2007

Fundamentals of the network neutrality debates

Tayfun Uslu

Fundamentals of the Network Neutrality Debates

Project Presented for the Fulfillment of the Master of Science in Telecommunications Engineering Technology Program at Rochester Institute of Technology

September 19th, 2007

Tayfun Uslu

TABLE OF CONTENTS

1) Introduction

Network Neutrality debates is about whether the network owners should be allowed to discriminate or prioritize certain traffic on their networks based on its origin or its type. Historical developments, technological changes, economical, and social aspects require in depth analysis to understand the debate. The purpose of this essay is to provide a summary of opinions on this debate including technical, economic and social issues

The essay begins with the analysis of the historical developments on both telephone and data networks in order to understand the roots of the centralized and decentralized network design. This portion also addresses end-to-end design and time sensitive data concepts that are crucial to understand this debate in depth.

The following chapter analyzes the Telecommunications Act of 1996 and looks into recent legal decisions and the FCC's stand on general broadband policy which is directly related to the Network Neutrality debates.

The fourth chapter analyzes the impact of Networked Information Economy (a term coined by Yochai Benkler) not only in economics but also in social, cultural, and political fields. This chapter is largely based on

Benkler's book titled "Wealth of the Networks". The benefits of Networked Information Economy on social welfare are critical to the Network Neutrality and must be included in the debate.

The fifth chapter finally focuses on the opinions of debaters and analyzes at least one work from each of the cited scholars. This chapter also includes an analysis of competition in the last mile, innovation, infrastructure and vertical integration concepts with respect to Network Neutrality.

In addition, the fifth chapter analyzes proposals by Yoo, Wu and Atkinson and Weiser. Yoo's proposal is based on Network Diversity and does not encourage any kind of Network Neutrality regulation. Atkinson and Weiser focus on government backed general broadband policy and Wu proposes a Network Neutrality regulation based on Internet freedoms and vertical integration in the last mile.

At the end, I list 5 points which should be the fundamental considerations in this debate. I believe that it is not possible to have a healthy debate without considering these points.

The debate is complicated because of the dramatic impact of networks, mainly the Internet, on people's lives. Therefore, concepts like innovation, decentralized networks, social and political aspects are analyzed

throughout the chapters to emphasize their importance along with economic concerns.

This essay is by no means a complete Network Neutrality Opinions guide. Although the essay attempts to analyze a wide variety of authors and papers, it is not large enough to include all of the desired details and all of the essays. Thus, all interested parties are highly encouraged to further read works about Network Neutrality debates*.

---

* For example, Jonathan Zittrain's *the Generative Internet* and Yoo and Spulber's *On the Regulation of Networks as Complex System* are not analyzed in this essay.

2) Developments in Technology

a) Telephone Networks History

Alexander Graham Bell received patent number 174,465 on March 7, 1876 for Improvement in Telegraphy or what we currently refer as the telephone [1]. This device, which is used to pass voice over copper wires, had tremendous impact on the human history by enabling geographically distanced people to talk to each other instantaneously.

Initially, all telephone calls needed to be connected to a central location where an operator would answer the phone. The caller would tell the operator where s/he would like to be connected and the operator would then direct his/her call to the appropriate party. However, not everybody was happy about the involvement of the operator for directing calls.

Almon Brown Strowger, originally from Penfield, NY, worked as an undertaker in Kansas City. He was convinced that the operators were intentionally directing business calls to his rival. Rumor goes that one of the operators was the wife or cousin of his rival and all of the business calls would be directed to Strowger's rival. This or some other reason led Mr. Strowger to invent the first electromechanical telephone switching system using rotary dials in 1891 [2]. The new switching system allowed the users to call the desired party without being connected to the operator who could

discriminate traffic. The invention of electromechanical switch by Strowger may be the first event in the modern telecommunications to enforce Network Neutrality.

There have been various changes over the years in the telecommunications world since the invention of the electromechanical switches. The phone industry migrated from electromechanical to electrical and then to digital switches [3]. Although the technology in the telecom has changed dramatically, "intelligence" or the ability to deliver services and make decisions always stayed on the network side. The telephones, mainly analog, were "dumb" and provided basic features like ringing, dialing and passing voice with the help of the network.

In the 1980s, the ISDN (Integrated Services Digital Network) was deployed in various countries [4]. Even though ISDN phones were more "intelligent" than their analog counterparts, the main "intelligence" still resided in the network. The network or the switching systems would provide all of the services ranging from billing to connecting calls to interpreting digits.

Signaling System # 7 (SS7) further increased the intelligence of the network by deploying Service Switching Points (SSP), Signaling Transfer Points (STP) or Service Control Points (SCP). These points are connected

through various links and the network provides various features ranging from caller name to the Local Number Portability to toll-free services. SS7 is still heavily used in various parts of the telecommunications world for wireless and wireline carriers and it is a network centric protocol.

Since the invention of telephone and electro-mechanical switches, the networks have played a major role in the telephony world. The "intelligent" network has provided services to the end "dumb" devices. The intelligence has resided on the network rather than the end devices. However, the end-to-end design of the data networks has changed this fact.

b) Data Networks History

In order to gain a technological lead during the cold war years, the United States launched the Advanced Research Projects Agency (ARPA, later known as the Defense ARPA or DARPA) in 1958 [5]. The purpose of this project was to create a robust and redundant network that can sustain losses and allow communication between researchers. Paul Baran, one of the developers of packet switching, recommended packet switching for this network to make it redundant and robust. In 1969, the first node of the ARPANET went live as the predecessor of the Internet [5]. The network allowed the sharing of links due to its packet based architecture and it allowed various computers to communicate on the network. The network kept growing to include more universities and eventually started to be used by the general public [5].
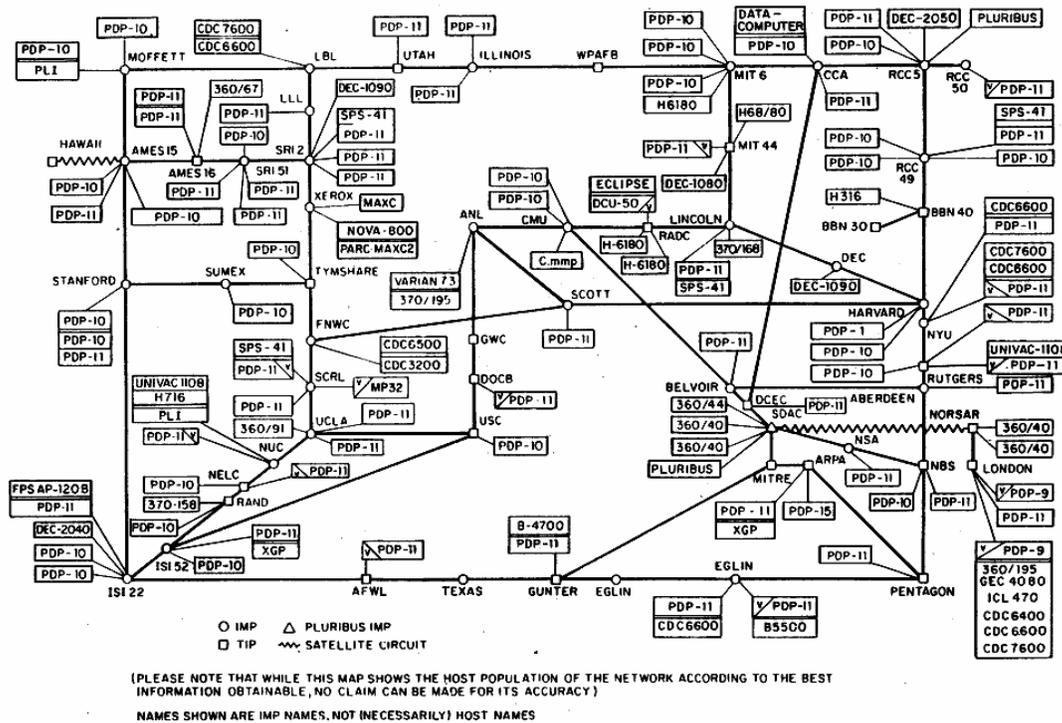
ARPANET Map, 1977 [5]

The invention of TCP/IP further increased the number of computers that are connected to the Internet. Since Transmission Control Protocol (TCP) provides reliable communications, the quality of the communication improved.

Today, there are millions of computers connected to the Internet and the speed of connection is constantly increasing. While a 56 Kbps modem might have been considered fast in the late 1990s for end users, today Mbps or Gbps connections are considered normal today. Nevertheless, the main task of the data network did not change much. The purpose of the

network is to analyze the packets and move them from one location to another. All of the applications ranging from e-mail to instant messaging to voice communications are all handled by the end users. The network is fast but dumb and the end terminals are intelligent. Compared to the telephony world, the intelligence has shifted from the network to the end terminals.

