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THE CELLULAR EMPIRE, DOMINION TO DEMOCRACY: A POLICY ANALYSIS OF OPEN ACCESS ON INNOVATION

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ABSTRACT

THE CELLULAR EMPIRE, DOMINION TO DEMOCRACY: A POLICY ANALYSIS OF OPEN ACCESS ON INNOVATION

By

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United States government policy towards cellular communication has a direct impact on the rate of innovation of new cellular technologies. Analysis of public policy and a series of case studies will explore the benefits of policies which foster an open environment which allows cellular devices the ability to connect to the cellular infrastructure free from cellular network provider control. This paper will analyze the impact of Carterfone rules on cellular networks and discuss how these rules have helped foster innovation in other industries.

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Introduction

Cellular communication has become ingrained within our lives. Over the upcoming decades cellular technology will continue to evolve into a communication medium which permeates into every facet of our lives. Cellular technology and its associated mobile devices have already experienced rapid growth both in user penetration and the number and types of features. Twenty years ago cellular phones were large, bulky and could only send and receive voice communication. From then until the present day cellular phones expanded their functionality enormously and evolved into mobile devices which offer many more services than just voice. No longer are cellular telephones mobile voice terminals. Instead they have evolved into mobile data terminals, mini-computers which fit in the palm or our hand and travel inconspicuously in our pockets. These mobile data terminals allowed us to access exponentially more information through the connectivity power of the Internet then their predecessors and opened up new forms of cellular communication. As Moore's law continues to hold true for mobile devices these terminals will continue to evolve and change the way we access information and communicate.

The speed and direction of their innovation is dependent on policies put in place by governments to regulate access to the wireless spectrum they use to communicate. The restrictive policies of the United States towards cellular communication have and will continue to hamper the development of new, innovative cellular products. The primary reasons for the failure of regulatory policy was the decision to forego applying Carterfone open access provisions to cellular networks and to allow the bundling of cellular phones with cellular service and the subsequent subsidization of these phones by the cellular service providers.

This paper will begin with an analysis of policies which govern the usage of the electromagnetic spectrum. The examination of their history and a study of the effects of new regulations will be used to determine the impact of policies. It will then move on to examine the impact of policies which control access to the infrastructure owned by spectrum licensees. Finally a conclusion about the impact of policies will be reached through an analysis of multiple case studies which represent both closed and open access to spectrum.

The Impact of FCC Policy on Innovation

Policies regarding the distribution and access to the electromagnetic spectrum have played an important role in the development of technologies which utilize it. The development of technologies we take for granted today such as cordless phones, radio, television and Wi-Fi have had the course of their development impacted in someway by the policies which govern the usage of the spectrum. The methods of allocating this valuable resource have been a subject of intense debate since the invention of the first devices which harnessed the electromagnetic spectrum for communication. The theories of efficiently allocating spectrum can be divided into five categories according to Ting et al.: administrative licensing, flexible licensing, individual ownership, commons (collective ownership) and open access.[1] Throughout the history of spectrum

[1] Carol Ting et al., The U.S. Experience with non-Traditional Approaches to Spectrum Management: Tragedies of the commons and other myths reconsidered. 31st Research Conference on Communication, Information and Internet Policy, Arlington, Sept. 19-21 2003.

management many, if not all, of these theories have been utilized at some point to attempt to efficiently allocate the electromagnetic spectrum to particular technologies.

The debate over spectrum allocation first came into being with the first wireless telegraphy transmission in 1895. Initially wireless telegraphy was only used for ship to shore communication and a limited number of other purposes. At first wireless telegraphy was used for a limited number of purposes including ship to shore communication. These types of communication occupied only a small portion of the spectrum and the transmitters were often geographically distant from one another.[2] The lack of a large number of transmitters and their distance from one another meant transmitters operating on the same frequency would have a low probability of interfering with one another. This dispersion led to a commons approach taken in regards to spectrum management since there was little need to regulate to prevent interference from adjoining stations. Noam eloquently describes the early approach to spectrum allocation, "[i]n the beginning, there was a brief idyllic stage of spectrum allocation, based on occupancy. Entry to the virginal ether was free, and a kind of electronic original state of nature prevailed."[3] In this early stage of spectrum allocation policy there were very few policies regulating access to the spectrum. Users were free to access and utilize the spectrum in any manner they wished.

The "electronic original state of nature", as Noam described the initial regulation of the spectrum, preserved until pressure from the United States Navy forced a change in spectrum allocation policy in order to curb the chaos it saw in the use of the spectrum.

