Chapter 6

The Shape of the Network

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What we are promulgating is a set of social norms for which the
various licenses are actually just proxies.

---Tim O'Reilly, personal communication, November 2000

Marketization refers to the unleashing of a market in a previously government-provided service. What is happening with government on the Internet and with information products takes marketization even further. In the rich tradition of creating nouns in the policy disciplines, I refer to this as *propertization*.[i] Marketization is about the utilization of market forces to distribute artifacts (such as a kilowatt-hour or a pound of postconsumer glass) already identifiable as subject to trade. Propertization is the creation or re-creation of property from intangibles.

The creation of information property, or information, is a necessary enabler in the network economy. However, there is nothing predetermined about the market parameters defined by propertization. Thus there is nothing predetermined about the network shaped by the resulting market. The types of property rights created and how those rights are balanced with other rights (such as speech and privacy) and values (innovation and equity) are determinations being made now. The information market will be bigger, but it may or may not be better, or even competitive, depending on the parameters chosen now.

It is my purpose here to examine how property and the property rights bundle are being defined. I classify the expansion of property rights into three categories: information property, code as a distinct class of information property, and information transport networks. I refer to these as content, code, and conduit. I discuss regulatory threads in the creation and expansion of intellectual property around both words and code, and changes in the regulation of transport networks. Together

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these trends threaten the characteristics of the Internet that have enabled an inchoate academic network to grow into an engine driving global prosperity.

The creation of an information market requires the creation of a bundle of rights that together create a tradable property. In the network society, the information revolution, or information economy (or whatever nomenclature is finally adopted), the size, duration, and reach of the bundles of rights that are property are increasing monotonically.

The creation of a market also requires the creation of a set of rules for transactions that involve the newly defined property. With physical property, the fundamental right has been the right of exclusion---the ability to prevent another from accessing or using one's property. The ability to exclude others creates the greatest incentive to invest in physical property and is thus the ideal outcome for society and for the individual.

With respect to intellectual property, the law has a fundamentally different orientation: the goal is to create more property and ensure the most fruitful possible use of that property. The goal of permanent exclusion of others is antithetical to the fundamental goals of intellectual property protection. Copyright, trademark, and patent have all been modeled in order to maximize the total amount of information in circulation. The total amount of information in circulation---that is, the size of the marketplace of ideas---is optimized by a short term of exclusion that creates an incentive to create. There is no comparable motivation with physical property. No owner of physical property is expected to return the property to the commons after some defined period. Limits on the rights of physical property owners would not expand the physical property marketplace. A physical property owner's exclusive right to ownership does not prevent others from creating additional property. However ill-suited, the linear model of property (that is, that more protection yields more production) is replacing the broader traditions of intellectual property.

Simultaneously with the change in the conceptualization of intellectual property, the ancient concept of the common carrier is being replaced by vertical integration. Common-carrier regulations

date from Roman times, when the owners of ships were forced to have nondiscriminatory pricing policies for those who would transport goods.[ii] There was an understanding that an infinite number of ships could not exist and that trade was thus optimized by limiting the property rights of the owners of the transport infrastructure. That basic concept of common carriers held sway as private investment built bridges in early modern Europe and as telegraph carriers laid lines across the United States. When the basic concept of common-carrier transport regulation has been forgotten, the result has often been economic disaster leading to yet more regulations in the long term. In America the resulting regulation of the railroads and the extensive broadcast regulation of what were open wireless networks are examples from the last great economic alteration. It is not coincidental that the physical layer as provided by the owners of local infrastructure is fundamentally connected with the transport layer. This lesson is being forgotten, and the result risks the closing of a network, the closing of the carrier layer on which our information commons critically depends. (The lesson has been forgotten, in the case of public Network Access Points [NAPs], yet this is not my focus.)[iii]

The construction of the Internet required available content, common-carriage conduit, and open code. I argue that the policy definitions of code, content, and conduit will alter the fundamental assumptions of the Internet and that the principles currently embodied in the network are the result of a particular set of assumptions and require certain regulatory realities. Those assumptions can be altered and will be shaped by the definition of the information property that crosses the networks and the regulation (or lack of regulation) of the wires on which the signals run.

Some may argue that the innate nature of the Internet will prevent it from being altered by definitions of property. John Gilmore's concept that "the net treats censorship as damage and routes around it" is a widely believed myth.[iv] Yet the governmental takeover of B-52 in Serbia illustrates that without virtual people real censorship is quite possible. Such a myth should not guide policy. A similar error can be seen in the famous cartoon by Peter Steiner that carries the caption, "On the Internet nobody knows you're a dog." Such a widespread assumption of anonymity reflects the

ability to project false identity but does not negate concerns about privacy.

In short, the "innate nature" of the Internet is neither. Of course, the Internet has not “nature.” It is entirely constructed. It is constructed on protocols and networks that today have fundamental characteristics that appear, in practice, to support democratic pluralism: content neutrality and bidirectional information flow. All three of these---code, content, and conduit---result from the design and implementation of the underlying system. There was no natural outcome in the choices made by protocol designers. The choices were made in a particular social environment. The design of the protocols underlying the Internet resulted not only from stated design goals (such as survivability) but also from certain social assumptions (such as equality of users). The assumption that technology has innate characteristics that will not be changed is referred to as technological determinism and has been widely discredited; technology and society form each other in a complex dance of a thousand steps.[v]

The design characteristics of the Internet that have consistently been said to support democratic pluralism are content neutrality, consumer voice, and synchronous information flow. Together these add up to the ability to create as well as consume content. At the technical level these result from the “end-to-end” argument---a reference to the ability to innovate. All two people need is compatible software on each of their machines; the network will connect them regardless of how innovative or radical the software is (radically good or radically bad).

Content neutrality refers to the idea that information is transmitted through the network regardless of the contents of the packet. This means that owners of specific content could not, traditionally, cause their content to be preferred over the content of others. Think of bits as water and the information flow as water flow. There are a few ways to make sure that water is transmitted to a particular location. One is to build very fat pipes and send as much as can possibly be desired. This so-called fat-pipe strategy was the Internet practice up to the late 1990s. A second way is to put meters on the water and decrease demand. This is the strategy of the various quality-of-service

proposals.[vi] A third is to have a slow normal flow and allow privileged areas to build tanks. This is the approach used by Akamai, an Internet content distributor. Note that the need for content distributors is in part a result of the failure of the governments or any self-governance mechanism to create functional interconnection agreements.

The ability to speak as well as listen is critical to maintaining the oft-heralded democratic implications of the Internet. But the ability to be heard is being undermined in at least two ways. First, the creation of a bundle of property rights for content producers prevents derivative works or criticism. The Internet Corporation for Assigned Names and Numbers (ICANN) and the expansion of trademark and copyright interests by Congress are effective legal mechanisms for silencing criticism.[vii] In particular, the Digital Millennium Copyright Act (DMCA) is undermining innovation by prohibiting individuals from reverse-engineering software.