The shift of intelligence towards the end terminals is the outcome of the end-to-end design. The benefits of end-to-end design were proposed in 1981 where the role of the network was considered minimal [6]. The End-to-end principle states that the network's job is to pass along the information without any kind of discrimination where one application may be favored over another. The end-to-end design, which empowers the end users rather than the network, is credited by many scholars who are addressed in section 5 as the main reason for the unprecedented success on the Internet.

c) Time Sensitive Data

The idea of using only one network for voice and data rather than having two separate networks has surprisingly been in existence for almost thirty years. Interestingly, Network Voice Protocol (RFC 741) has been written to provide high quality, low bandwidth, and secure voice over the data network as early as 1977 [7]:

Currently, computer communication networks are designed for data transfer. Since there is a growing need for communication of real-time interactive voice over computer networks, new communication discipline must be developed. The current HOST-to-HOST protocol of the ARPANET, which was designed (and optimized) for data transfer, was found unsuitable for real-time network voice communication. Therefore this Network Voice Protocol (NVP) was designed and implemented [7].

NVP never became widely used and telephony networks continued carrying voice successfully for many years. Data networks continued to expand over the years and the idea of deploying real time data like voice or video was resurrected in the mid 1990s.

Although TCP is a great protocol for data applications, real time applications like voice and video cannot solely depend on TCP/IP for successful deployment because the requirements for time sensitive and non-time sensitive data are different. Successful deployment of the time

sensitive data like voice, require low delay and low jitter (the change in delay). If these criteria are not met, real time data applications like Voice over IP (VoIP) are basically useless. On the other hand, non-time sensitive data applications like e-mail, web browsing, and file transfer can tolerate high delays in the networks.

In order to provide low delay and low jitter for real time applications, network support is needed via priority mechanisms which would allow the voice packets to go ahead first in the case of congestion. Unlike end-to-end design that usually does not need the support of network beyond providing transport, real time applications need extensive help of the network to provide Quality of Service (QoS).

The need to provide Quality of Service with the assistance of the network is at the heart of Network Neutrality debates. The real time communications needs the support of the network to provide QoS while creating a more intelligent network (the one that can prioritize or discriminate traffic) may jeopardize the success of the end-to-end design which does not depend on the network beyond transportation.

3) Developments in Policy

a) Telecommunications Act of 1996

Since 1934 The Telecommunications Act of 1996 has been the most comprehensive act in the telecommunications world. Concerning Network Neutrality, there are two services in the Act: Information and Telecommunications services. Information services can be considered as data applications like e-mail, web browsing and even television services, while telecommunications services can be considered as telephony services.

In the Act, Telecommunications services are heavily regulated while Information services are lightly regulated. In fact, a search for the word "Telecommunications Services" would result in 65 hits while a search for the word "Information services" would result in 16 hits [8]. This fact demonstrates the attention given to the Telecommunications services over Information services. One can also speculate that the regulations that could inhibit the expansion of the Internet were not introduced at the time when the Internet was in its infancy.

According to the Telecommunications Act, telecom carriers have the duty of interconnecting directly or indirectly with other telecommunications carriers. During the time of the Act, only the telephone companies offered

voice services. As of today, cable providers and even companies such as Vonage, which do not own any infrastructure, provide voice services. The phone companies wanted these restrictions to be extended to the other companies which offered voice services, but the U.S. Supreme Court did not agree.

The U.S. Supreme Court's FCC vs. Brand X decision determined that cable companies are not telecommunications carriers and thus are not subject to the telecommunications regulations. In this case, this specifically meant that cable companies do not have to interconnect or open their network to Internet Service Providers (ISP) like Brand X [9]. The FCC argued that by keeping the cable companies from sharing their networks with others, broadband expansion would be faster and benefit the customers in the long run. This is a clear sign of FCC's full commitment to the broadband expansion in the U.S.

Another significant event in which the FCC intervened is the Madison River ISP decision. Madison ISP offered both telephony and DSL service to its customers. However, some of its DSL customers decided to use a rival voice service from Vonage. This meant that Madison ISP would lose some of its customers that were using its traditional analog lines. In 2004, North

Carolina ISP Madison River blocked their DSL customers from using rival VoIP services.

FCC, acting on a complaint from Vonage which is the provider of VoIP service, intervened and reached an agreement with the ISP requiring it to stop blocking VoIP calls and make a "voluntary payment" of $15,000 [10].

b) FCC

As can be seen in the aforementioned example, the FCC intervenes whenever it sees a threat to the expansion of the broadband. However, this expansion cannot be at the expense of the consumers' Internet Freedom. Actually, the former chairman of the FCC, Michael Powell, challenged the broadband providers to respect Consumer's Internet Freedom in a speech given in 2004 in Boulder, Colorado [11]. He listed four freedoms that customers have come to expect and challenged the broadband providers to follow these principles.

(1) Freedom to Access Content.
First, consumers should have access to their choice of legal content. Consumers have come to expect to be able to go where they want on high-speed connections, and those who have migrated from dial-up would presumably object to paying a premium for broadband if certain content were blocked. Thus, I challenge all facets of the industry to commit to allowing consumers to reach the content of their choice. I recognize that

network operators have a legitimate need to manage their networks and ensure a quality experience, thus reasonable limits sometimes must be placed in service contracts. Such restraints, however, should be clearly spelled out and should be as minimal as necessary. [11]

(2) Freedom to Use Applications.

[C]onsumers should be able to run applications of their choice. As with access to content, consumers have come to expect that they can generally run whatever applications they want. Again, such applications are critical to continuing the digital broadband migration because they can drive the demand that fuels deployment. Applications developers must remain confident that their products will continue to work without interference from other companies. No one can know for sure which "killer" applications will emerge to drive deployment of the next generation high-speed technologies. Thus, I challenge all facets of the industry to let the market work and allow consumers to run applications unless they exceed service plan limitations or harm the provider's network. [11]

(3) Freedom to Attach Personal Devices.

[C]onsumers should be permitted to attach any devices they choose to the connection in their homes. Because devices give consumers more choice, value and personalization with respect to how they use their highspeed connections, they are critical to the future of broadband. Thus, I challenge all facets of the industry to permit consumers to attach any devices they choose to their broadband connection, so long as the devices operate within service plan limitations and do not harm the provider's network or enable theft of service. [11]

(4) Freedom to Obtain Service Plan Information.

[C]onsumers should receive meaningful information regarding their service plans. Simply put, such information is necessary to ensure that the market is working. Providers have every right to offer a variety of service tiers with varying bandwidth and feature options. Consumers need to know about these choices as well as whether and how their service plans protect them against spam, spyware and other potential invasions of privacy. [11]

The four freedoms that are listed are very important for the Network Neutrality debate and many proponents of Network Neutrality regulation like Wu and Lessig used these principles in their arguments [12, 13].

Currently, Kevin J. Martin is the chairman of the FCC. He is not a pro-regulation person and hopes that the cable telephone companies will not discriminate. He states that if the telephone and cable companies continue to follow the principles that are addressed above, there would not be a regulation required [14]. Interestingly, Kevin Martin's statements are used by Christopher Yoo to oppose Network Neutrality regulations [15] and Powell's words are used by Wu and Lessig to support Network Neutrality regulations [12,13].

4) Networked Information Economy

a) Social Production

Yochai Benkler defines two types of information economies: Industrial Information Economy and Networked Information Economy [16]. The Industrial Information Economy refers to the information economy that has been occurring in the last 150 years. The most distinctive character of this economy is the centralization of power and distribution. In order to be a player in this type of economy, one needs substantial capital investment. Benkler states:

In the industrial economy in general, and the industrial information economy as well, most opportunities to make things that were valuable and important to many people were constrained by the physical capital requirements of making them. From the steam engine to the assembly line, from the double-rotary printing press to the communications satellite, the capital constraints on action were such that simply wanting to do something was rarely a sufficient condition to enable one to do it [16].

The average person did not have the financial means to be involved in the industrial information economy. However, the declining cost of the computation, communication and storage enable the average person to be involved in the information economy [16]. As the financial and technical burdens on the end users decreased dramatically, a new kind of information exchange started to occur. The consumers now would become users where they would be able to choose what they want to follow rather

than being fed a generic message that would usually come from television. The end users can now create their own content or modify other content and be actively involved in the production of information.

In the last decade, we have seen the Internet Revolution spreading to the whole world. As more and more people can connect to the Internet, a new kind of social production is developing. This social production can be characterized by [16]:

1) Non-proprietary production
2) Non-market production
3) Large scale collaboration

Non-proprietary production, also referred to as open source software, allows the end users to modify any portion of the software for their own use as long as they publish the results with the same license. Ubuntu, an operating system based on Linux, is an example of such a non-proprietary production.

