (indecent radio broadcast); See, also, *Rowan v. Post Office*, 397 U.S. 728 (1970) (indecent material sent via postal system).

[57] *Kovacs v. Cooper*, 336 U.S. 77 (1949).

[58] *Action for Children's Television v. FCC*, 852 F.2d 1332 (D.C.Cir 1988); (indecent messages via broadcast); *Sable Communications of California v. FCC*, 492 U.S. 115, 109 S.Ct. 2829, 106 L.Ed.2d 93 (1989) (indecent messages via telephone).

[59] *FCC v. WNCN Listeners Guild*, 450 U.S. 582, 101 S. Ct. 1266, 67 L.Ed.2nd 521 (1981).

Thus, much regulation of senders and channels is, at least ostensibly, for the benefit of receivers. This is a predictable public policy since receivers are also voters. But it is undeniable that senders and their trade associations are also important parts of the political process and can be expected to continue to assert their rights under the constitution. One of the difficult parts of many of these debates is separating out the function of sending from that of acting as a channel because the public policy, regulatory authority and constitutional parameters may be different for each. The analysis may be different for activities that involve the operation as a channel (carrying the messages of other senders) and as a sender (being the source of the message sent). But separating the issues in this way enables the courts and policy makers to ask the same questions and arrive at the same answers for all similarly situated persons (natural or corporate) regardless of which or how many of the various parts of the communications process they engage in.

MESSAGES AND SUBSTANCE

Because Shannon was developing information theory outside the journalistic/entertainment "media"[60] the concept of "content" was not relevant for him. His concept of "message" was a coded token (something that stands for something else) that moves through the channel and has no meaning for anyone until it is decoded. The messages in a channel using a binary digital system are a series of 0's and 1's that have no meaning unless the receiver knows how they were coded. Except in the context of standard setting to find the most effective and efficient ways to encode and send these messages, this concept will be of limited value for public policy discussion.

What the receiver actually perceives has been referred to as "meaning" or "content" but we will use the term "substance" to avoid any hint that messages contain anything that is separate from the coding and the information already possessed by the receiver. Thus, substance = coded messages + information already

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[60] He was employed by Bell Laboratories, a common carrier environment where the emphasis was on the efficient and effective conveyance of the messages of other people without regard to the substance of those messages.

possessed by the receiver. If I code a message into French and attempt to convey something about snow to someone who does not understand French and lives near the equator the "substance" received will be quite different from the same message sent to a person in Paris. This assumes that no two human beings will perceive a message in exactly the same way.[61]

Tragically, many public policy makers and courts continue to act on the belief that messages are like bullets: if you aim them at someone they will perceive the intended (or unintended substance) and will perceive the message as "truth" regardless of their previous knowledge and experience. This is, in fact, the basis of most censorship. A more informed view of the communication process might result in more success for these laws.

Another statement we can make about messages is that they can have economic value. In most cases the substance of the message is critical to this value. Moreover, this value can diminish with time and the message may have no value at all if it does not reach the intended receiver in the appropriate time. Stock quotes, for example, have the most value when they are sent in "real time," i.e., as the trades are being made.

But, since neither messages nor substance can be a person whose choices can be limited, they cannot be regulated directly. However, as we have seen, they can be affected by the choices (or lack of choices) of any of the persons in the process.

ENCODING AND DECODING

All messages are encoded by the sender to make sure that the receiver gets the intended message. A code is a set of agreements between potential communicators that sets out significance for certain words, gestures, electronic signals or other ways that messages will be sent. Language is a code whereby two or more people agree in advance that a particular set of sounds (or letters representing those sounds) will signify a specific thing or concept. In Morse Code a certain number and arrangement

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[61] This difference in the effect of messages is well documented in communications literature. See, e.g., Jackson, Sally, *Message Effects Research: Principles of Design and Analysis*, (New York, Guilford Press, 1992).

of dots and dashes denotes a specific letter of the alphabet. In broadcasting, sounds and pictures are encoded using certain wave lengths and frequencies of the electromagnetic spectrum and then decoded back into sounds and pictures by receiving devices in our homes, offices and cars.

In all forms of communication it is critical that agreement has been reached in advance. For mass communication channels this requires some coordination between senders and receivers on a large scale. It is a job that has generally fallen to government or other large institutions. For example, the more intricate rules of the code we know as English (formal grammar, spelling, punctuation, etc.) are taught in schools along with the language codes of other cultures to insure that we will be able to communicate with each other and other people in a global marketplace.