The second force undermining content neutrality is the marketization of information flow. The Internet creates an affordable mechanism for distributing content by depending on best-effort transport and network mechanisms. This means, using the analogy above, that no water can be targeted or delivered more quickly than any other water because they all use the same pipes. While this may be true of water pipes, it is not necessarily true of bits, because bits can be self-identifying. The network can be engineered so that widespread distribution of content requires contracts with the holders of selected caches and discovery requires payment for selected search engines. Engineering the network in this manner would remove the advantage of cheap distribution and create a closed network.

Bidirectional information flow is the assumption that people speak as well as listen. Synchronous information flow means that my machine can send as much as it receives in a standard connection to the Internet: 56.6k means 56.6k either way, uploading or downloading. Next-generation broadband technologies are altering that assumption. Next-generation broadband networks presume that home users are always clients and never servers---for example, that people

listen and speak only when given permission by the owner of a server. Next-generation networks can be built so that independent Internet service providers (ISPs) must jump additional hurdles to reach clients and wireless users receive only information selected by the marketer of connectivity, so that content is determined by conduit. Further, with closed code such decisions cannot even be seen by the customer.

In this discussion I touch on namespaces, markets, and governments, with the common thread being how the construction of social and technical standards can create, negate, enable, or handicap civil society. The issues I bring to light are often referred to in engineering as the "law of unintended consequences"---meaning that the unintended consequences of a widely adopted technology will overwhelm the design goals in the long term. I argue that these consequences, though unintended, can nonetheless be predicted in the case of the policies and technologies being considered now. This offers the promise that such consequences can be avoided. Policy is very much like engineering in that at its best what is built is an infrastructure that enables individuals and societies to pursue their goals with efficient grace. They are also alike in that both policy and engineering are invisible when successful and gracefully designed, and dramatically visible when they fail.

Code

Is code a machine or speech? Should code be patented like a machine or subject to copyright like text? Previous work has focused on the ethical implications of code, a specific regulatory approach, industry practices, or potential regulatory regimes for intellectual property as a whole.[viii]

Code comes in several forms. First, there is source (or high-level) code. Second is assembly code. And Third is executable or binary code, which can be disassembled or reverse-engineered into source code; but this is a difficult, tedious, and uncertain process. High-level source code is readable by humans:

```
#include <stdio.h
main()
{
int a,b;
a = 1;
b = 2;
printf("%i\n", a + b);
}
```

With some examination one can see that the code adds two numbers (a + b) and prints out the result.

Code may be translated to an interim form, which is called assembly. Assembly is a low-level language, in contrast to high-level languages. Assembly code consists of human-readable commands in the order in which they are implemented: for example, move a previously stored number from one register to another so that the number can be loaded into the arithmetic logic unit to be added. Grace Hopper's invention of compilers freed humans from writing in binary (see list below).[ix]

Alternatively, high-level code may be interpreted into a lower-level form and then executed on a virtual machine. Interpreted code is compiled every time it is run. LISP and Java are interpreted languages. In this discussion, interpreted code can be considered equivalent to compiled code. Scripting languages such as Javascript are interpreted every time they are run and inherently distributed in source form. Similarly, HTML is simply a mark-up language and the distribution is inherently open.

The following is annotated assembler pseudo-code for adding two numbers:

```
ORG 0          The program begins at location 0
LDA A          First number is at location A
ADD B          Add number from location B
```

```
STA C       Store the result in location C
HLT         Stop computer
DEC 01      First number is 1 in base ten (e.g., decimal)
DEC 02      First number is 2 in base ten (e.g., decimal)
DEC 0       Sum stored in location C
END         End of program
```

Machines read binary code. Machine code is specific to a particular hardware and operating system. Interpreted code is specific to a particular virtual machine, which can theoretically be run on any hardware with any operating system.

In licensed, proprietary software, users receive binary code, which cannot be read by humans. This part of the binary code is for a particular machine and a particular compiler, which does part of the work of adding two numbers.

0010 0000 0000 0100

0001 0000 0000 0101

0011 0000 0000 0110

0111 0000 0000 0001

0000 0000 0101 0011

1111 1111 1110 1001

0000 0000 0000 0000

Currently the protection of the various levels of code is complex. Code can be subject to copyright, as with the Gnu General Public License (GPL).[x] Code can be the subject of trade secrets, and code can be patented. Because it can be treated as a service, it can also be licensed. In particular, the Uniform Computer Information Transactions Act (UCITA) would allow the producers of software to share the same very low levels of liability with custom professional services customers, negating traditional consumer protection.

Code is subject to trade secret. Microsoft is using a combination of contract law and trade secret claims to prevent the publication of its implementation of Kerberos. Kerberos is an open

standard or protocol. A protocol is a definition of the syntax and order of messages. Kerberos is used to manage resources (such as web sites, databases, or particular digital services) which are protected by passwords. When you receive a response to your submission of a password, you have usually interacted with Kerberos. Microsoft's implementation of Kerberos changes the protocol so that it no longer works with traditional implementation.

To understand the importance of viewing code, a note on Microsoft business practices is in order. Microsoft has a business practice called "embrace and extend," which is commonly referred to as "embrace, extend, and extinguish" by those who have been so embraced. Microsoft "embraces" a standard by implementing it and ensuring its compatibility with Windows. Microsoft then "extends" the standard so that it is not compatible with any but Microsoft products. With Linux, a Microsoft competitor, making headway in the server market, making a cornerstone of network security inoperable with Linux would leverage Microsoft's monopoly on the desktop to extend the hold to the server.

In other words, in Microsoft's view, Kerberos would be an ideal standard to embrace, extend, and extinguish. The current Microsoft policy is to allow individuals to look at source code on the web on the condition that the user view and accept a contract prohibiting discussion or any public exposure of the code. This could prohibit open code proponents from making implementations interoperable with the new "extended" Kerberos.

A reader of Slashdot.org, a community of open code developers and proponents, crafted a small program that allows anyone using to view the Microsoft Kerberos code without agreeing to the license provisions. By clicking on the link provided on Slashdot to this small program anyone could see the Mircosoft Kerneros code and never see the license. Using this license bypass, another reader of Slashdot posted the Kerberos code. Microsoft sued Slashdot on the basis that Slashdot was exposing a trade secret.

Code can also be subject to patent. In particular, the algorithms used to write the code can be

patented. Algorithms are widely seen as ideas in the scientific environment, even among those who own or are pursuing patents. It is seen as a necessary practice required by bad law and worse business practice. Software patents have been the subject of much derision because they do not cover the implementation of a particular idea; that is, they do not cover the particular coding of an idea but rather the concept itself. This claim is in opposition to the written law of patents but is widely shared among scholars.[xi]

Patents and propertization have expanded the rights of patent holders over innovators and consumers. Proprietary software and patents have trumped consumers' right to choose and know what they purchase, entrepreneurs' desire to add value, and scientists' right to investigate.