Non-market production allows the end user to engage in activities that do not necessarily provide financial incentives. Such production occurred for hundreds of years, but now many members of the community can actively participate even more because of ease of access. The rise of websites like sourceforge.net which offers thousands of free software programs is clearly outside of the market production.

Large scale collaboration is the driving force behind the development of the products of the Networked Information Economy. People from all over the world cooperate to create various open source software programs and websites like Wikipedia. In the case of Wikipedia, the cooperation of the masses regardless of their education or background is so effective that the outcome of this cooperation would even compete with organized structures that can include subject matter experts.

Nupedia, the predecessor of Wikipedia, was a web-based encyclopedia whose articles were written by experts and licensed as free content. It was founded by Jimmy Wales, the person who founded Wikipedia. Nupedia had an intense editorial process which included mainly true experts who possessed PhDs. However, Nupedia could not achieve success because it was slow and Wikipedia became far more popular as a choice of a web-based encyclopedia [17].

Wikipedia, like Nupedia, allows editors to contribute and it is also licensed as free content. The main difference between Nupedia is the fact that the editors are not required to have any kind of degree. Anyone can edit this editorial; however, only referenced works can stay permanently.

One can ask the question of how accurate an encyclopedia can be in an environment where anyone can edit the content. The journal *Nature*

compared 42 science articles from *Wikipedia* to the gold standard of the *Encyclopedia Britannica*, and concluded that *"the difference in accuracy was not particularly great"* [17].

There are other examples of such large scale collaboration ranging from Mozilla's FireFox web browser to SETI@Home to Linux. The Networked Information Economy enables the participation of a significant portion of the world population for social production.

b) Individual Freedoms

Emerging networks have the potential of increasing individual autonomy in various ways. First of all, individuals are not subject to the large investments that were required to create or access the information. This allows individuals to do something for themselves or by themselves. For example, an individual can create a website that is literally available worldwide. Individuals can access to the ideas across the Internet within seconds.

Individuals can create productions that will be only related to their immediate surrounding but still be accessible all over the world. For example, one can create his/her own family tree in Turkey and that tree can

be accessed from U.S. As Benkler [states, individuals have the necessary tools to be effective in the information world [19].

Secondly, the extent of non-proprietary communication alternatives decreases the influence of traditional communication methods on users. For example, television's passive listeners are turning into active users of emerging networks. The non-proprietary aspect of these communication alternatives allows the users to modify the communication method as they desire.

Thirdly, networked information economy makes a diverse range of information available to the users. The availability of these ideas increases an individual's ability to follow or reject these ideas. Such variety of ideas cannot be found in mass media where the purpose is to deliver a generic message that is somewhat relevant to the consumers.

Davinci Automata* blog is an example of how the Networked Information Economy increases individuals' autonomy. Davinci Automata is a blog on the Clockpunk genre of Science Fiction. It is designed for a segment of the population that is interested in this genre; thus it makes diverse information available to individuals. The owner has the open source tools to customize the blog as he wishes. The readers get turned into users by leaving comments or even submitting their work to be posted in this blog.

---

* http://davinciautomata.wordpress.com/

c) Political Freedoms

In order to appreciate the value of political freedom, we first have to look into the existing relationship between media and politics. Mass media and modern democracies coevolved throughout the twentieth century [20]. One of the problems with the mass media is the fact that it sees the readers as consumers. The stream of information is usually one way and a generic message that would offend the least amount of people is published. The commercial concerns are always existent in the mass media.

As the Networked Information Economy increases its impact, we see some changes in this pattern. Now the individuals are able to take a position in the Internet public sphere. Since the cost of being a speaker is very little to none, the messages can be shared without commercial or political concerns. This is actually part of the claim that the Internet democratizes. The end users have the ability to choose and ignore the messages that they want [20].

The end users can now participate in the information processing, analysis of certain events that could have stayed obscure because of the expensive resources in the Industrial Information Economy like the Diebold Case.

Diebold Case:

A great example of the political power of networked information economy is the Diebold case which focuses on the generative capacity of the newly emerging networks. Diebold is one of the leading manufacturers of the electronic voting machines in the world. Bev Harris, an activist who focuses on electronic voting machines, received a tip through her website blackboxvoting.com. She found a link to a publicly available website that included all of the files that described the working of the electronic voting machines [21].

She pointed out that being able to access this site could have compromised the integrity of the election results in Georgia in 2002. Surprisingly, mass media did not show interest to this news. However, the editors of Scoop, an online journal in New Zealand, published the links for these files on their website and encouraged the readers to copy the content on their own computers in case it becomes inaccessible in the future. In addition, they provided tools to unzip (uncompress) the documents easily and repair the compressed files. It was reported that the data is not completely analyzed and their may be further security flaws in the system [21].

The trend in this example was:

1) Distribute the data for all to see it (no cost for being a speaker).
2) All were provided tools to [receive the data in its integrity (easier access to information).
3) Forums were created for analysis and scooping (social collaboration).

Meanwhile, someone provided thousands of internal e-mails that came from Diebold to Wired magazine. Wired magazine did not publish these e-mails; however, Bev Harris received the same e-mails as well and she published them. Diebold threatened litigation and the e-mails were removed from her site. However, the e-mails were already copied by two students at Swarthmore College in Pennsylvania. These students distributed the data in the peer-to-peer networks like eDonkey and Bit Torrent. Although the students were threatened with infringement of copyrights, the court decided otherwise [21].

The e-mails revealed that, through the analysis of some individuals without any direct financial motives, Diebold patched or updated the machines in California after their certification. Someone in the California Voting System Panel became aware of these e-mails and brought it to the attention of the Voting System Panel. Upon this information, Voting System Panel decertified many of the Diebold machines installed in California.

The importance of this case is that a group of individuals who may never have met in person in their lifetime were able to access, distribute, analyze a certain amount of data, and present their findings to the rest of the

community. Commercial or even legal concerns did not stop individuals from presenting their findings. The empowered individuals' action led to the decertification of certain voting machines.

d) Cultural Freedoms

Networked Information Economy contributes to cultural freedoms in two ways:

1) The individuals can easily express their culture

2) The impact of market based production is none to little in cultural production

Firstly, individuals can express their own cultures. For example, one can create a website that focuses on Sufism in the Second Millennium in Anatolia while another can focus on folk songs in Kazakhstan. Contributors can create their own websites or blogs and relay the message directly to the readers without the involvement of a third party.

Secondly, the individuals can express their own cultures without being influenced by market production because the cost of presenting such cultural information is almost none; the cultural expression is not bound by capital expenditures. Therefore messages are not shaped by commercial concerns and act outside of the market sphere.

On the other hand, Hollywood and the recording industry rightfully worry about the financial concerns. Ultimately, they try to create works that make the most profit for their companies and they [have to be extremely careful of the message that they give in their works. A message that is perceived in a wrong way by the masses can create a backlash for their companies and negatively impact financial considerations [22].

Networked Information Economy gives power to the individuals to express their cultures easily without being bound by the prohibitive cost of developing material. Networked Information Economy allows the spread of diverse cultures that could not be distributed within the market framework because the small but unique audience of these cultural works may not yield financial gains.

e) Justice and Development

There are two fundamental benefits of the Networked Information Economy in justice and development around the world.

- *"Development: Countries or societies have access to the basic needs like food to survive and education to develop,*
- *Justice, meaning that humans in a society will have somewhat equal opportunity to contribute and benefit to the developments."* [23]

The spread of the products that arise from social production towards the world body allow poor countries to develop themselves. The chart below

shows the importance of having the ability to access information and its impact on the human development index (HDI).

- Food security
- Medicines
- Health care
- Research & journals
- Outcomes data

- Books, teaching materials
- Computation/communication
- Libraries
- Academic centers: journals

Health/ Life expectancy

Education/ Literacy

funding   human capital

labor   nutrition
          medicines   GDP per capita
                       → Growth

- Growth driven by innovation & information everywhere
- Particularly for latecomers

HDI and Information [23]

HDI consists of life expectancy at birth, adult literacy, and GDP per capita. Life expectancy is affected by adequate nutrition and access to the life saving pharmaceuticals. Biotechnological innovation for agriculture as well as the spread of best practices of medicine uses Networked Information Technology characteristics including mass collaboration, non-proprietary products, and non-market production. The outcome of these practices and innovations allow people to live healthier and longer.

Education is heavily dependent on access to materials such as textbooks, libraries and computers. GDP is driven by innovation and being able to live a healthy life and access to educational material is the basis of innovation.

Following are some examples that contribute to the development arount the world.

Software: The development of open source software, the publicly available specs of the Internet Engineering Task Force's (IETF) for the Internet and the services that do not depend on proprietary methods are already taking place as part of the Networked Information Economy [23].