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[2] Thomas Hazlett, "The Rationality of U.S. Regulation of the Broadcast Spectrum." *Journal of Law and Economics 33,* (1990): 235

[3] Eli Noam "Spectrum Auctions Yesterdays Heresy, Today's Orthodoxy, Tomorrow's Anachronism." *Journal of Law and Economics,* 41 (2998): 766

Pressure from the Navy along with the Titanic disaster, which had rescue efforts hampered by confusion caused by chaos with the spectrum, led to the passage of the Radio Act of 1912 which authorized the Secretary of Commerce to license use of the spectrum.[4] Under the Radio Act of 1912, those wishing to have access to the spectrum were required to apply for a license in order to broadcast. Despite the implementation of licensing any citizen could apply for a license and an unlimited number were given out. Due to the decision to issue an unlimited number of licenses the commons approach still regulated the majority of frequencies. Thus any radio station could still broadcast on any frequency. As the number of radio transmitters increased a number of problems arose as early receivers, such as radios, were unable to differentiate between transmitters on the same frequency within transmission range of each other. As a result early radio transmissions were subject to interference from nearby stations operating on the same frequency. This interference would prevent the less powerful of the two stations from being heard by its listeners. Henck describes the state of broadcasting using the commons approach to spectrum management.

> In a half dozen years after the start of commercial broadcasting by KDKA in Pittsburgh in 1921, the broadcasting industry had gone totally out of control. Stations went on the air willy-nilly at the whim of entrepreneurs, picked whatever frequency they wished to use, and broadcast in a way to interfere with the signals of others using the same slot in the radio spectrum.[5]

As the problems with interference grew both public and private parties engaged the government to solve the problems with radio stations operating on the same

[4] Jonathan E. Nuechterlein and Philip J. Weiser "Digital Crossroads" (Cambridge: MIT Press, 2005), 232
[5] Fred Henck and Bernard Strassburg, *A Slippery Slope: The Long Road to the Breakup of AT&T* (1998)

frequency. Then Secretary of Commerce, Herbert Hoover, attempted to mitigate the problems of interference by restricting access to the spectrum through refusal to issue licenses. However despite Hoover's attempts to mitigate the problems of interference, the courts believed Hoover had superseded the authority given to him by the Radio Act of 1912 and forbid him from refusing to authorize any licensee. In respond to the growing problems over radio interference Congress authorized the creation of the Federal Radio Commission via the Radio Act of 1927 to manage the electromagnetic spectrum.[6]

The Federal Radio Commission was given "broad jurisdiction to regulate access to the spectrum" and would issue licenses for the right to use specific frequencies.[7] These licensees would be issued out of "public interest, convenience or necessity" and would be allocated to potential licensees based on a system of comparative hearings.[8] Each potential user would be required to prove why they would be best suited for the rights to the frequency and also prove they had the financial capital available to utilize the frequencies to their fullest extent.[9]

While the process of comparative hearings solved the problems present in the commons approach they presented their own set of unique problems. Some theorized the process of comparative hearings was too slow and rigid for the pace at which technology was advancing and was an inefficient way to allocate usage of the spectrum. Noam describes the problems with comparative hearings:

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[6] Jonathan E. Nuechterlein and Philip J. Weiser "Digital Crossroads" (Cambridge: MIT Press, 2005), 232
[7] *Ibid.*
[8] Radio Act 1927, 69th Congress, 1927.
[9] Thomas Hazlett, "The Rationality of U.S. Regulation of the Broadcast Spectrum." *Journal of Law and Economics 33,* (1990): 136

> The only problem was that the system did not work very well. As the utilization of spectrum grew, so did the latter's value. Fights over new allocation became shrill and (of course) lawyer intensive. Competitors were excluded. Foreigners were barred. New technologies were excluded or delayed. Politics intervened ham-fistedly. Some spectrum bands were as deserted as Nevada, others crowded like Times Square, with no usage transfers possible. Government hogged vast stretches. Scarce licenses became highly valued, and fortunes were made in the reselling of licenses from the well connected to the merely efficient.[10]

Nuechterlein continues Noam's criticisms of comparative hearings.

> For most of its history, the FCC relied on 'comparative hearing' for this purpose: drawn-out affairs designed to evaluate the relative worthiness of rival applicants for a free spectrum license. In theory, this procedure discharged the FCC's statutory obligation to serve the 'public interest' by assigning the use of the airwaves to the most qualified' users. In practice, however, it tended to favor entrenched incumbents and those with political ties.[11]

These short comings of the comparative hearing process led some academics to discuss new methods of spectrum allocation. The first to propose the then radical departure from comparative hearings was University of Chicago law student Leo Herzel in 1951 and later expanded upon by Ronald Corse in 1956. [12] They proposed frequencies should be allocated via a system of auctions with the highest bidder winning the license

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[10] Eli Noam,"Spectrum Auctions Yesterdays Heresy, Today's Orthodoxy, Tomorrow's Anachronism." *Journal of Law and Economics,* 41 (2998): 767

[11] Jonathan E. Nuechterlein and Philip J. Weiser "Digital Crossroads" (Cambridge: MIT Press, 2005), 236

[12] Leo Herzel, Comment, *"Public Interest" and the Market in Color Television Regulation,* 18 U. Chi. L. Rev. 802 (1951)

to the frequency. At first their theories were debunked by academic and government officials and the system of comparative hearings operated for almost six decades before a new regulatory system was put in place.