In addition, the legal definition of code is confusing and has no clear underlying principle. Where clearly applicable principles exist in the law, such as in the assignment of liability, those principles are not being applied to the case of code. The creation of code in its varying forms of property offers an irrational distribution of liability; expands the rights of those who market the code at the expense of consumer and citizen rights; and allows an excessive fencing off of the commons through patents.

Content

Imagine that a builder could own all the papers taken into any building he or she built, and that extracting the papers from the building is extremely expensive, requiring a specialist with specific tools. Now imagine that that building is your home or your office. Even detecting the surveillance equipment and learning what information about you has been compiled and resold would require special tools. But the law prohibits the use of those tools. Who owns your ideas and who owns your business? Who owns your identity? How much autonomy do you have?

Welcome to the world of the Digital Millennium Copyright Act. The DMCA, which prohibits reverse-engineering, has enabled Microsoft to sue programmers for speaking about the

Microsoft implementation of a public standard. The DMCA has enabled the prosecution of an innovative programmer who unbundled Microsoft's operating system (Windows) and movie player (DVD content scrambling system). Because the programmer's software allowed users to view movies on operating systems not made by Microsoft, and because the software enabled this unbundling by decrypting the weak security of the Content Scrambling System (CSS) this act of innovation is illegal. While the Department of Justice tries to prevent the bundling of browsers with one hand, it requires the bundling of video players with the other.[xii]

You have just entered the office and the home of the future, according to U.S. government policy. Imagine that your papers are digital and your words are written in an application. You have no rights over the file format. If the files were written in a secure (encrypted) manner, or even encrypted with something as trivial pig latin, any reverse-engineering to create a compatible product would be prohibited.

Trademark

The old forms of property were defined as trade secrets, patents, and copyrights. Intellectual property law is almost as varied and confused as real property law, yet there are a few clear issues. The primary threads of intellectual property law are trademark, patent, copyright, and trade secrets. Trademark law was originally established to allow businesses to distinguish themselves and prevent customer confusion.[xiii] Trademark law was applicable when one company presented itself in such a way as to be confused with another. Trademark law has not been actionable in cases where businesses with similar names were separated by lines of business or geography.

The rights of trademark holders are being radically expanded on the Internet with applications of trademark law not only to businesses but also to geographic regions, union organizing drives (Historic Williamsburg), artistic endeavors (etoys), and political speech (gwbush). Trademark holders are being given rights over speech that criticizes their commercial practices. In

the case of Colonial Williamsburg, the Hotel and Restaurant Employees Local 25 had a site both to unionize the employees in the area hotels and to inform potential area visitors of the practices of the hospitality businesses with respect to workers. The members of the union had been working without a contract, while the employers were seeking federal permission to import workers. On the basis that such a site harmed the identity of the businesses that had invested in the regional name Colonial Williamsburg, the union was required to cease using the domain name "colonial-williamsburg.com." The court so ruled despite the fact that Colonial Williamsburg is the name of a region, not of a particular business. the union changed its domain name to “cwunions.com.”

The result was to take away what was an effective bully pulpit for the workers. Because some of the original site's content was clearly political and social speech; it was moved on the basis that the recipient of the criticism had property rights, which trumped the speech and organization rights of the union. Judge Rebecca Smith issued the injunction against the union and for the hotels without union counsel present, stating, trademark violations "can happen very quickly, potentially in minutes, hours and certainly days.”[xiv]

In another case, etoys.com sued etoys.org on the basis of trademark violation. etoys.org was the site for a performance art group whose speech was entirely artistic. etoys.org preceded etoys.com on the Internet by several years, but etoys.org had no legal recourse.[xv] There is no place in the current domain name resolution policy or trademark law as it is being applied to domain names for artistic, political, or critical speech. The only defense available to etoys.org was public outrage. etoys.org maintained its domain name only through an effective consumer boycott, yet there was no change in legal doctrine despite the clear citizen outrage at the ability of etoys.com to remove etoys.org’s domain name.[xvi]

A trademark is a valuable piece of intellectual property. Before the battles over domain names, trademarks existed for the purpose of differentiating products. Now propertization has expanded the property rights of trademark holders by redefining the balance between trademark

rights and speech rights.

Copyright

The radical changes in copyright law, intended to bring copyright to the digital age, are evidenced in the Digital Millennium Copyright Act. Recall that the objectives of copyright are to encourage and protect innovation and to create a marketplace with the greatest amount of innovation.

The best-known case being brought under the new copyright law is known as the DeCSS case. The Content Scrambling System was not a technical masterpiece. Its primary purpose was to create in code a protection of the business practices of the Motion Picture Association of America (MPAA). Currently movies are released in different places around the world. The Content Scrambling System controls when, how, and where movies are watched. It marks copies of otherwise identical movies with location markers so that a movie meant to be sold in one region cannot be resold in another (for example, through Ebay). Purchased and rented videos are watermarked to prevent consumers from making copies. (Unfortunately this watermarking often prevents the digital tracking mechanisms on video players from working, so that consumers get worthless goods, but that would be the subject of another paper.) CSS was intended to control the legal viewing of movies, yet CSS was included in a typical pirate copy and the pirate copy would fit well with the CSS-enabled player.

The factual core of the case is as follows. A young man in northern Europe wanted to watch movies in France while on vacation. He had a DVD player at home, with the television. He also had a portable computer, which he took on vacation. Because his portable computer used the Linux operating system, which did not allow him to watch movies protected with the Content Scrambling System. In fact, even if his machine had had the CSS, the machine would have been useless in France because the rentals would play only on players identified with the region.

Only machines with Microsoft or Apple operating systems can legally use DVD players to play movies protected with the Content Scrambling System. So this young man subverted the Content Scrambling System in order to be able to rent videos and watch them while on vacation. He then posted the code so that others could use it. In no case or court has it been proposed that this young man, Jon Johansen, intended to copy movies in order to avoid having to purchase them. He wanted only to be able to watch movies he had already purchased or rented.

Johansen and his father were arrested and brought to the United States for trial. In addition to prosecuting this teenager and his father, the MPAA has filed suit against every website that posts the DeCSS code or links to the DeCSS code. Judge Lewis A. Kaplan issued a preliminary injunction on January 21 ordering the 2600.com website and its ISP to cease posting or in any other way "trafficking" in DeCSS. The fact that the posting at 2600 was in part to discuss the technical and legal merits of the DMCA case was not held to be justification to allow posting or linking.

So, in short, an information innovation that allows consumers who buy or purchase movies to watch them on the operating system and in the location of their choice is a felony. It is a felony even to discuss this debate at the source code level. In other words, it is prohibited by law to take a movie from New York and watch it in Amsterdam if the MPAA would like such an action to be prohibited and can implement this prohibition in computer code.