The development of open source software allows the developing countries to benefit from low cost alternatives that perform well. This allows the masses to benefit from developments that are occurring worldwide.

Scientific Publication: One of the emerging scientific publications methods is similar to the open source architecture. Arxiv.org contains a copy of the working papers in physics, mathematics, and computer science which are available to the general public. Another example of scientific publication is the Free High School Science Texts (FHSST) project that has been developed for South Africa. MIT's Open Courseware initiative makes

public thousands of notes. Syllabi from courses at MIT is successful proof of the impact of Networked Information Economy on scientific publication [23].

Agriculture: There are promising developments like PIPRA (Public Intellectual Property for Agriculture) that combines the efforts of public universities and "*agricultural research institutes aimed at managing their rights portfolio in a way that will give their own and other researchers freedom to operate in an institutional ecology increasingly populated by patents and other rights that make work difficult*" [23].

BIOS, an initiative by a non-profit in Australia, is focused on making publicly available tools and technologies used in agriculture. BIOS has a license similar to the General Public License of Linux, where anyone who builds upon the contributions of others must contribute improvements back to the other participants [23]. Like open source, the participants do not have to come from academic institutions or traditional government organizations and the general public can benefit from these licenses.

f) Economics

IBM's business model is an excellent example of a strategy based on non-exclusivity. The firm has obtained the largest number of patents every year from 1993 to 2004, amassing in total more than 29,000 patents. IBM has been one of the firms most aggressively engaged in adapting its

business model to the emergence of open software. Figure 2.1 shows what happened to the relative weight of patent royalties, licenses, and sales in IBM's revenues and revenues that the firm described as coming from Linux services.
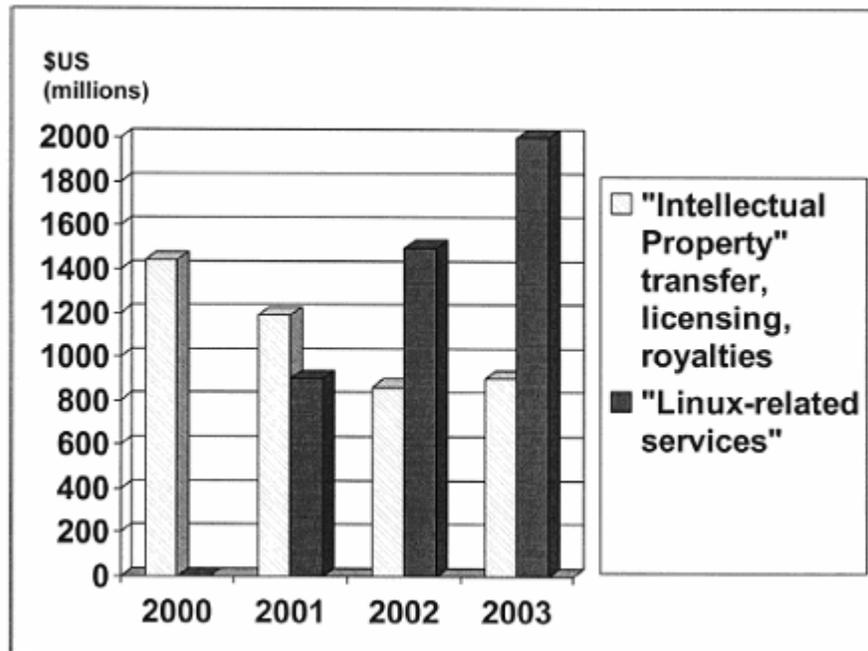
Selected IBM Revenues [24]

Within a span of four years, the Linux-related services category moved from practically no revenues, to providing double the revenues from all patent-related sources. IBM has described itself as investing more than a billion dollars in free software developers, has hired programmers to help develop the Linux kernel and other free software; and has donated patents to the Free Software Foundation. This helped IBM to provide better

operating systems for its server business— making the servers better, faster, more reliable, and therefore more valuable to consumers. Participating in the free software development has also allowed IBM to develop service relationships with its customers, building on free software to offer customer-specific solutions. In other words, IBM has combined both supply-side and demand-side strategies to adopt a non-proprietary business model that has generated more than $2 billion annually for the firm [24].

Networked Information Economy is a reality and keeps evolving. The growth of this economy is at times outside the scope of Industrial Information Economy but sometimes complements or replaces the Industrial Economy. Networked Information Economy will not completely replace the Industrial Information Economy but as said it will compete in certain areas. The only question is how much this growth will be assuming that the current environment does not change.

Network Neutrality regulation is critical for the development of Networked Information Economy. End users enjoyed an environment where they did not have to ask permission from the networks owners to contribute to whatever they wanted to. End users' applications were not discriminated against because they are not commercially viable. Network

Neutrality Regulation is seen as a protection that would preserve the current environment where end users enjoy great autonomy which allows them to contribute and benefit from the Networked Information Economy.

5) Works on Network Neutrality

Network Neutrality debates take place in the academia. This chapter focuses on the works of scholars who defended or opposed Network Neutrality Regulations.

1) Christopher Yoo
a) Beyond Network Neutrality Essay

No Clear Competitive Harm

Yoo* focuses on the no clear competitive harm principle to show that Network Neutrality regulations are not justified. Yoo states that: *Fortunately, competition policy offers a potential way out of this analytical limbo. It suggests that when policymakers cannot determine whether a new*

institutional form would help or hinder competition, the proper response is non-regulation until a practice is shown to affect a concrete harm to competition. Forbearance from either forbidding or mandating any particular solution leaves room for the experimentation upon which markets depend… [10].

Not So Neutral Network

Yoo further states that networks are not neutral since most of the Internet is based on the TCP/IP protocol, time-sensitive packets like voice or video are performing poorly compared to the non time sensitive data like e-mail or text messages. He also states that installing Network Neutrality will forestall the realization of economic benefits from the marketplace because it will prevent the generation of those benefits [10].

Consequence of Regulation

Yoo states that Network Neutrality can lead to market failures*: "For example, Network Neutrality can exacerbate the impact of up-front, fixed costs and network economic effects, which are the most commonly identified sources of market failure that justify the regulation of*

* Associate Professor of Law, Vanderbilt University Law School.

telecommunications markets" [10]. Yoo states that the competition in the last mile is basically a duopoly and increasing the competition in the last mile can be a remedy for Network Neutrality. However, regulation attempts may actually create a market failure in the last mile competition which might be the remedy for neutrality.

b) Network Neutrality and the Economics of Congestion Essay

Club Goods

Yoo discusses the Club Goods concept that he has inspired from Nobel laureate James Buchanan. Club goods are goods that can be shared by more than one person; however they are not public goods. The increased usage of these goods by some members of the "club" deteriorates the experience of other members.

One of the primary issues that have emerged in the literature is whether a club should charge a single flat-rate price for membership or whether it should charge a price that varies with usage. Yoo states that flat rate pricing results in excessive consumption of club resources, which eventually leads to deteriorated service for the members [15].

Vertical Integration

Yoo states that vertical integration is a viable option that the network providers should be allowed to practice. A proposed Network Neutrality regulation may inhibit the usage of vertical integration. He further argues that the Supreme Court's view on vertical integration has been initially negative but now the Court is more hospitable towards competition among vertically integrated enterprises [15].

Yoo points to the other factors besides economic congestions for the Network Neutrality debates. He believes that allowing *"network owners to differentiate the services they offer, exclusivity can play a key role in mitigating the sources of market failure that require regulatory intervention in the first place"*.

Wrong Basis

Yoo states that the supporters of the Network Neutrality use irrelevant examples from the past as their basis for argument. He indicates that using classic telecommunications precedents such as Hush-a-Phone Carterfone, and the Computer Inquiries ignore the fact that those decisions arose during an era when in which local telephone companies represented the only available means of transmission and in which the traffic consisted

solely of person-to-person communications. Network providers have less power today and they may not be involved in such practices [15].

FCC

Yoo states that the FCC intervenes whenever it sees an anti-competitive practice that may inhibit the users from accessing the best services. He gives the example of Madison River ISP, where FCC intervened after the ISP blocked VoIP traffic. He is against a "*blanket prohibition of any restrictions on end users' ability to access content, run applications, or attach devices*" [15].

c) Yoo's Network Diversity Proposal

Professor Yoo explains in detail his alternate solution, Network Diversity. He believes if the producers specialize in one way, they will not be threatened by carriers which are trying to offer the same products. He gives the example of specialized stores that are surviving despite competition from low-cost mass market discounters. He further offers three different network types for markets.

1) Traditional Internet Application Network for e-mail and website access

2) Enhanced access with protection from viruses and spam

3) Time sensitive Internet for voice and video

He believes that if the network diversity were to be embraced, it would be better for the public policy because network diversity would provide product variety and be involved in the supply and demand side of the economics [10].