In the case of more complex, technological systems the coding system used is closely linked to the sending, receiving and channel equipment that will be used. Coding of a broadcast signal, for example, is dependent on the equipment that will be used by broadcast stations and the receiving devises used by consumers. It would not pay to code this signal in digital form if these devices only "understand" the code for analog. These functions are generally tied closely together in the regulatory setting, particularly in the area of standards.

As an alternative to government coordination, each communications firm could develop unique standards for its new technologies (for both equipment and coding systems) and then wait to see which of the competing technologies survives the rigors of the marketplace. This "winner take all" rule is illustrated in the battles for dominance in video and audio tape. VHS and audio cassettes eventually emerged as the preferred code/storage, and, because communication devices are valuable only if they are ubiquitous, the alternative systems (Betamax and eight-track tape) did not survive in the mass market. This method of choosing communications codes and/or channels can be seen as survival of the fittest or as a waste of resources for both the senders and the receivers who invested in the loosing technology. This can lead to resistance by both suppliers and consumers and hinder the introduction of the technology and explains why regulators are sometimes asked to act as a referee or to decide the fight before it takes place by setting mandatory standards.

This process can be seen in the current regulatory battles over the standards that will be used to encode and transmit high definition television. Unlike in traditional broadcasting the standard for HDTV in the US will not use a code based on the waves of the electromagnetic spectrum but will use the digital language of computers.[62] But in order for this communication to be ubiquitous there must be some prearranged agreement about what kind of digital language will be used and how it will be used by the decoding devices that will bring consumers audio and video messages. Since all current broadcasting equipment and all television sets will have to be replaced no one wants to invest in equipment that will go the way of the eight-track tape player. So the FCC set out to decide which of a number of competing technologies would become the US standard. This proved to be extraordinarily difficult because the basis upon which such a choice would be made was not clear and because the process results in a "winner take all" decision that would negate the investments that had been made in the losing technologies. Ultimately, the FCC played the role of mediator and not referee because the competitors reached an agreement on the standard before the final decision was made. But this is not the end of the battle for HDTV because it only establishes the US standard. International sending of HDTV messages and worldwide sale of equipment for sending/receiving will be impeded unless a standard is accepted worldwide.

These public policy questions can be framed for all coding regulation: When should government impose standards for coding and/or sending and receiving equipment, thereby limiting the choices of the marketplace and giving a potential windfall to one of the competing standards? Presumably the public policy to be furthered by any such activity is the ubiquitous availability of the technology made possible by enhanced consumer confidence in the viability of the technology and reduced waste of resources going into the losing technology.

But on what basis should public officials choose one system over another? One of the measures of any system is its efficiency: how much information it can accurately

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[62] Tirman, W. Robert, *The Elephant and the Blind Men: The Phenomenon of HDTV and its Would-be Stakeholders*, Center for Information Policy Research, Harvard University, (Cambridge, MA, 1991, P-91-3.)

deliver if given a certain amount of time and resources.[63] Another measure of any dynamic system is its adaptability: the system must change as the outside forces that affect it change (e.g., competitive forces, consumer education and needs, product and process innovations in the industry, etc.).

Another important criterion is security. In many cases messages are coded in order to deny access to them. Only people who know the code will be able to decode the message, as in messages sent by intelligence operatives who do not want operatives for other countries to read them. This is also useful if you want to sell access to information that is sent to lots of potential receivers. For example, information sent to subscribers via cable for "premium" channels is encoded so that only people with the appropriate receivers can decode them. The same is true for messages sent via the many new satellite and telephone based services. The commercial value of such services depends on the ability of the sender to control the distribution of the code or, more often, the distribution of decoding devices.[64] To accomplish this senders have asked government to make unauthorized receiving of their messages a crime because it amounts to "stealing" access to the message, just as if they had stolen a copy of a movie at a video store or a copy of a book from a library.[65]

By reformulating this problem based on information theory it can be discussed for all channels and/or coding systems: Should government impose regulations in order to make sure that people who expend resources to collect and/or edit messages are compensated for this activity (e.g., by enforcement of copyright laws or laws that restrict access to codes and/or receiving equipment)? If so, whom should it regulate

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[63] Here information theory would measure entropy. See note 38.