The findings in the DeCSS case will have tremendous implications. Removing the option to innovate cripples the open-source and free software communities. The bindings created by weak technical protections in bad code can be sufficiently strengthened by criminal law to cripple the open code movement. Without free code there would have been no Internet. The destruction of open code through the redefinition of patents and copyright will prevent the evolution of an Internet that maintains democratic principles in design. Modern copyright law is radically extending the amount of control copyright holders have over content and users of content. This is not happening only in entertainment but also in education.

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Richard Stallman, founder of the Free Software Foundation, claimed in 1984 that password-protected, single-user, code-controlled textbooks and reference books would eventually be introduced. At the time he was widely seen as paranoid. From today's vantage point it remains clear that having medical reference books that become unavailable after the semester in which they are used is over is not socially optimal. Yet Vital Source Technologies is providing time-limited and user-specific digital medical textbooks to universities to sell to students. Should a medical emergency, or even a question, arise after the textbook's life has expired, the student would no longer have access to the text. These are exactly the controls enabled by the Digital Millennium Copyright Act. Should the student who becomes a doctor break the encryption that protects the content in order to review the information, that doctor would technically be a felon, subject to a $500,000 fine and five years in jail. Or, should a medical student lend another student his or her textbook, both the lender and the borrower could face similar penalties. The Copyright Office recently released the acceptable reasons for circumventing encryption technology, and protecting fair use for education is not among the exceptions. (Only computer security research and breaking filtering software are allowable.)

The Digital Millennium Copyright Act is radical legislation, judging by its results. Intended only to protect modern business models, it has instead negated fair use and limited speech rights. Although the income of the movie studios is insignificant in comparison with that of the software industry, some argue that movie production creates soft power for the United States.[xvii] Yet that soft power is most important in areas where the DMCA and CSS would prevent users from watching the content. Soviet citizens could not have watched American movies with the CSS in place. Similarly, today any person under a regime opposed to the United States could be prevented from watching a movie protected with DeCSS because the MPAA would never have released the content in that region. Smugglers and sellers of information would have to be hackers as well as traders.

In short, the DMCA harms American strategic interests, economic interests, and the

marketplace of ideas. The DMCA was seen as merely enabling a market. Instead, it altered the right of content producers from the right to sell their product to the right to control who uses the product, in what locations, under what terms, and on what equipment. In addition to this increase in control, DVD players that are network enabled also have an "ET feature"---that is, the software phones home to the MPAA and reports what material was watched, when, and under what conditions. Breaking this surveillance software would make the user seeking privacy a felon. The expansion of property rights under copyright is so extreme as to undermine the original and fundamental tenets of copyright.

Trespass to Chattel

Thus is it clear that, increasingly, intellectual property rights triumph over speech rights. A second significant area where property law is trumping speech law is in the noble service of prohibiting spam. Under the doctrine of trespass to chattel, narrowcast or broadcast e-mail can be prohibited on the basis of content. In one case, a former Intel employee obtained an employee e-mail list through public sources.[xviii] He then sent his thoughts about Intel, intended to be scathing, to Intel employees. Intel was able to legally prohibit the ex-employee from sending his opinions to Intel employees. The construction of the spam law is such that firms, including ISPs, can object to mail entirely on the basis of its content. Given the concentration of the backbone and high-speed routing in the hands of very few firms (in many regions and nations just *one* firm), the ability to limit distribution of speech offers a very real concentration of power.[xix] Badly written definitions of spam have defined as chattel the networks of those who connect to the Internet. Such a definition allows network owners to reject content; the effect is propertization that overpowers listeners' right to hear. This practice has already been widely used in the America Online (AOL) network. AOL users are not allowed to come together to discuss topics of which AOL management disapproves. In particular, users are not allowed to organize to discuss AOL rates. Certainly the company will not consider any filtering or

surveillance that AOL and Time Warner choose to implement to be worthy topics of conversation. Current definitions of spam allow the network provider to censor information that the user may want to hear. Combined with the lack of open-access requirements, this means that AOL and Time Warner will be able to determine the information available to homes in their service area by deciding which e-mail, television channels, discussion groups, and web content are acceptable. Spam laws will provide the force of law to AOL should users attempt to make anti-AOL speech widely heard.

A Proposal for Code and Content

Given the critical comments I have made in this chapter, it is only fair for me to offer alternative ideas of my own design for consideration. My own perspective on how the different types of code should be regulated is summarized in the following list.[xx]

Models of Protection

Code type	*Application*
Code as a product or functional invention	Patents (limited to specific implementations)
	Object code (a functional invention)
Code as a professional service	Custom code (code written once for a specific customer)
Code as embodied speech	Source code
Ungoverned code	Code in the public domain

This is a coherent and cohesive proposal on at least three levels. First, it treats executable code as if it were a machine. Code that is sold in executable form is expected to work, as any other machine would work. Patents would be granted for the particular design and implementation of an idea, not for the algorithm or concept underlying the idea. Reverse-engineering would be allowed for

interoperability, as in the DeCSS case. These are the principles of machines, engineering, and innovation in the machine age.

Code as a professional service would allow open code creators to prosper. Open code is frequently used to create custom designs for specific consumers. In contrast, UCITA would provide the lowest level of protection and consumer expectation for widely used source code. UCITA would subject custom code to the highest reliability constraints and mass-marketed code to no constraints. This is clearly an irrational distribution of liability.

Treating source code as embodied speech is not ideal because it is possible to write code that functions but cannot be read. The code-as-speech analogy fails on this one point. In order to be functional and useful, speech must be readable by humans, but the same is not true of code. Open code can be made difficult to read, and it is possible that spaghetti code[1] would proliferate under such a regime, in order to avoid the liability associated with the manufacture of machines. Yet badly written code proliferates now, so even the worst-order effect would produce nothing worse than the status quo.

My proposal would leave open the question of the extent of copying allowable under fair use. Yet it would solve the problems of excessive protection of code and content and irrational assignments of liability; and it would not undermine open code. This framing fits well with what can be said about the open code agenda. This agenda is based on "funding for basic research, avoidance of excessive intellectual property protection, and enforcement of open-source licenses---or the policies can be direct---government funding for open-source developers and government promotion of open-source standards."[xxi] Other members of the community also seek to create economic mechanisms that can support younger hackers trying to build reputations.[xxii] This objective is at least

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[1] If you would like to add the note defining spaghetti code, please complete the following **(the note you started on the front page of the earlier edited ms. continued on the back of the page and thus did not appear on the photocopy I received):** "Code must allow the data to flow in a logical line. Yet instead of being laid out like the dividing line on asphalt, this code is rather more like the single noodle in a package of quick instant Raman or Bachelor's noodles, entangled so as to be impossible to lay out flat."

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not harmed by these proposals, and the rational application of patents would allow young innovators to innovate.