2) Timothy Wu

a) Network Neutrality, Broadband Discrimination Essay

Does Discrimination Occur?

Wu* produces results of a study he conducted on the contractual restrictions that were defined by different cable and phone companies in 2002. As seen below, cable companies imposed more restrictions than the phone companies. More importantly, some cable companies restricted the usage of VPNs, attaching of WiFi equipment or even home networking.

---

* Associate Professor of Law, University of Virginia Law School.

RESTRICTION	CABLE	DSL
Using a Virtual Private Network	10%	0%
Attaching WiFi Equipment	10%	0%
Making the Connection a Network End Point	10%	0%
Using Home Networking	40%	0%
Misusing IP Addresses	60%	0%
Any Commercial or Business Use	100%	33%
Operating a Server or Providing Public Information	100%	33%
Overusing Bandwidth	100%	33%
Reselling Bandwidth or Acting as an ISP	100%	33%
Conducting Spam or Consumer Fraud	100%	100%
Hacking or Causing Security Breaches	100%	100%
Any Unlawful Purpose	100%	100%
Any Offensive or Immoral Purpose	100%	100%

Restriction of Broadband Providers on End Users [25]

Few people who would argue that the spam, unlawful, offensive or immoral actions should not be restricted. Nevertheless, there would be many people who would be against the restrictions on VPNs or Wifi equipments.

Is the Threat of Regulation Good?

Wu argues that threat of regulation may be good for the industry. He states that the regulatory threat in 2003 pushed *"Comcast and Cox Communications to openly disavow their old practices of placing bans on Virtual Private Networks, and fill documents with the FCC to that respect. Cable industry furthermore begun to publicly insist that it wants to avoid*

broadband discrimination in the future, stating, for example, that "Cable

Believes in Open Connectivity for the Internet." [25].

Why might thinking in discrimination terms be useful?

Wu argues that discrimination is a familiar method that is used to achieve

new goals. He gives an example in the employment context where the

employers have the freedom to "*fire or refuse to hire where the individuals*

for a range of reasons, such as education-level, intelligence, and

demeanor." However, the employer cannot use race, sex, religion or

ethnicity as a discriminatory tool. Wu continues to talk about two kinds of

discrimination.

Good Discrimination

This kind of discrimination bans activities that may hurt the network. For

example the usages of spam or viruses are harmful for the network and

should be banned. Wu understands that this is a departure from Network

Neutrality but the network needs to be protected against harmful

application. He states that "*few could or would argue that this is a bad*

thing."

Bad Discrimination

The bad discrimination would be an unjustified one and would cause harm to the users. He gives the hypothetical example of banning chat programs because they may be perceived as a waste of time. He continues that such discrimination would first harm the chat users. However, there would be some negative externalities that are produced with this ban such as:

1) The impact on applications programs like Aimster, which use chat programs as middle ware.

2) Some people may not want to have broadband without chat programs.

3) Positive Social Externalities such as scheduling a meeting, not bothering people on the public places by talking on the phone would be affected.

Wu concludes: *"there are considerable potential costs from an irrational or unjustified ban on certain application types."* [25]

Why Do Operators Discriminate?

Wu argues that there are two reasons for the regulators to discriminate.

1) *Price Discrimination:* This is to exclusively offer some services that other market powers offer.

2) *Bandwidth Management:* This is to reduce the amount of bandwidth that has been used by certain users.
Wu argues that it might be good idea for operators to offer various levels of bandwidth, thus making a less-restrictive discrimination.

Open Access as a Means for Network Neutrality?

Wu questions whether Network Neutrality can be accessed through Open Access models. Open Access in the context of networks would mean that network providers would open up their networks to the incumbents. Wu argues that the *"proponents of open access have generally overlooked the fact that, to the extent an open access rule inhibits vertical relationships, it can help maintain the Internet's greatest deviation from Network Neutrality."* Such favoritism means the support of data applications over delay sensitive applications like voice or video. Imposing open access models can prevent the network owner from offering low latency applications which need the support of the network. He concludes that, "*There is also reason to believe that open access alone can be an insufficient remedy for many of the likely instances of network discrimination*" [25].

Network Neutrality Regime

Wu argues that that *"the basic principle behind a network anti-discrimination regime is to give users the right to use non-harmful network attachments or applications, and give innovators the corresponding freedom to supply them. Such a regime avoids some of the costs of structural regulation by allowing for efficient vertical integration so long as the rights granted to the users of the network are not compromised."* [25].

b) The Broadband Debate, A User's Guide Essay

In this essay, Wu categorizes the opponent and proponent of Network Neutrality regulation as Openists and Deregulationists and further breaks down their arguments [12].

Openists

1) Infrastructure

Openists believe that the Internet is a public infrastructure. Thus the principal value of the network is indirect: it as a source of positive spillovers, or externalities that enable the work of others. Openists suggest that the value of the network would be achieved by those who use it rather than those who deploy or own it [12].

2) Neutrality Principle

Openists believe that communications infrastructure must not discriminate between uses, users or content. Wu quotes the FCC commissioner Michael Copps: *"From its inception, the Internet was designed, as those present during the course of its creation will tell you, to prevent government or a corporation or anyone else from controlling it. It designed to defeat discrimination against users, ideas and technologies"* [12].

3) End-to-end design

End-to-end design rejects centralized, planned innovation where the network drives the progress. End-to-end design brings nearly unlimited end points which contribute to the innovation. Wu says: *"The e2e principle assumes that innovation is an evolutionary process, driven by contests between competing approaches to a problem. For Openists, the e2e principle puts as many players in the contest as possible to ensure the true champion emerges"* [12].

Openists' example

"Openists point to the electrical grid and say it is successful precisely because we don't care about electricity as a product, but care instead about what the electric grid makes possible. It provides a standardized platform for the development of appliances that serve human needs, such as the hair dryer or DVD player. Sony and IBM do business safe in the assumption that American electricity will be predictable, standard provided without preference for certain brands or products."

The electric grid does not favor one electric appliance over another and no permission is needed on what to plug on to the network besides regulatory compliance such as UL [12].

Deregulationists

Wu breaks down the Deregulationists' position into three Principles.

1) Propertization Principle

This principle states that, *"any given resource will generally reach its best use when mapped out as property, and assigned owners."* The commons is a contentious issue because the owner of the commons is the public in general. Wu quotes Frank Easterbrook in "Cyberspace and the Law of the Horse: *"'we need to bring the Internet into the world of property law . . . without which welfare-increasing bargains cannot occur.'"* [12].

2) Incentive Principle

This principle states that, *"communication networks are expensive investments and that companies will only build when given the prospect of a reasonable return on investment."* Since the government does not fund the majority of the infrastructure investments, the private sector needs incentives to build networks. Although some aspects of the

Internet (like Internet addresses) may be a public good or controlled by a natural monopoly, in general the private sector needs incentives.

3) Deregulation Principle

Wu states that the deregulationists are always, *"suspicious of government regulations outside of the assignment of property rights."* Deregulationists believe more in the power of the network than the ideas that ride over it. Deregulationists believe that in the long term the private network owners will drive the next-generation of the Internet although in the short term it is the opposite.

Common Vision between Openists and Deregulationists

Wu states that both sides idolize innovation and with a few exceptions (Frischmann) worship at the shrine of economist Joseph Schumpeter and admire his concept of innovation as "creative destruction." So both sides believe that innovation is the principle driver of the economic growth. As seen above, both sides disagree where most innovation occurs. While Openists believe that innovation occurs at the end users, the Deregulationists believe that innovation occurs at the network. Actually, this is similar to the historical development of telephone and data networks where one was focused on the network while the other one is focused on the end users.

Critical of both sides

Wu criticizes both sides of the debates. First of all, he criticizes *"Openists for being too prone to favor regulation without making clear the connection between ends and means".* He gives the example of attempts to make open access mandatory by Openists.

He criticizes the Deregulationists for two reasons: *"First, the Deregulationists have overlooked the fact that limiting government, as they desire, sometimes requires government action"*. Secondly, he criticizes "*Deregulationists for an exaggerated faith in industry decision-making"*. [12].

As seen in Wu's broadband discrimination essay, the open access is not a remedy for the Network Neutrality debates and industry may discriminate unjustly [25].

Vertical Integration

Wu brings the vertical integration concept to the table because of the open access debates. As he previously criticized the open access as a remedy to the Network Neutrality debates, he quotes the proponents of vertical integration who say that vertical integration *"leads to important*

efficiencies" and *"broadband operators, even if vertically integrated, want to make their product as valuable as possible and can therefore be expected to provide their customers with wide access to content and services"* [12].