[64] Devices that have been thought of as decoders are rapidly taking on other functionality. For example, the cable box that is used to decode cable signals in the home is being redesigned to allow subscribers to participate in interactive services like online information services and computer bulletin boards, making a TV with a cable box look a lot like a personal computer with a modem. See, "Cable Converters Entering New Era," *Broadcasting and Cable*, June 14, 1993, p.79. But the agreements necessary to set up the appropriate coding have not been worked out and representatives of the cable and consumer electronics industries are hoping to come to some meeting of the minds on this before the FCC steps in. "Working Toward Compatibility," Id, at p. 92.

[65] See, Abney, David L., "The Judicial Outlook on Signal Piracy," *Communications and the Law*, v.8, n.3, pp. 3-19, June 1986.

(i.e., reduce choices for)? Senders? Receivers? Coders? When constructed this way the issues regarding the protectability of information compiled for various kinds of directories[66] as well as other compilations of information becomes easier to deal with. At the same time it moves the more visceral issues like "the big, bad corporate giant versus the little guy" to a separate discussion of antitrust issues.

As messages move faster in the various digital channels (as well as between channels) these critical questions need to be addressed with diminishing regard for traditional concepts of media and with increasing consideration for what kinds of laws are realistically enforceable on this new frontier.

NOISE

Regulation of message coding is sometimes used to decrease the presence or the effect of noise in a channel. Noise can decrease the clarity of the message or even distort it.[67] This is easy to see if one thinks of trying to talk to someone next to you at a very exciting basketball game. The channel (the air around you) is so filled with messages that you must talk louder than the ambient noise level in order for your message to reach the intended receiver. Talking in a place with less noise will require less energy and will result in more accurate transmission of the message.

In the context of information theory this concept can be applied to all forms of communication in all channels. In this broader sense, noise could be defined as unwanted messages in the channel that are not part of the message sent by the sender. For example, radio and telephone receivers are prone to hiss or crackle in certain atmospheric conditions when natural electromagnetic fluctuations join with messages of human origin. Similarly, when two radio programs or telephone conversations are sent on the same channel the listener will have some difficulty separating out the message they are trying to receive. When broadcasting video images, noise is

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[66] See, Ginsburg, Jane, "No 'Sweat?' Copyright and Other Protection of Works of Information After *Feist v. Rural Telephone*," *Columbia Law Review*, v.92, n.2, March 1992, pp. 338-388.

[67] It is important to emphasize again that "accuracy" of the message in this context does not deal with its substance. A message is accurately received if the coded tokens (words, bytes, etc.) are received in the same way they were transmitted.

perceived as "snow" in the picture. Messages that are encoded using digital rather than analog technology are somewhat less affected by electronic noise in the channel, but the problem is a perennial one.

In addition to decreased efficiency (requiring more power by the sender or time in decoding by the receiver) noise in the channel can cause errors in the communication process, i.e., the receiver receives a message different from the one sent. These errors can be merely irritating (like missed letters in the transmission of text) or they can create big problems (like errors in the numbers received in a banking transaction).

There is little public (or private) interest in the presence of noise in any communication channel and so regulation that leads to its reduction has generally been welcomed by senders, receivers and channels alike, even if this reduces their choices to some extent. As discussed below, this was the original basis for the regulation of the broadcast industry and it is the stated purpose behind many quality of service regulations for telephony and cable at all levels of government.[68] The questions that will be presented to regulators with regard to noise include: How much regulation of noise is justifiable in a market-driven industry where companies can compete on the basis of quality?[69] Should regulation of the various options for coding signals be judged (among other things) on the basis of their ability to reduce noise or reduce the effect of noise on the message?

Of course, in some cases, one person's noise is another person's message. Several members of an audience shouting down a speaker with whom they disagree is one example. Who has the right to send a message in a channel that neither has the exclusive right to use? These contests are generally decided by which speaker has the greatest amplification power. This issue might be reformulated as a discussion of noise or the rights of senders and/or receivers in a particular channel.

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[68] 47 CFR 63 (telco); 47 CFR 76(k) (cable).

[69] For a discussion of government regulation of quality in a competitive market, see, Goodman, David J., "Government Regulation and Innovation," in *Information Technology: Public Issues*, ed. Raymond Plant, et al., (New York, St. Martins Press, 1988) p. 65.

CHANNELS

The use of information theory to structure public policy may find its most urgent need in the current debates over the relative rights and responsibilities of those who own or control the many channels through which messages flow today and will flow tomorrow. If, as many predict,the companies that currently distribute information via paper (newspapers, magazines and books) will soon be distributing that same information via cable and/or telephone wires[70] does it make sense to deprive them (and other senders) of the constitutional protection they enjoyed when they used forest products and public streets as their channel for distribution? Should some channels be required to offer universal, low cost access while others are allowed to distribute the same information on an ability to pay basis? Should the government prefer one channel over another by offering it special protection from competitors, subsidizing research and development, or by giving it special tax or rate breaks?