Another alternative is a strict limit of five years on copyright.[xxiii] The argument against this is that such a change would destroy the free software and open-source communities that depend on copyright. Furthermore, code, unlike prose, is not readable just because it is open. Obtuse, compressed, and unreadable code can provide almost as little information as closed code, as an annual competition held by Carnegie Mellon University to write unreadable code clearly illustrates. Another alternative is to retain copyright and limit its use. This requires rejecting the Digital Millennium Copyright Act and protecting fair use. Recalling the forgotten wisdom of the importance of common carriage and the value to consumers in trademarks is critical. Yet any and all of these proposals would require a government that sees itself rightfully as the creator, not the handmaiden, of markets.

Conduit

Conduit has been used in telecommunications to refer to the medium of transmission. The word itself reflects that the transmission medium is simply that: a conduit for something else rather than intrinsically valuable in and of itself. Yet it also reflects the reality of telecommunications that it is not the wire or cable that is valuable, but its placement. The most expensive element is the labor of putting the cable in place---making the wire into conduit.

The Internet was enabled by interconnection. The ability to connect modems to telephone systems was hotly contested by the telephone systems. AT&T sought to prohibit connections as benign as a small plastic cup on the receiver to improve the clarity of the speaker's voice (the Hush-A-Phone), and if the Courts had upheld this claim to network purity the Internet would have remained exclusively an academic pursuit.

The interconnection of networks requires open standards, open protocols, and open

implementations of the code that implements these standards and protocols. A protocol is a description of an ordered set of messages to implement a specific task. A standard may be an implementation of a protocol for a particular environment (for example, the Internet protocol [IP] over coaxial cable) or a description of the goals that should be met by a protocol (see various International Standards Organization [ISO] standards).[xxiv] Code is the implementation of a protocol as described in a standard. In this section I discuss how the rules governing conduit are changing and how the technologies being built in this time of transition are in opposition to the practices of common carriage and interconnection.

The dominant high-bandwidth technologies in the home are digital subscriber line, cable Ethernet, and wireless. Each of these involves conduits and regulations that enable a one-way system, with the result being that there is emerging an oligopoly in content control based on ownership of the wires.[xxv] Consider for a moment the developments that have driven cable Ethernet and high-speed phone line (xDSL) services. Initially there was stasis, with no line of business threatening another. Packet-switched technologies enabled convergence as early as 1980, but there was no driving business logic pushing companies to abandon their cash cows. The rush for broadband to the home arrived with the creation of direct broadcast satellite and threatened the income flow of the owners of the cable infrastructure. Competition with direct broadcast satellite companies forced cable companies to upgrade their services and networks. When cable companies with upgraded networks began to offer high-speed network connections, they could compete directly with the small-office and home-office markets that were purchasing T1 and T3 frame relay services at ten times the cost from local telephony providers. Before this competition existed there was no reason for the phone companies, cable companies, or wireless companies to roll out services that would require massive investment in the network and gutting the companies' profit margins in their core markets (data, pay TV, and mobile voice, respectively). Thus competition is without question the critical driver in the marketplace. And competition and common carriage are not only

complementary; competition in service provision *requires* common carriage.

Phone Lines

Phone lines are being moved to the next generation with asynchronous digital subscriber line technologies, known as xDSL.[xxvi] DSL is of interest for several reasons. Phone lines consist of sets of wires, each individually clad with insulating material and then twisted together and clad a second time. Thus discussions of phone wires often refer to a twisted pair, even though modern phone lines have more than two wires.

Phone company rollouts of DSL are closely correlated with rollouts of cable modems. Cable modems are closely associated with the availability of direct broadcast satellite services. In fact, ISPs could provide DSL-equivalent technology by using the clean copper provided for alarm circuits. When the purchase of alarm circuits for cheap data transmission was noted by the phone companies, phone companies responded by refusing to offer new alarm circuits. Thus even when there is money to be made, companies will prevent innovation when it is a radical departure from their way of doing business and cannibalizes far more profitable offerings. Phone companies were content to have data lines remain forever segregated into modem lines and expensive frame relay lines. The principle of interconnection, if applied to alarm circuits, would have allowed a far earlier rollout of DSL. Thus the arguments against open access---arguments that say monopoly returns the best investment in infrastructure---have been proven wrong in the case of the telephony.

Digital subscriber line (DSL) technologies enable broadband speeds over telephone wires. DSL technologies are much slower than cable technologies for a single subscriber's link because the two telephone wires are a twisted pair of wires. Thus while telephone technologies may continue to increase data transmission rates, the coaxial cable has a fundamental physical advantage in terms of the interaction of the currents in the two wires, so cable will always be able to provide higher throughput than a twisted pair. However, just as with cable companies, phone companies are slowly

pulling fiber closer to the home. Thus any analysis of hybrid fiber coaxial cable should compare it with a hybrid fiber twisted pair, not with a twisted pair.

Cable provides more bandwidth on a single line, yet DSL may provide more bandwidth for a single subscriber. DSL provides each subscriber with his or her own line up to the switch. Thus the higher bandwidth provided over cable is shared by multiple households for the last mile. The lower overall bandwidth provided by DSL may be higher than the cable bandwidth to a particular home depending on the intensity of the use of Internet services on the street or in the neighborhood.

Recall that the first point of interest is that competition increases rollout. The second point is that DSL technologies are often asynchronous. DSL technologies may expect the user to listen rather than speak. DSL services, however, can support home servers. DSL offers in the Boston area often include fixed domain names, with the purpose of enabling servers. Of course this is in part because the DSL market targeted by the phone companies is the small-office and home-office (SOHO) market. DSL contracts do not prevent the user from setting up his or her own server. DSL offers open access and is not bundled with content.[xxvii]

DSL technologies enable users to speak as well as listen. When possible, DSL technologies were delayed by phone companies, even when the companies were offering their own ISP services. A stronger requirement for interconnection and service guarantees could have provided DSL services far earlier. However, some believe that allowing phone companies to offer the service with only the phone companies' ISP would have encouraged faster rollout. Yet even with the increased income from ISP subscriber fees, the phone companies would not have had economic justification to cannibalize their frame relay services.

Wireless

Wireless systems may be built in a manner that enables fully synchronous information flows or as a strictly broadcast model where the user is a passive recipient. Consider synchronous

networks. Point-to-point microwave networks are an example of this type of architecture, as are some third-generation cellular technologies.

Consider asynchronous technologies. Wireless systems may be built with the assumption that the greater bandwidth is downstream---that is, with the assumption that the user is a listener. This is most common with wireless systems that depend on satellite downlinks because low back-channel bandwidth allows for lower power and cheaper home equipment.