Wu eases the concerns for vertical integration stating that even *"a monopoly platform owner may find it a bad idea to make everything vertically integrated"*. Nevertheless, there may be problems with Vertical integrations such as ''incompetent incumbents'' which do not realize the benefits of increased competition in the marketplace or other holes in the vertical integration [26].

Deregulationists' Objections to Network Neutrality Laws
(Do no harm) Primum Non Nocere
Wu states that Primum Non Nocere objection has problems which means if there is no clear harm, there should not be any regulation. He discusses *"it simply raises a question of dueling baselines. The existing design of the Internet is neutral. Why should it not be private entities who follow the principle of ''do no harm'' before monkeying with the proven strengths of the existing design? In this sense the slogan does nothing but restate an underlying difference in visions. "* [12]

He continues: *"Second, the objection relies on an anti-regulatory straw-man. Because it is possible to imagine a bad Network Neutrality law, any Network Neutrality regulation is suspect."* Network Providers do not want a Network Neutrality rule that would prevent them from entering the market. Wu states that there is no indication that the network providers would be excluded from the content market [12].

Yoo's Critisism

Wu criticizes Yoo in three different aspects:

1) Wu does not see any clear reason why a neutral Internet would cause problems in the last mile. He adds: *"Yoo seems to have it backward: if the neutral network is no good for certain applications, that would drive facilities-based competition, not inhibit it. Much of the cell-phone networks, for example, were built in the 1990s, and the Internet proved no barrier."*

2) Wu states that the proposed network diversity is already in our lives through mobile networks which prioritize voice and also offer data.

3) Wu criticizes *"Yoo's premise that vigorous competition at every layer is always better for the consumer is overstated. He downplays, to the point of elimination, the basic economic benefits of standardization... Most people in the United States speak a standard language, English. This undoubtedly*

leads to some sacrifice. We lose, for example, the precision of German; we

lack the Chinese vocabulary for food; and we lose righteousness and

occasional elegance of the French language. But few would argue that

vigorous and ongoing competition for a standard American language would

clearly serve consumer welfare. It would be, instead, the Tower of Babel."

[12].

Wu concludes with the following two questions: How valuable neutral

standards and networks are? When they are worth a loss in competition in

the network.

c) Wu's Network Neutrality Proposal

Wu proposes a Network Neutrality draft in his essay titled "The Broadband

Debate, A User's Guide" [12].

§ 1. General Right to Unrestricted Network Usage. Broadband Users have the right reasonably to use their Internet connection in ways which are not illegal or harmful to the network. Accordingly neither Broadband Operators nor the Federal Communications commission shall impose restrictions on the use of an Internet connection except as necessary to:
(1) Comply with any legal duty created by federal, state or local statute, or as necessary to comply with any executive order, warrant, legal injunction, subpoena, or other duly authorized governmental directive;
(2) Prevent physical harm to the local Broadband Network caused by any network attachment or network usage;
(3) Prevent Broadband users from interfering with other Broadband or Internet Users' use of their Internet connections, including but not limited to neutral limits on bandwidth usage, limits on mass transmission of unsolicited email, and limits on the distribution of computer viruses, worms, and limits on denial-of service-or other attacks on others;

(4) Prevent violations of the security of the Broadband network, including all efforts to gain unauthorized access to computers on the Broadband network or Internet;
(5) Serve any other purpose specifically authorized by the Federal Communications Commission, based on a weighing of the specific costs and benefit of the restriction.

It is worth noting that the following exception which was previously presented in a submission to the FCC has been taken out of this draft.

"Ensure the quality of the Broadband service, by eliminating delay, jitter or other technical aberrations." [28]

Actually, the draft which included the above exception has been presented to FCC along with Lawrence Lessig's draft in August 2003 [28].

3) Robert Atkinson and Phil Weiser

a) A "Third Way" For Network Neutrality

Atkinson* and Weiser** (A&W) analyze the reasons for heated Network Neutrality debates and relate it to the lack of competition in the last mile. They analyze the arguments of both supporters and opponents and propose their own solution which includes government incentive as a remedy to the debate [27].

Extreme Attempts

A&W focus on two bills in the congress that failed to pass regarding Network Neutrality. On the one extreme, the Barton Bill (H.R. 5252, "The

* Atkinson is President of the Information Technology and Innovation Foundation
** Weiser is an Associate Professor at the University of Colorado, where he has a joint appointment with the School of Law and the Interdisciplinary Telecommunications Program

Communications Opportunity, Promotion, and Enhancement Act") tried to limit the power of the FCC to regulate broadband providers. On the other extreme, the Markey Bill (H.R. 5273, "The Network Neutrality Act of 2006") would limit the broadband owners to provide and charge for higher quality of service. However, neither of the bills passed the congress [27].

Why debate is so heated in the U.S. ?

A&W believe the lack of competition on the last mile is one of the reasons for the heated debate in the U.S. They state that, *"unlike many other nations, such as France and Japan, which employed a "line-sharing" model (that facilitates multiple DSL competitors using the incumbent's copper local loop), the United States pursued a different strategy. The issue of net neutrality is largely moot in these nations because consumers in these countries enjoy both a greater level of competition and more bandwidth than in the United States."* [27]

Therefore, A&W believe that the Network Neutrality rules reflect a short-term solution in the absence of a longer-term imperative: more robust competition in broadband markets and the build-out of higher speed, best-effort data pipes.

Three Sides of the Debate

Transparency

"*This issue relates to how clearly broadband providers state the policies that govern the uses of their networks*". Although this subject did not get much attention yet, the broadband providers may need to clearly state their offerings and may need to meet some bandwidth requirements to use the term "broadband" for their networks.

Blocking

Network providers have the ability to block the content based on of its type and origin. As of today, as seen in the intervention of the FCC in the Madison ISP case, blocking – unless justified by a legitimate business purpose (such as protecting the network) — should be illegal.

Tiering

The two proposed regulations, the Barton and Markey Bills, were on the extreme side of the tiering. Barton Bill proposed unfettered rights to broadband providers to prioritize traffic and Markey Bill proposed a complete ban on all kinds of prioritizations.

Network Neutrality Supporters' Camp

A&W divide the discussion into two camps. Actually, they call them "*The End of the Internet As We Know It?"* Part I and Part II because both sides claim that regulation or no regulation will change the Internet as we know it. First of all, they cite Lawrence Lessig and Senator Ron Wyden who support Network Neutrality regulations. Lessig mentions the importance of the end-to-end design which is critical for *"the freedom and innovation that has characterized Internet to date*". Wyden supports a Network Neutrality agreement that would ban any kind of tiers of Internet service. Wyden is aware that such proposals would inhibit certain services that require QoS but he states that such a trade–off is warranted because *"[c]reating a two-tiered system could have a chilling effect on small mom and pop businesses that can't afford the priority lane, leaving these smaller businesses no hope of competing against the Wal-Marts of the world."*

Lessig and Wyden's concerns can be summarized as "innovation without permission" which also represents "the essence of the Internet."

A&W state that Wyden's approach overlooks certain concerns such as the incentive of network providers to deploy new networks. Network owners should be able to involve in vertical integration. A&W give the movie theater example: *"For movie theatre owners, for example, an effective and consumer-friendly price discrimination strategy is charging a*

high price for popcorn. By charging a high price, movie theaters are able to identify and serve consumers with sufficient discretionary income to buy popcorn. For other consumers, the high priced sale of popcorn subsidizes their ability to go to the movies" [27].

Network Neutrality Opponents' Camp

On this side, there are people such as Randy May who believe that Network Neutrality regulations similar to the one proposed in the Markey Bill can inhibit new investments by network operators. May argues that there is no need for Network Neutrality regulations because customers can change their broadband provider if one of the providers starts discriminating certain traffic [27].

A&W argue that there is not enough competition in the last mile that would allow the customers to change broadband providers easily. *"In terms of the state of competition, deregulatory opponents of any Network Neutrality regulation often maintain that competition between broadband providers is a sufficient check on the possibility of anticompetitive conduct. Unfortunately, the current reality of the broadband market is that in most local markets there are only two principal competitors—the incumbent telephone companies (with their DSL offering) and the incumbent cable companies (with their cable modem offering)"* [27].

b) Atkinson and Weiser's Proposed Model

A&W propose a model that would address the problems of Network Neutrality in the long run. As discussed before, their key elements are transparency, blocking, and tiering.

Their proposed model consists of three parts:

1) **Consumer Protection**: The broadband usage policies need to be clear. Once they are well understood by the customers, the FCC needs to monitor the broadband providers to make sure that they are complying. Broadband providers must offer some unmanaged broadband that should be delivered on the best effort basis.
   Broadband speed needs to be increased and those who do not meet that speed should not call themselves a broadband provider.