These questions have been (and will continue to be) debated in judicial, legislative and regulatory arenas. Unfortunately, the debate continues to center on the question "Is it a duck?" Once again, focusing on what people or firms do rather than what they did before may be the most productive way to proceed.

Channels have at least two characteristics that could provide the basis for rationalized regulatory treatment: 1) channels vary in the number of potential senders and receivers, and 2) the potential of the channel for interactivity. It is entirely possible than one channel can exhibit a variety of possibilities for these characteristics. For example, both telephone and cable[71] lines can be interactive (as in POTS or more sophisticated services like video-on-demand) or noninteractive (data transmission services). Interactivity does not necessarily require that a communications system be centralized in the way that the telephone system has been. The "brains" of the system can be distributed in the equipment that is located close to

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[70] See, e.g., Glaberson, William, "Creating Electronic Editions, Newspapers Try New Roles," *New York Times*, p. 1 (n&l), August 16, 1993.

[71] With the addition of switching capability to cable systems.

the senders or receivers.[72]

Similarly, many channels can be used in a wide variety of distribution schemes that let senders reach different numbers of receivers: point to point (one sender to one receiver, like POTS); point to multipoint or "broadcast" (Fax newsletters); multipoint to point (credit card verification systems); and multipoint to multipoint (video conferencing and computer bulletin boards). Wireless technology can be used in the same ways and will, in many places, compete directly with wire-based services. It will be increasingly difficult to justify different regulatory treatment for channels that do essentially the same thing in every way that matters to the people who use them.

If a decentralized system or a system of competition among channels is chosen, certain rules of the game must be evolved by some combination of the marketplace and the government. For channels that operate as networks, Ithiel de Sola Pool saw these rules as falling into three categories: interconnection, technical standards for interface with the channel(s) and a directory system.[73] Organizing consensus on these issues will be one of the great policy challenges of the next century, especially if global interactivity is the goal.

Ownership and Control of Channels

Ownership of the channels of communication is a common regulatory concern due to the American distrust of concentrations of ownership in key components of the economy that dates back to the breakup of the industrial empires set up by the late 19th century "robber barons." This fear has been greater in communication than most other economic sectors. Evidence for this can be seen in the unwillingness of regulators to depend on antitrust laws to prevent competitive abuses, preferring to pass specific regulations about who can (and cannot) own the various channels. FCC

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[72] "There is no reason to assume that the communications network of the future will be a single large organization with a central brain. Having a hierarchical structure governed by a central brain is only one was to organize complex systems. A human being is organized that way; so is a nation-state. But the capitalist economy is not, nor is the complex system of scientific knowledge, nor is the ecological system of the biosphere. For an uncentralized system to function, there must be some established ways of interconnecting the parts other than by command; the interconnections may be managed by conventions, habits, or Darwinian process." Ithiel de Sola Pool, *Technologies of Freedom*, pp. 229-230.

[73] Id. at p. 230.

rules govern how many broadcast stations any person or corporation may own in a given market and in the country as a whole.[74] Other rules prohibit companies from operating newspapers and broadcast stations in any given market[75] and telephone companies from operating cable TV services in markets where they provide POTS.[76] There has been very little regulatory activity regarding crossownership between telcos and newspapers or broadcasters because, until recently, nobody (including the companies themselves) thought of them as being competitors.

But this competition appears to be inevitable and the battles waged by the publishing industry in the early 1990's to keep telcos out of the information and advertising businesses offer some evidence of how intense that competition is likely to be. Newspaper publishers asked Congress to enact legislation that would reinstate the restrictions on the Bell Operating Companies (BOC's) that had been enforced as part of the antitrust settlement that broke up the Bell System.[77] This settlement divested the operating companies from AT&T and restricted their entry into a number of businesses including the potentially lucrative area of information services. This restriction was lifted by the Federal Court 1991.[78] The publishers have argued that the danger of monopolistic practices by the BOCs is so great that they should be kept out of information services until other potential players in this field are strong enough to give them significant competition and they argue that monopolization of this channel of communication will result in fewer choices for receivers, abrogating one of the historic goals of communications regulation: many voices. Government has

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[74] 47 CFR 73.3555 However, these limits have recently been eased somewhat in order to give broadcast companies the ability to control more stations in order to give them an opportunity to lower their costs of operation through economies of scale that can be thus achieved. Apparently the fear that broadcasters will garner too much economic and political power has been replaced by the realization that broadcasters are no longer the only (or even the most powerful) show in town.