The greatest threat to the end-to-end argument comes from the wireless access protocol (WAP), which is not HTML compliant. WAP interacts with wireless markup language (WML) rather than with HTML. WML addresses the low-bandwidth and limited-screen-space issues with wireless.[xxviii] However, WAP does more than that. WML rewrites simple HTML so even the most basic tags (such as a link or a page break) no longer mean the same thing in WAP that they do in HTML. Thus authors who would speak to the world must write two versions of a web page: an HTML version and a WAP version. The market as currently constructed does appear to be addressing this: there is currently a consumer WAP-backlash.

All intelligence in WAP is built into the gateway rather than the endpoint, which means choices are made or delineated at the gateway, not by the user. The relative intelligence required in a machine to support a browser client is more than that available in a handheld device (such as a HandspringVisor or a Palm Pilot) or a modern cellular phone. Moving intelligence to the gateway is a fundamental rewrite of the network protocols, which ends the end-to-end argument. The distinction between obscure protocol elements such as the style of acknowledgments and encryption may seem trivial until one notes that these all require one fundamental design assumption---that the WAP user connects to a predetermined gateway and the gateway defines these services. The services provided at the gateway include content selection and portal provision. Note that concurrent with the development of WAP, the Internet Engineering Task Force (IETF) is developing protocols to enable transactions over wireless networks. However, the IETF assumes some processing capacity in the

wireless receiver and there the ability to change providers. IETF places a premium on interoperability and flexibility. The IETF proposals and the WAP proposals are not interoperable.

Imagine if you had to buy a new computer to change ISPs or to select a new portal or home page. This is the choice offered the user by WAP. WAP systems connect conduit and content.

Cable Ethernet

The differences between Ethernet and cable Ethernet connection are primarily contractual and regulatory. A core policy difference is the (lack of) open-access requirements. In addition, it is worth mentioning that many providers of cable Ethernet contractually prohibit users from setting up servers. This prohibition is interesting for three reasons. One, it forbids the user from using certain technologies that allow a machine to serve others and be a client itself. Possibly prohibited are highly distributed computing applications, of which the SETI program is the best known. Similarly, this prohibition in theory covers the use of Napster and its many clones and derivatives (such as Gnutella). All peer-to-peer computing is, in theory, prohibited by contract. Again, as with the phone companies and DSL, the cable companies have a specific business model. These companies are uninterested in any innovation that may alter that model.

Most important, the inability of user computers to be servers over cable Ethernet means that the cable Ethernet provider does not support home servers. The expansion of this high-bandwidth network topology to the home should mean that all users could provide simple servers. That is, everyone could be a publisher on the Internet on equal terms, as in the days when Usenet dominated dialogue. Combined with a domain name system that is hostile to small users and free speech, this lack of technical support threatens the potential for democracy on the Internet.

Ethernet as implemented in cable networks is quite capable of supporting multiple providers and supporting servers. However, some of the networks are being built in a manner that prevents open access. Open access is a traditional requirement of owners of conduit so that all may speak on

equal terms. The new terms of connection are an example of propertization---that those who own fast conduits own the data and eyeballs of those they connect. The regulation of the transport layer of Ethernet ignores the fundamental reality of common carriage: that transport networks need to be open for all comers to optimize economic growth. In an information economy, the transport networks need to ensure the free flow of information.

With the AOL Time Warner merger the assumption is that users should see what is determined by conduit owners. Furthermore, the AOL-Warner policies and protocols make certain that users are allowed to speak only in limited arenas and on approved topics. AOL, for example, allows only those in positions of authority in the corporation to broadcast e-mail. In addition to preventing subscribers from discussing its rates, AOL software also does not support the creation of e-mail lists by its subscribers. AOL audits and tracks all subscriber use, reserves the right to censor web pages, does not support user-owned domain names, and prevents user innovations. Sadly, AOL will be the only option available to many Americans for high-speed Internet access, which means that many Americans will not have access to the two-way Internet but rather carefully controlled access where offending AOL is not allowed.

Caching

Caching is the storage part of the store-and-forward network. A network cache holds packets while waiting for the call to forward them. As packets and information are routed, temporary copies are made (and cached) in servers across the network. When the network is congested, each router chooses which bits to forward and which bits to discard. (Congestion occurs whenever the demand for network services is greater than the supply.) Similarly, servers choose which bits are kept, in case another copy is needed, and which are deleted. Such decisions have long been made on the basis of technical efficiency using variable such as protocol and file size. For example, it is unlikely that many people will request an e-mail but very likely that many people will request a web page. So e-

mail protocol-based messages are not stored for later local use, while web pages are.

There are several levels of storage across the network. There are caches at the point where the local area network and the wide area network connect. There is a cache on each individual hard drive and a cache where the wide area network meets the Internet. Caching choices have traditionally been driven by research on networks. Of course, some research suggests that the research done on the networks of research institutions may be misleading, because researchers' use of the Internet varies somewhat from the average surfer's.[xxix] Yet regardless of the efficacy, the practice of caching in the networks of the 1990s has been to minimize transmission and optimize network performance.

The practice of optimizing network performance as driven by user desires for content has been altered with the entrance of ISP provider Akamai into the market. Dave Clark, past head of the Internet Architecture Board and senior network researcher at MIT, is fond of saying, "The Internet routes packets and Akamai figures out how to route the money." Akamai provides caching at strategically chosen network points in order to provide higher-quality network service for those who pay for the space. Thus information provided by rich backers can be provided quickly and made universally available, while speech from random individuals, nonprofits, and NGOs other than corporations can be slowed.

Caching expands property rights by creating technologies that can alter the fundamental assumptions of the network. There has never been regulation of caching, only the social norms that assume that caches are designed to optimize network performance. Thus while this change alters the fundamental assumption of content-neutrality of routing on the Internet, it is likely to be problematic only if transport networks are not open. With open networks, consumers could choose to use a different provider with different caching practices.

Policy-Based Routing

The Gilmore statement about routing around censorship has a foundation in truth, and that foundation is IPv4, the Internet protocol as currently implemented. Traditionally routing has been based entirely on engineering concepts of efficiency (which can be very different from economic concepts of efficiency). Policy-based routing enables the owners of routers to charge differential rates for different customers and to block those who will not pay the acceptable rate. Thus routing is moving from engineering concepts of efficiency to more narrow economic concepts of efficiency. For example, AOL could give priority to all Time Warner and AOL content, thus giving AOL e-mail higher priority than video not owned by Time Warner. The result would be time delay for video content not owned by Time Warner, perhaps so long that such video would be difficult to watch.

The losses in the embrace of policy-based routing are the following: the loss of common carriage, the potential end of price certainty, the end of overprovision, and the ability to remove content critical of the owner of the router.