2) **Competition Policy**: The FCC should rely on Powell's four points. Broadband providers can offer QoS arrangements and interestingly can even block some content if necessary. The Clearwire example suggests that it is better to have competition in the last mile rather than having blocked VoIP content. The FCC should look at anti-competitive cases one by one; however, it is not certain whether the FCC has the power to perform such a task.

3) **Depreciation and Tax Incentives:** The broadband should be extended by depreciation and tax incentives. This can be done through depreciation of deployed networks and extension of the current moratorium on broadband related taxes.

4) Brett Frischmann

An Economic Theory of Commons and Infrastructure Management

Reframing Network Neutrality Debate

Frischmann* believes that the focus of the Network Neutrality debate needs to change. *"The Network Neutrality debate is not really about neutrality per se; nor is it about innovation alone. The debate must broaden its focus from the merits of sustaining an innovation commons to the merits of sustaining an infrastructure commons —that is, of sustaining open, public access to infrastructure. The debate ought to be about optimizing the Internet for society as a whole and it ought to take into account the full range of interests at stake."* [29].

Infrastructure

Frischmann refers to the infrastructure as a physical resource made by humans for public consumption. Examples can include (1) trans*portation systems*, such as highway systems, railways, airline systems, and ports; (2) *communication systems*, such as telephone networks and postal services; (3) *governance systems*, such as court systems; and (4) *basic public services and facilities*, such as schools, sewers, and water systems [29].

Frischmann then refers them as Traditional Infrastructures and states two generalizations about them. First of all, government plays a significant role in these infrastructures and secondly they are generally managed in an openly accessible manner. Open does not mean free as people pay for

* Assistant Professor of Law, Loyola University Chicago School of Law.

phone calls or pay for tolls on the highways. Open also does not mean unregulated as hazardous items are regulated for shipping or mailing. All of these infrastructures provide positive externalities ranging from helping people to go from home to work, connecting people via phone or e-mail or shipping life saving medications.

End-to-end Design and QoS

Frischmann is aware that end-to-end design may not be the best choice for the real time communications, but he states that QoS implementation would create a different kind of bias. *"Just as the current end-to-end design favors data applications at the expense of time-sensitive applications, shifting to a fine-grained QoS regime also may exhibit a bias for particular applications, specifically for commercial applications that generate observable and appropriable returns."* [29].

He believes that such bias would remove the insulation enjoyed by the end users because the network would discriminate against certain end user created applications.

Frischmann notices the pressure to make the Internet more centralized rather than more distributed as it is today. He believes that such pressure should be resisted and the Internet should be sustained as an infrastructure commons. There will be some costs related to it like poor or no QoS for real

time communications but this is necessary for the benefits of the infrastructure commons. The benefits are the positive externalities that are created on this infrastructure commons. One of them is innovation as discussed many times in this essay. However, Frischmann' focus on innovation is not limited to the observable market response because Frischmann states that: *"market competition judges the merit of outputs on the basis of observable and appropriable returns rather than on overall social welfare."* [29]

Internet

Frischmann states that the "*Internet is a mixed commercial, public, and social infrastructure" and* he believes *that* "*public and social aspects of the Internet infrastructure are largely undervalued in the current debate*". He expresses that "*bringing these aspects of the Internet into focus strengthens the case for preserving the end-to-end architecture of the Internet.*" [29].

Although it is very hard to measure the social value of the Internet, it is apparent that Internet changing the lives of people like other infrastructures but also in a very "rapid, widespread and dramatic fashion" [29]. This is similar to the comments made by Yochai Benkler about the Networked Information Economy [16].

The Debate for Net Neutrality is Myopic

Frischmann argues that the current debate is skewed because it focuses myopically on neutrality, competition theory, and innovation. Because much more is at stake than the current debate reflects, a new lens is needed. He summarizes his opinion with the following diagrams.
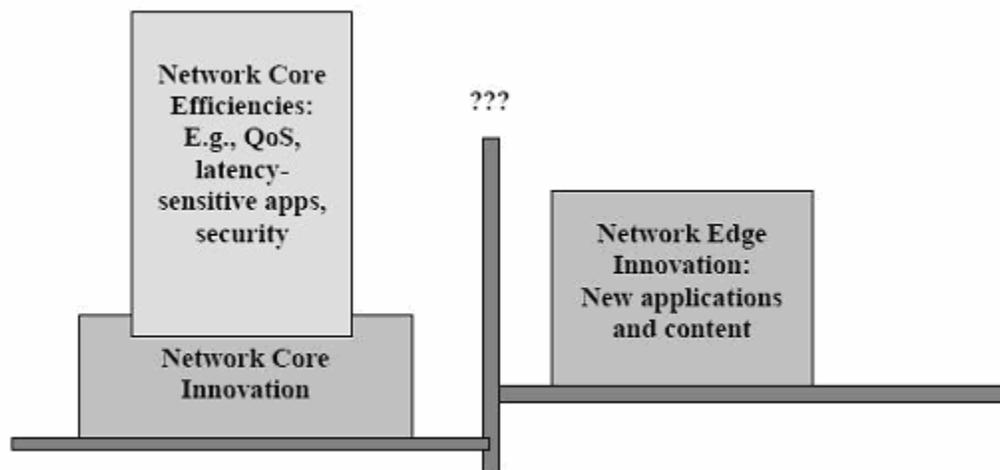
**Network Neutrality Balancing:
An Oversimplified View of the Current Debate [29]**
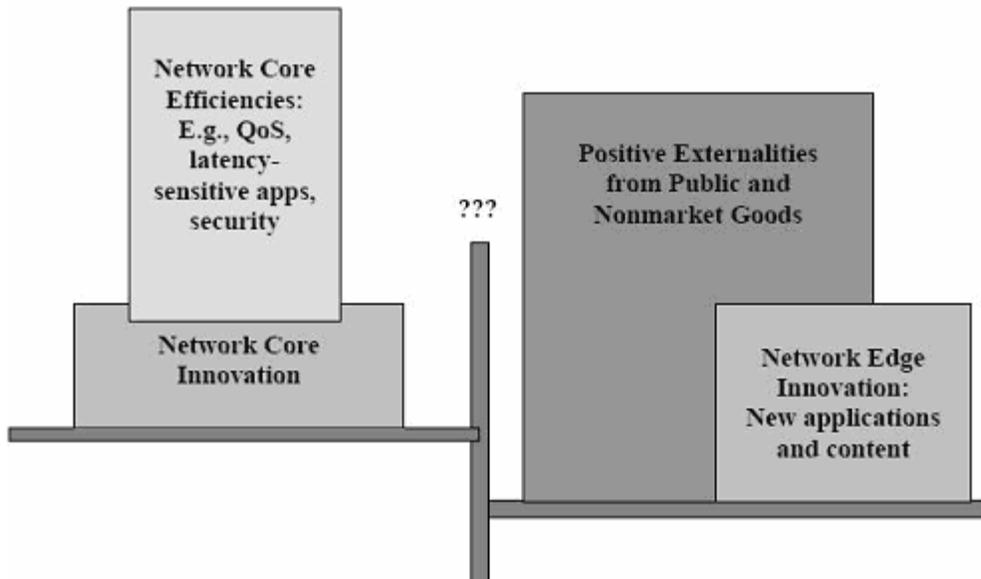
Network Neutrality Balancing:
Modified by Infrastructure Theory [29]

5) Barbara van Schewick

Towards an Economic Framework for Network Neutrality Regulation Essay

Barbara van Schewick* first analyzes whether the discrimination threat is real. She states that, *"Although a network provider does not generally have an incentive to discriminate against independent providers of content, applications or content, the analysis has highlighted a variety of*

circumstances under which it may have such an incentive. Such an incentive may not only occur if it has a (local) monopoly in the market for Internet services, but also if it faces competition. Whether the conditions giving rise to such an incentive are present in a real life situation, is an empirical question." [30]

Once she concludes that the threat is real, she looks at the impact of this threat on different levels. She first examines the impact on the application-level innovation and she determines that there will be detrimental impact on this kind of innovation. She believes that even though there might be innovation coming from the carriers on the application level, the innovation that would be generated by the independent users that are blocked by discrimination is far greater than the carriers can create [30].