[75] 47 CFR 73.3555(d).

[76] 47 CFR 63.54-58 But see, *Chesapeake and Potomac Telephone Company of Virginia, et al., v. US et al.*, 830 F. Supp. 909, (D.C. Eastern Dist. Virginia, Aug. 24, 1993), LEXIS 11822.

[77] See, e.g., "A New Bill on the Baby Bells," *New York Times*, May 8, 1992, Sec. D, p. 16; and, Seitz, Rob, "All About Information Services: Phone Companies Join Their Rivals in the Facts Business, *New York Times*, June 7, 1992, sec. 3, p. 10.

[78] *US v. Western Electric Co.* 767 F. Supp. 308 (D.D.C. 1991); see, also, *US v. Western Electric Co.* 900 F. 2d 283 (D.C. Cir. 1990) and *MCI Communications Corp. v. US.* 498 US 911 (1990).

historically taken on the function of encouraging the existence of a variety of sources of information, i.e., a variety of senders of messages on any given subject. The publicly stated purpose of these regulations has not been to protect senders or channels, however. It has been justified as protection for receivers by assuring them access to as many senders of information as possible. It has been proposed that the existing regulatory structures designed to enhance this diversity be reformulated into a uniform regulatory framework for all "media of mass communications."[79]

One attempt by government to control a "monopoly" channel by mandating access for certain senders was seen in the "Must Carry" provisions of the Cable Television Act of 1992.[80] That law requires cable systems to carry the messages of local broadcasters because, in most markets, the cable service operates as a monopoly based on the "franchise" awarded by the city.[81] Of course, broadcasters can still send their messages through their own over-the-air channel, but they fear that anyone who is hooked up to the cable will not be able (or willing to take the time) to move between channels, i.e., to disconnect the cable service or use a separate TV set to pick up broadcasts. This controversy also illustrates several other emerging issues. First, when is a channel a monopoly? Do cable services only compete with other cable services or do they compete with local broadcasters, newspapers and telephone companies? Second, should government demand that channels be used for public purposes because they are monopolies if government *made* them a monopoly by granting them an exclusive franchise or license to operate on a particular frequency?

Cable television offers an interesting case history for the proposition put forward in this article. It is a classic example of a new bird that everyone tries to call by old names. Attempts to regulate it were originally justified by the FCC (and upheld by the

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[79] Johnson, Andrea L., "Redefining Diversity in Telecommunications: Uniform Regulatory Framework for Mass Communications," *U.C. Davis Law Review*, Vol. 26, No. 1, Fall 1992, pp. 87-156.

[80] Pub. Law No. 102-385, 106 Stat. 1460, 47 USC sections 534,535.

[81] The Act was upheld in *Turner Broadcasting v. FCC* C.A. No. 92-2247 (D.D.C. 1993). The case has been appealed. Similar rules enacted by the FCC have been struck down as unconstitutional. *Quincy Cable Television, Inc. v. FCC* 768 F.2d 1434 (D.C. Cir.1985); and, *Century Communications Corp. v. FCC* 835 F.2d 292 (D.C. Cir.1987).

courts)[82] because it was "reasonably ancillary" to the authority of the FCC to regulate broadcasting. It looked like a duck. But defining cable as duck-like became a problem when the FCC attempted to mandate that cable systems provide public access channels. The Supreme Court found that if cable was like broadcasting it couldn't be regulated like a common carrier and made to provide nondiscriminatory access to the channel.[83]

In the face of these failures to compel senders and/or channels to perform services thought to be desirable by government, some proposals call for the state itself to set up systems for access to information. In Kansas, the state government has set up the Information Network of Kansas (INK) to provide citizens with access via computer and telephone modem to public information of government agencies and also to develop information bases for which they will charge access fees.[84] As in the case of municipally-owned cable systems, this puts government in direct competition with other commercial senders and channels (e.g., newspapers, broadcasters, commercial cable systems, computer-based information systems, etc.) and is one of the most significant problems for government regulation of the communications industry since it is not clear how one sender or channel will be able to regulate all the others.

An innovative approach to this issue can be seen in the FCC rules[85] for the service known as "video dialtone." This would offer access to a central computer where customers could order a variety of video services sent to them via telephone lines. It was originally thought that this service would require the large bandwidth of fiber-optic cables but there is now some evidence it can be implemented in a limited way over regular copper wires with the use of sophisticated message compression techniques. Since this does not have a limited number of "channels" like a cable system and it doesn't look like broadcast or telephone service, the new technology

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[82] *US v. Southwestern Cable Co.* 392 US 157 (1968).