The first, the loss of common carriage, is covered earlier in this essay. The second, the end of price certainty, would result in far lower adoption rates of Internet services. Every known study of adoption and use of communication technologies illustrates that individuals prefer a flat rate, even when a flat rate is more expensive. Every telecommunications service has adopted an increasingly simple fee structure over time. As fees become more predictable, more users are able to use the service. The variance possible in monthly rates is the dominant driver of disconnection of the poor in telephony.[xxx]

The end of overprovision would vastly increase the cost of networks over time, and policy-based routing could encourage scarcity. Although traditional economics rarely sees scarcity as an inherently bad thing, those interested in universal access and the ability to innovate with systems requiring greater performance recognize that created scarcity is not ideal in all markets. To return to

the metaphor of physical property, a created scarcity of water in an urban environment may make economic sense, but it does not make sense in the policy arena, where death by dehydration and cholera are not feasible options.

The End of End-to-End? [xxxi]

History is rich with battles over property rights and human rights. With the recent battles over environmental laws, physical property rights have been rewritten and balanced with the common good. It is easy to forget that battles over property rights were a part of discussion about the abuse of children (the abuse of animals was prohibited first) and the abomination of slavery, and those same battles underlie environmental debates as well. Just as the definition of physical property is an ongoing process, the definition of intellectual property will be at least as difficult. Yet it will be made less difficult by recalling the lessons learned in the past with respect to common carriage and by addressing the meaningful distinctions between real and virtual property.

In information property the trend toward limiting real property rights to create a functional and balanced market is being reversed. The theory that there are no costs, only benefits, to the expansion of property rights is applied in the extreme, thereby limiting opportunities for the exchange of ideas and innovation.

The issues of intellectual property are not linear. More control of owners does not automatically lead to more innovation or investment. The balance between the commons and the private has been and continues to be a complex question. The issues are no easier in the information realm, and assuming away complexity does only harm. The democratic potential of the Internet requires user-driven content: "On one side of the battle over freedom of information are people who believe that sharing information with other interested people is a good thing even if the information comes from someone who does not want it to be shared. Individuals and companies that would prefer that the information remain proprietary are on the other side of the fight."[xxxii] As Jack Valenti

of the MPAA notes, his ideal protection time frame would be "forever minus one day.[xxxiii] Even the compromise solution on content suggests that some content would "never be available in digital form," with the canonical example being the movie *The Wizard of Oz*.[xxxiv] Valuable information was always meant to become part of the commons, with copyright only a temporary monopoly. Now that trend has been reversed, with information being made forever proprietary if it becomes culturally valuable. This appears to be a global rush to fence in the commons, beyond the point of reasonable economic returns.

The wires as well as the content are being closed. Open access refers to the requirement that owners of transport networks (that is, conduit) must resell the transport at reasonable rates to allow competition, particularly for value-added services. Open access is common carriage. The current regulatory arguments suggest that companies will not invest in bringing high-bandwidth services to the home without the ability to capture users and the right to exclude content. History both near and far argues that the rollout of services, in this case broadband services, is best served by truly competitive forces and not by government-enhanced monopoly. Furthermore, rejecting open-access regulation violates the fundamental tenet of telecommunications and centuries of transport regulation---interconnection and common carriage.

Competition in transport and common-carrier status can be and has been compatible.[xxxv] The defeat of open access allows technology that expands the rights of network holders over the traditional rights of liability-exempt common carriers. In this case it is the regulatory redefinition that allows transport network holders to fence in their users, withholding from them the information commons.

Freedom of ideas, freedom to innovate, and freedom to speak should belong to all citizens, computer users as well as companies. The Internet has enabled all of those things, simply by its construction. Yet the construction of the Internet is not the result of its innate nature. Being entirely constructed, it can be entirely reconstructed, so that the open and free part of the Internet returns to

technologists and scientists while the bulk of the population receives the AOL version. IP over everything is a choice, an optimal choice for the information commons but not for the individual income-maximizing players.

Under the banner of progressive "un-regulation" the Federal Communications Commission (FCC) is encouraging the creation of closed broadcast-style networks. The courts are expanding property rights to include the right to prevent speech unwelcome by the property owners, even if the occupants of the virtual property are interested in the speech. Congress has passed legislation (the DMCA) that denies even the most basic rights of speech, evaluation, and full information to citizens, thus redefining us as consumers of narrowly licensed information goods. This act is supported as a simple definition and modernization of contracts for information property, with no examination of the long-term costs or the implications for civil society.

Governments create markets, except in the most primitive barter societies. In the creation of post-convergence markets, governance faces a fork in the road. Many governments believe that their decisions are enabling Internet commerce and thus choose as guides only stakeholders in the private sector. Yet the power of the government is to create the market. Ignoring government power when "enabling" a market does not decrease that power; rather it increases the unintended consequences. By expanding the rights of intellectual property holders in a misguided attempt to motivate production, abandoning past commitments to interconnection in networks, and forgetting principles of democratic leadership by taking the role of mere handmaidens to the market, governments are creating a marketplace in which democratic principles will be subverted. Democratic governments ignore their own strength only at the peril of democracy.

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i. See, for example, Carl Shapiro and Hal Varian, *Information Rules* (Harvard Business School Press, 1999); Chris DiBona, Sam Ockman, and Mark Stone, eds., *Open Sources: Voices from the Open Source Revolution* (Cambridge, Mass.: O'Reilly and Associates, 1999); and Michael Froomkin, "Of Governments and Governance," in *The Legal and Policy Framework for Global Electronic Commerce: A Progress Report* (Berkeley, Calif., 1999).

ii. Even today most shipping lines and railroads are common carriers. Shipping lines participate in organizations that set the schedules and usually the rates charged by common carriers on most major ocean routes. Railroads are usually under national regulation.

iii. "Fool Me Once Shame on Me, Fool Me Twice Shame on You: What We Can Learn from the Privatizations of the Internet Backbone Networks and the Domain Name System," Law and Economics Working Paper 00-01, University of Illinois College of Law (February 2001).

iv. See John Gilmore, "How Publius Thwarts Censorship," *Scientific American*, October 2000, p. 86.

v. Donald Mackenzie, *Inventing Accuracy* (MIT Press, 1990); James R. Beniger, *The Control Revolution: Technological and Economic Origins of the Information Society* (Harvard University Press, 1986); Brian Winston, *Media Technology and Society: A History: From the Telegraph to the Internet* (London: Routledge, 1998); and Susan J. Douglas, *Inventing American Broadcasting 1899--1922* (Johns Hopkins University Press, 1997).

vi. D. Clark, "Explicit Allocation for Best Effort Packet Delivery Service," in Mackie-Mason, L.W. & Bailey, J.P., 1997, *Internet Economics*, MIT Press, Cambridge, and Shapiro and Varian, *Information Rules*.

vii. See Pamela Samuelson, "Intellectual Property and the Digital Economy: Why the Anti-

Circumvention Regulations Need to Be Revised," *Berkeley Tech. Law Journal,* vol. 14, no. 2 (1999), p. 519.