The second impact she analyzes is the social welfare. She states that there should be a regulation for Network Neutrality if the social benefits are greater than the cost of the regulation. She states that the Internet has the potential of significantly increasing economic growth. Actions that reduce the amount of application-level innovation have the potential to significantly harm social welfare by significantly limiting economic growth. There would definitely be costs associated with regulation such as the impact on

* Senior Researcher, Telecommunication Networks Group, Department of Electrical Engineering and Computer Science, Technical University Berlin, Germany, and Non-Residential Fellow, Center for Internet and Society, Stanford Law School

network providers and the cost of regulation itself. As a result, she makes the following comparisons:

a) Application-Level Innovation vs. Innovation at the Network Level:

"Research on information-technology based general-purpose technologies suggests that increasing co-invention is more important than increasing innovation in the general-purpose technology itself. Applied to the Internet, this implies that increasing application-level innovation is relatively more important than increasing innovation at the network level" [30]*.*

b) Application-Level Innovation vs. Deployment of Network Infrastructure

Even though the network providers' profits would be negatively affected by a regulation, it would not prevent them from investing. They just would not have an advantage to discriminate against rivals. It there is not enough profit, it does not necessarily mean that they will stop deploying new networks as the competition can force them to do that.

She concludes that calls for Network Neutrality regulations are justified [but she states that more research is needed to determine the coverage of such regulation [30].

6) Lawrence Lessig

* Professor of Law, Stanford Law School

In my opinion, Lessig is the most influential person among the scholars who are mentioned above. His work is beyond Network Neutrality debates and it includes topics such as copyright, fair use, and free culture. He is named one of Scientific America's Top 50 Visionaries [31].

Lessig cosigned with Wu a submission to the FCC about Network Neutrality [28]. In 2006, he testified in the congress about Network Neutrality and proposed his own recommendation [13]. In his recommendation, he said that Powell's four freedoms need to be kept and a fifth one should be added. The fifth one should be about the prohibition of access-tiering. This would mean a company cannot receive special treatment on the network. Lessig also adds: "*To oppose access-tiering, however, is not to oppose all tiering. He proposes that the broadband providers can do customer-tiering where they are eligible to provide different classes of services for voice, video or regular Internet. However, none of these should be geared towards a company. Thus, anti-competitiveness of access-tiering would be eliminated and customer-tiering will create enough incentives for companies to deploy networks*" [13].

Although Lessig may have less work in the specific area of Network Neutrality than other scholars, he is the inspiration to many works in this area including the author of these lines.

* Professor of Law, Stanford Law School

6) *Conclusion*

The debate about Network Neutrality is a complex one because data networks, mainly the Internet, have tremendous impact on billions of people's lives. In this essay, I attempted to summarize some of the discussions about Network Neutrality. Scholars cited in this essay looked at the issue from different perspectives ranging from economical gains to threats to innovation environment to infrastructure concepts.

The following points need to be considered before entering in this debate as it summarizes most of the concerns which are cited in this essay.

1) The extent of any Network Neutrality regulation needs to be explained further. Being against or for Network Neutrality regulation is meaningless without knowing the details of such regulation.

2) We cannot ignore the fact that there is a duopoly in the last mile and there is no clear sign that this will change in the near future. Although there are some attempts to have wireless networks or Broadband over Power lines as competitive alternatives, they still do not reach to the level of cable or DSL and it is not certain when they will reach that level. Thus consumers may not have too many choices to allow the market to regulate itself.

3) The end-to-end design has been very important on the development of the Internet. Networked Information Economy is based on end-to-end design and it has economical benefits. Its social impact on freedoms and justice around the world cannot be ignored.

4) The End-to-end design is very powerful and should be kept. However, it does not always perform well for certain applications. Therefore, network providers should be able to benefit from vertical integration while

watching out for holes in the vertical integration. The applications should be favored rather than the companies that deploy them.

5) Networks are public infrastructures that bring many positive externalities. This does not mean that companies that deploy networks should be exempt from making money, but the social benefits of the networks as shown in the Networked Information Economy are crucial. Thus the debate should not be limited to economical terms.

It is difficult to predict what the future will bring for the Network Neutrality debates. The supporters and opponents of Network Neutrality regulations are far from reaching a consensus. I believe that as the amount of scholarly works which address the economical and social aspects of this debate increase, it will be easier to reach a consensus.

References

[1] A. G. Bell, "Improvement in Telegraphy," United States 174465, Mar, 1876. [Online]. Available: http://www3.iath.virginia.edu/albell/bpat.1.html [Accessed May 29, 2007].

[2] Wikipedia Contributors, "Almon Brown Strowger," May 2007. [Online]. Available: http://en.wikipedia.org/wiki/Almon_Strowger [Accessed June 6, 2007].

[3] Wikipedia Contributors, "1ESS Switch," May 2007. [Online]. Available: http://en.wikipedia.org/wiki/1ESS_switch [Accessed June 7, 2007].

[4] R. Becker, "ISDN tutorial: History," Dec. 2006. [Online]. Available: http://www.ralphb.net/ISDN/history.html [Accessed April 29, 2007].

[5] Wikipedia Contributors, "ARPANET," May 2007. [Online]. Available: http://en.wikipedia.org/wiki/ARPANET [Accessed June 7, 2007].

[6] J.H. Saltzer, D.P. Reed, and David Clark, "End-to-End Arguments in System Design," *In Proceedings of the Second International Conference on Distributed Computing Systems*, pp 509–512, Aug. 1981. [Online]. Available: http://web.mit.edu/Saltzer/www/publications/endtoend/endtoend.pdf

[7] D. Cohen, "Specifications for the Network Voice Protocol," Jan. 1976. [Online]. Available: http://tools.ietf.org/html/rfc741

[8] U.S. Congress, "Telecommunications act of 1996" Jan. 1996. [Online]. Available: http://www.fcc.gov/Reports/tcom1996.pdf

[9] M. Reardon, "FAQ: What is Brand X really about?," *Tech News on ZDNet,* June 2005. [Online]. Available: http://news.zdnet.com/2100-6005_22-5764187.html [Accessed June 8, 2007]

[10] C. S. Yoo, "Beyond Network Neutrality," *Harvard Journal of Law & Technology,* Vol. 19, Fall 2005. [Online]. Available: http://jolt.law.harvard.edu/articles/pdf/v19/19HarvJLTech001.pdf

[11] Michael K. Powell, "Preserving Internet Freedom: Guiding Principles For The Industry," *Silicon Flatirons Symposium*, 2004. [Online]. Available: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-243556A1.pdf

[12] T. Wu, "The Broadband Debate, A User's Guide," *Journal on Telecomm & High Technology Law*, pp. 69-95 Vol 3, 2004. [Online]. Available: http://www.cdt.org/speech/net-neutrality/2004wu.pdf

[13] L. Lessig, "Hearing on Network Neutrality" *Senate Committee on Commerce, Science and Transportation,* Feb 2006. [Online]. Available: http://www.lessig.org/blog/archives/Lessig_Testimony_2.pdf

[14] FCC Chairman Kevin J. Martin, "Comments on Commission Policy Statement, " *FCC News,* Aug. 2005. [Online] Available: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-260435A2.pdf

[15] C. S. Yoo, "**Network Neutrality and the Economics of Congestion,"** *Georgetown Law Journal,* Vol. 94, June 2006. [Online] Available: http://lgst.wharton.upenn.edu/cmcl/Documents/Yoo.pdf

[16] Y. Benkler, *"Wealth of Networks: How Social Production Transforms Markets and Freedom,"* New Haven and London: Yale University Press, 2006, pp. 1-6.

[17] ibid at pp. 71-74

[18] ibid at pp. 8-13

[19] ibid at pp. 133-175

[20] ibid at pp. 176-211

[21] ibid at pp. 212-272

[22] ibid at pp. 273-300

[23] ibid at pp. 301-355

[24] ibid at pp. 46-50

[25] T. Wu, "Network Neutrality, Broadband Discrimination," *Journal of Telecommunications and High Technology Law,* Vol. 2, p. 141, 2003. [Online] Available: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=388863

[26] J. Farrell, P. Weiser, "Modularity, Vertical Integration, and Open Access Policies: Towards A Convergence of Antitrust And Regulation In The Internet Age" *Harvard Journal of Law & Technology,* Volume 17, Number 1 Fall 2003. [Online]. Available: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=452220

 [27] R. Atkinson, P. Weiser, "A "Third Way" on Network Neutrality" *The Information Technology and Innovation Foundation,* May 30, 2006. [Online]. Available: http://www.itif.org/files/netneutrality.pdf

[28] L. Lessig, T. Wu, "Ex Parte Submission in CS Docket No. 02-52" Aug. 2003. [Online] Available: http://www.freepress.net/docs/wu_lessig_fcc.pdf

[29] B. Frischmann, *"An Economic Theory of Commons and Infrastructure Management" Minnesota Law Review*, Vol. 89, pp. 917-1030, 2005. [Online] Available: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=704463

[30] B. van Schewick, "Towards an Economic Framework for Network Neutrality Regulation" *Journal on Telecommunications and High Technology Law*, Vol. 5, 2007. [Online]. Available: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=812991

[31] Anonymous, "Lawrence Lessig, A short biography". [Online]. Available: http://www.lessig.org/bio/short/ [Accessed June 10, 2007]