[83] *FCC v. Midwest Video Corporation* 440 US 689 (1979). For an overview of cable regulation in this area, see, Roof, E. Dana, et al., "Structural Regulation of Cable Television: A Formula for Diversity," *Communications and the Law*, Vol. 15, No. 2, 1993.

[84] Kansas Statutes 74-9301.

[85] Telephone Company-Cable Television Cross-Ownership Rules, Sections 63.54-58, Second report and Order, Recommendations to Congress, and Second Further Notice of Proposed Rulemaking, 7 F.C.C.R. 5781 (1992).

required some new ways of thinking. The FCC broke down this communication process into its component parts to create three possible types of service.

> Essentially, channel service, video dialtone, and cable service form a hierarchy relating to the degree of control an entity has over the content being transported. When providing channel service the telephone company acts purely as a conduit, not interacting in any way with the transported content. Video dialtone envisions the provider contributing to and enhancing the content by providing non-programming services and gateways. Finally, cable service itself is distinguished by an entity's ability to have complete editorial control over content, as well as control over the selection and pricing of programming.[86]

Under this scheme the functions of channel and sender are broken out and treated differently. This is a significant step in the direction of rational and broadly applicable foundations for communication regulation.

Constitutional Treatment of Channels

In 1983, while most of the communications world rested comfortably in their own niches, Ithiel de Sola Pool was making impassioned pleas for freedom of speech in the new media that were just coming on the scene.

> Perhaps the continued existence of one forum for uninhibited debate would be enough to assure a ferment of opinions and ideas. If so, it would suffice that free speech in the traditional media continued unaffected by the regulations applied to the new media. That, however, is not the case. The new media are not only competing with the old media for attention, but are also changing the very system under which the old media operate.[87]

New channels continue to fight for equal protection under the Constitution. In deciding the extent of constitutional rights that will be afforded cable TV the Supreme Court has framed the issue as whether cable is like a newspaper or a broadcaster[88]

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[86] Pettit, Robert L. and McGuire, Christopher J., "Video Dialtone: Reflections on Changing Perspectives in Telecommunications Regulation," *Harvard Journal of Law and Technology*, Vol. 6, Spring 1993, pp. 343-362, at p. 348.

[87] *Technologies of Freedom* p. 22.

[88] In an order denying a request to enjoin enforcement of a law that requires cable operators to carry the signal of local broadcasters, Justice Rehnquist stated that, "Although we have recognized that cable operators engage in speech protected by the First Amendment... we have not decided whether the activities of cable operators are more akin to that of newspapers or wireless broadcasters." *Turner Broadcasting System, Inc. et al. v. FCC et al.* 113 S.

when, in fact, it is like neither in many respects and, at the same time, shares the fundamental aspects of a communication system with both. All three are channels through which messages (primarily news and entertainment) flow from senders who have gathered and edited them for distribution to many receivers simultaneously. In many communities essentially similar messages about local news will be traveling through several channels at the same time and *exactly the same* substance sent by the broadcaster will be sent by the cable operator that is distributing the broadcast signal on its system. The same substance sent in these different channels will receive different levels of constitutional protection.[89]

The genesis of this different treatment began with the law's perception of a print/broadcast dichotomy. This focused on the differences between the two channels and could (if it had been left at regulation of codes and noise) have been fully consistent with constitutional law regarding the print media. But once Congress had its hand in the regulation of broadcast channels it wasn't long before it was regulating the senders as well.

Broadcast technology is based on the sending and receiving of messages coded by using variation in the wavelength or frequency of an electromagnetic wave. If all broadcasters tried to send their messages on the same wave length or frequency this would, as noted above, create noise resulting in chaos where no receivers could sort out the messages they wanted to receive. In the early days of radio it began to look like this was going to happen so Congress set up a regulatory scheme to allocate space on the spectrum to broadcasters so they did not interfere with each other.[90] Due to the nature of the electromagnetic spectrum and the atmosphere, the coding of the messages was regulated and each option for coding (broadcasting on a certain frequency) created a separate "channel". But, because Congress and the FCC allocated only a small part of the spectrum for commercial use, this made the number of channels in any geographic area a scarce resource thereby making it necessary to

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Ct. 1806, at 1808 (1993), 123 L. Ed. 2d 642, at 645.