viii. Rob Kling, ed., *Computerization and Controversy: Value Conflicts and Social Choices* (Academic Press, 1996); Deborah G. Johnson and Helen Nissenbaum, eds., *Computer Ethics and Social Values* (Prentice Hall, 1995); DiBona, Ockman, and Stone, *Open Sources*; Carliss Y. Baldwin and Kim B. Clark, *Design Rules: The Power of Modularity* (MIT Press, 2000); Shapiro and Varian, *Information Rules*; National Academy of Sciences, *The Digital Dilemma: Intellectual Property in the Information Age* (Washington: National Academy Press, 2000).

ix. For further explanation of these examples and the interaction of computer hardware and software in general, see Mano, 1982 as update 1992, *Computer System Architecture* (Prentice Hall, New Jersey).

x. Richard M. Stallman, *The GNU Manifesto* (http://www.fsf.org/gnu/manifesto.html), originally written in 1984.

xi. As a patent owner myself, I also oppose software patents. Yet I have no desire to force Carnegie Mellon University, which sought and obtained the patent on my work, to unilaterally disarm. See Tim O'Reilly, "Ask Tim" (http://www.oreilly.com/ask_tim/amazon_patent.html), last viewed July 5, 2000. See also League for Programming Freedom, "Against Software Patents," *Communications of the ACM*, vol. 35, no. 1 (1992), available at (http://lpf.ai.mit.edu/Patents/against-software-patents.html); Simson L. Garfinkel, "Patently Absurd," *Wired*, July 1994.

xii. For a clear discussion of the case, see Wendy Grossman, "DVDs: Cease and DeCSS?" *Scientific American*, May 1999; also available at (http://www.sciam.com/2000/0500issue/ 0500cyber.html).

xiii. Johnson and Nissenbaum, *Computer Ethics and Social Values.*

xiv. Alison Freehling, Patti Rosenberg, and Deborah Straszheim, "Judge Issues Order against

CW Union," *Daily Press*, Hampton, Va., April 21, 2000; also at (http://www.gilinda.com/ clippings/ injunction.html).

xv. Patricia Jacobus, "eToys Settles Net Name Dispute with etoy", *CNET News.com*. January 25, 2000, available at (http://news.cnet.com/news/0-1007-200-1531854.html?tag=st.ne.1002.bgif.1007-200-1531854.).

xvi. For other cases where the property rights of those criticized or satirized have trumped speech that is clearly satirical or political and other dialogue critical to civil society, see http://208.56.174.5/ domainnews.htm. In only one case has a complainant claiming misuse of trademark been unable to show that the use of the trademark was not identical or confusing.

xvii. Robert Keohane and Joseph Nye, *Power and Interdependence* (Longman, 1989).

xviii. Jonathan Rabinovitz, "Gadfly Presses His Email Case against Microsoft," *San Jose Mercury News*, July 6, 1999; Maria Alicia Guara, "Email delivered by Horsemail," *San Francisco Chronicle*, p. B2, September 29, 1999; alternatively see (www.faceintel.com.)

xix. Dan Burk, "The Trouble with Trespass," *The Journal of Small and Emerging Business Law*, vol. 4, no. 1 (2000), pp. 27--55.

xx. L. Jean Camp & Serena Syme, http://elj.warwick.ac.uk/jilt/01-2/camp.html, "A Coherent Intellectual Property Model of Code as Speech, Embedded Product or Service*", Journal of Information, Law, and Technology*, Vol. 2, 2001.

xxi. Lawrence Lessig, Eric S. Raymond, Nathan Newman, Jeff A. Taylor, and Jonathan Band, "Should Public Policy Support Open-Source Software? A Roundtable Discussion in Response to the Technology Issue of *The American Prospect*," *American Prospect*, vol. 11, no. 10 (2000), available at (http://www.prospect.org/controversy/open_source/).

xxii. Stig Hackvan (http://www.devlinux.org [November 2000]).

xxiii. Jonathan Zittrain, "The Un-Microsoft Un-Remedy: Law Can Prevent the Problem That

It Can't Patch Later," *Connecticut Law Review*, vol. 31, no. 4 (1999), p. 1361.

xxiv. See Camp, 1999 for an extended discussion of standards/protocols/code. for the lay person. L. Jean Camp, *Trust & Risk in Internet Commerce*, MIT Press, Winter (Cambridge, MA) 2000

xxv. For a detailed discussion of access technologies see the May 2001 issue of *info*, which has a series of articles written for the layperson on access technologies.

xxvi. I use "phone companies" to refer to LECs. Because this is about broadband access, I refer to those providing modem-based services as ISPs, to distinguish them from local exchange carriers. The local exchange carriers (LECs) are either CLEC, meaning new *competitive* phone competitiors, and ILEC meaning old *incumbenet* phone competitiors. Thus these companies own the network and provide Internet access. I do not address any long-haul networks, like the five Internet backbone carriers or the long distance companies, because the local loop is my focus. CLECs are predominantly local exchange bypasses for densely populated areas that have broadband access, or cable-based companies that also offer phone services.

xxvii. Because of flaws in privatization of the network, five major companies can provide fixed IP addresses for small business and home users. While this oligopoly of five may limit competition and hinder small ISPs, the availability of IP addresses to home users enhances the ability of those subscribers to speak.

xxviii. Ruth Cover, "The XML Cover Pages: WAP Wireless Markup Language Specification (WML)" *OASIS*, 2000 (http://www.oasis-open.org/cover/wap-wml.html).

xxix. S. Manley and M. Seltzer, "Web Facts and Fantasy," Proceedings of the 1997 USENIX Symposium on Internet Technologies and Systems, Monterey, Calif., December 1997.

xxx. Milton L. Mueller and Jorge R. Schement, "Universal Service from the Bottom Up: A Study of Telephone Penetration in Camden, New Jersey," *The Information Society,* vol. 12, No. 3**,**

(1996), pp. 273--92.

xxxi. taken from the title, " David Clark and Marjory Blumenthal "Rethinking the Design of the Internet: end to end arguments vs. the brave new world." Presented at TPRC 2000, Alexandria, Va., September 23-25th, 2000.

xxxii. Samuelson, "Intellectual Property and the Digital Economy."

xxxiii. E. Eldred, *Battle of the Books: The ebook vs. the Antibook* (Derry, N.H.: Eldred Press, 1998).

xxxiv. National Academy of Sciences, *The Digital Dilemma*.

xxxv. The clearest exposition of the reasons for interconnection can be found in the work of the Berkeley Roundtable on the International Economy; see François Bar, Stephen Cohen, Peter Cowhey, Brad DeLong, Michael Kleeman, and John Zysman, "Defending the Internet Revolution in the Broadband Era: Why Open Policy Has Been Essential, Why Reversing That Policy Will Be Risky," BRIE E-conomy Working Paper 12, August 1999, (http://econ161.berkeley.edu/Econ_Articles/Broadband_BRIE.html)