[89] See, generally, Lively, Donald E., "Modern Media and the First Amendment: Rediscovering freedom of the Press," *Washington Law Review* Vol. 67, p. 599-624.

[90] Radio Act of 1927, recodified in the Communications Act of 1934.

choose between competing applicants for a license in the same locality. This power to choose made necessary the development of criteria for the choice and led directly to the power of government to demand that certain messages be sent (public service programming, children's programming, political advertising) or not sent (indecent messages, certain advertising for legal products and services). The Supreme Court approved this regulatory scheme in spite of the fact that it would not have been constitutional for the print media. It accepted the argument that the spectrum is a "scarce resource" that belongs to the public. And therefore the public can demand certain speech (and refraining from speech) in return for the license.[91]

Ironically, it was government licensing of channels (i.e., printing presses, thus effectively regulating the content of newspapers and books) in Great Britain and the colonies that was one of the sparks for the American Revolution. History tells us that anytime government can license channels it can also control messages/substance.[92] Government created scarcity is also the basis for government control over Cable TV and the telephone industry in spite of the fact that both are being subjected to increasing competition, including competition from government owned channels. This government propensity to create a monopoly (therefor scarcity of choice for consumers) is often justified as necessary in order to stimulate the introduction of new technology, giving the monopoly provider a chance to recoup high up-front costs.

Communications firms may be glad to get the chance to operate under the monopoly (or restricted entry) status conferred on them by their license or franchise and only later realize the price that government will attempt to extract for the privilege. The price became evident to broadcasters when it became clear that the print media (with whom they are fierce competitors for local advertising) had economic advantages based on the fact that they did not have the same forced (or restrained) speech obligations that increased costs and eliminated sources of revenue.

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[91] *Red Lion v. FCC* 395 US 367 (1969).

[92] Many local governments became so enamored with the power to license the media in the 1980's that they attempted to license newsracks, claiming that there were too many on the street and so they had to be limited. These attempts were struck down as unconstitutional based on the long tradition in the law that protects the print media. *Lakewood v. Plain Dealer* 468 US 750 (1988).

For example, broadcasters can be forced to air a response (at no charge) from someone who had been personally attacked on the station[93] while the same requirement of a newspaper would be unconstitutional *in spite* of the fact that in most American communities there is only one newspaper but a number of broadcasters.[94]

The application of constitutional principles should not be limited by "facts" that no longer exist (if they ever did) like the scarcity of certain communications channels. A change in focus to the rights of senders, receivers and channels will be more broadly applicable and will keep the courts and the constitution out of the bird-naming game.

Universal Service

Once government has given a channel some kind of government franchise in the form of a license or other authority to do business (with entry restrictions for potential competitors in that channel) it generally attempts to make sure that all citizens have access to it. In the case of broadcast, the FCC has bent over backward to establish and nurture broadcast services in rural areas and in metro areas it has given special preferences to services aimed at underserved groups like racial and cultural minorities. These efforts to promote rural and multicultural broadcasting have been seriously undermined by changes in the U.S. economy and the competition from cable television and other information and entertainment services.[95]

For public policy decision makers the question will inevitably become the lengths to which government can go to protect broadcasters from their new competition by eliminating the public service obligations that add to their costs or by direct subsidies in the form of tax breaks or grants. Should all citizens have access to free (advertiser supported) over-the-air broadcasts of news and entertainment or should universal service questions be asked more broadly? For example, should government insure that all citizens have access to a certain minimum level of information at no cost from the

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[93] 47 CFR 73.1920.

[94] *Miami Herald v. Tornillo* 418 US 241 (1974).

[95] See, e.g., *Notice of Proposed Rulemaking (Regarding Ownership Restrictions)*, MM Docket No. 91-140; *Notice of Inquiry, in the Matter of Review of the Policy Implications of the Changing Video Marketplace*, MM Docket No. 91-221, Adopted July 11, 1991; Florence Setzer and Jonathon Levy, *Broadcast Television in a Multichannel Marketplace*, Office of Plans and policy, Working Paper No.26, June 1991.

channel(s) that can deliver this information with the greatest efficiency? If so, how should government compensate the owners of the channel for this public use of their facilities? When this question was posed with regard to the channel we know as telephone service the government decided to compensate telephone companies for universal service obligations by protecting them from competition. Since this created a monopoly supplier of an important service, regulations were put in place to insure adequate service and the lowest possible cost to consumers while guaranteeing a reasonable rate of return to the company. Thus, rates higher than actual costs were charged to business, long distance and urban customers in order to subsidize the service to households, local and rural users.[96] But as technology and regulators started to push the telecommunications envelope, making it possible for companies outside "the system" to deliver point-to-point audio,[97] the deal that had been struck to insure universal service began to unravel and shows no sign of being knit back together any time soon.[98]

Many regulators and consumer advocates want government to assure that all Americans have access to the channels of information that they believe will be critical for individual and organizational success in the next century. But they also want government to encourage competition in this industry and to make sure that it is never again dominated by a few companies. Regulators on all levels of government have let it be known that they want competition *and* universal service.[99] Clearly, a new paradigm for regulation is necessary if we are to accomplish both of these goals.

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[96] See, generally, Phillips, *The Regulation of Public Utilities*, Second Edition, Public Utilities Reports, Inc., Arlington. Va. 1988.

[97] Interestingly, network television was one of the first competitors to break the Bell System monopoly. They were among the first to ask the FCC for permission to construct their own system to transmit programming to local affiliates. The exact same messages were now being regulated under two different parts of the Communications Act merely because they were transmitted on two different parts of the spectrum. FCC Report and Order, Docket 11164, "Amendment of Part 4 of the Commission's Rules and Regulations Governing Television Auxiliary Broadcast Stations" (Video II), August 4, 1958, 44 FCC 1354.

[98] For a fascinating, inside view of the beginning of the end of the Bell monopoly see, Peter Temin, *The Fall of the Bell System*, Press Syndicate of the University of Cambridge, Cambridge, U.K. and New York, 1987.

[99] Both are expressed as goals in "Agenda for Action" (see note 22) but the document does not acknowledge that they may be mutually exclusive because competition will, in theory, reduce prices to cost and this will leave no money in the system to subsidize users who can not pay the full cost of service, e.g., rural users (with high cost for outside plant) or low income persons.

And because communication services will be available from a variety of vendors it is critical that the regulation and responsibilities for providing government mandated services fall evenly on all vendors, regardless of what service they have historically been associated with (and the responsibilities and privileges that had been associated with that service). In an era when cable and wireless vendors will provide point-to-point communication that is (as far as consumers are concerned) exactly the same as the service provided by the telephone company, a continuation of the current system for universal service regulation applied only to "telephone" companies will be counterproductive and will suffer that most un-American of all defects: it will be unfair.

Fairness and predictability can be brought back to the system by treating all channels of information as potential sources of citizen enlightenment and entertainment and as potential monopolists whose power could threaten the very underpinning of a market economy. Once again, it is not our purpose here to suggest the form that this new regulatory scheme would take, but to frame the issue on a broader basis so as to encompass all the problems and opportunities presented by the melding of the communications industry.

V. CONCLUSION

A law that begins by defining these basic parts of the communication process and then regulates (restricts choices) for persons engaging in one or more of those parts could bring a measure of uniformity and predictability to the application of the law both for traditional and emerging communication technologies. Different treatment of similar activity is not foreclosed by this approach but the difference would be determined by specific public policy goals and not static technological distinctions.

For example, as we get a clearer picture of the information needs of the next century we might choose to impose universal service or mandated access obligations on certain channels (at public expense) if they can be characterized as "public goods" or are not available as the result of other market failures. But like so many of the policy dilemmas in this area, there is some question whether decisions about universal service can be made now because it is unknown how much of this information infrastructure will be provided in the new competitive environments. This seems to make a case for an evolutionary approach to policy making in this area.

This evolution could take place in several different ways. New laws or regulations could be drafted broadly to set up a case-by-case development of the specifics, or, by attempting to set out many of the specifics in advance within a detailed law. The former approach would have the advantage of flexibility in a changing environment but would give the stakeholders less confidence in their ability to predict how the law will work in new cases. It would also put much of the decision making into the hands of the courts unless some sort of administrative process or specialized alternative dispute mechanism is put in place. The later approach assumes that policy makers have all the information necessary to make specific rules.

But legislative action is not necessary in order to begin the evolutionary process. This analytical framework could be used by any court which finds it necessary to rationalize or harmonize the regulatory, common law or constitutional principles applicable to the many new communications technologies that are about to emerge and converge in the global marketplace.

As in all evolving systems, it is difficult to predict where this one will go. But the goals of flexibility, adaptability and fairness seem to be destinations that all the people along for the ride have be able to agree on. The hard part will be taking the first steps away from systems we have grown accustomed to when ducks were ducks and everybody knew the rules.

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