The system of comparative hearings was not modified until after years of deliberations the FCC, facing the daunting task of awarding thousands of licenses for the new cellular bands, asked Congress for the authority to assign licenses via a lottery system. The FCC argued the system of comparative hearings would take too long given the large number of licenses required for the new service.[13] In response to these requests Congress authorized the FCC to use lotteries as a replacement for "comparative hearings for cellular telephone licenses."[14] While the lottery system addressed many of the short falls of the comparative hearing system it was not the ideal method of spectrum allocation. Due to the random nature of the drawings there were a large number of applications for the frequencies. Many of which had no experience with technologies which utilized the spectrum. The system of lotteries was described as a "bizarre system that attracted in the United States almost half a million applications looking for a windfall."[15] In essence many of the applicants had little knowledge of the proper use of the spectrum. They simply were hoping for a chance to get a section of valuable spectrum real estate for free.

The limitations of the lottery system were quickly recognized and in response Congress authorized the FCC to instead auction licenses for some services. However, this transition from the lottery system to auctions was a long process which took years.

[13] Thomas Hazlett, "Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years." *Journal of Law and Economics 41, (1998):* 532

[14] Jonathan E. Nuechterlein and Philip J. Weiser "Digital Crossroads" (Cambridge: MIT Press, 2005), 232

[15] Eli Noam "Spectrum Auctions Yesterday Heresy, Today's Orthodoxy, Tomorrow's Anachronism" *Journal of Law and* Economics, 41 (1998): 767

The first inroads began in 1986 when Congress authorized the FCC to allocate spectrum rights based on a system of auctions rather than the previous system of allocating spectrum based on what licensee could provide the best "public use" of the spectrum as stipulated in the Communication Act of 1934.[16] In 1993 Congress passed the Omnibus Budget Reconciliation Act, which gave the Commission authority to use competitive bidding to choose from among two or more mutually exclusive applications for an initial license. Finally the Balanced Budget Act of 1997 expanded the FCC's authority to auction licenses. The Act required the FCC use auctions to resolve mutually exclusive applications for initial licenses. However certain exemptions applied, including exemptions for public safety radio services, digital television licenses to replace analog licenses, and non-commercial educational and public broadcast stations. This new method of spectrum assignment was first exercised in 1994 on a newly available section of spectrum previously used for military use but transferred to civilian use by the Clinton administration.[17]

Those who advocated the use of spectrum auctions for their more efficient licensing model were correct in their beliefs. In a 1991 report the National Telecommunication and Information Administration (NTIA) reported "a comparative hearing imposes substantial costs on the FCC as well as the applicant.[18] The FCC itself agreed that substantial burdens are imposed by comparative hearings and stated "the substantial time consumed in the process of selecting among competing applicants greatly disserves the public." Additionally they noted the "average hearing case takes

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[16] Dick Olfus, "The Making of Communication Policy (Boulder: Rienner, 1999), 80
[17] Dick Olfus, "The Making of Communication Policy (Boulder: Rienner, 1999), 80
[18] National Telecommunication and Information Association, "U.S. Spectrum Management Policy: Agenda for the Future" (Diane Publishing, 1994), 34

almost three years to complete through a hearing, initial decision, review board decision and Commission decision."[19]

The revenue generated by these auctions also stands as a testament to how much revenue was lost by using the comparative hearings system. By 1996 over 20 billion dollars in receivables from FCC auctions were recorded by the Treasury Department. [20]

The structure of the U.S. cellular industry has been heavily influenced by the method of spectrum licensing used. The first licenses for cellular technology issued by the FCC were based on geographic areas similar to the way radio licenses were issued. They assigned two licenses in each of 734 geographic areas via a lottery system with the hopes of generating competition in the mobile telephony marketplace.[21] These licensees were known as "A" and "B" licenses. The "B" license was assigned to the local wireline operator (usually a Bell) and the "A" license was given to an independent cellular provider.[22]

The initial result of this method of cellular licensing was the lack of a nation-wide network. In order to offer nationwide cellular service carriers were forced to purchase licensees in each market area or to form network sharing agreements, more commonly called roaming agreements, with other carriers. These early carriers would often use more than one cellular standard and cellular development responded by

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[19] Proposals to Reform the Commission's Comparative Hearing Process to Expedite the Resolution of Cases, Notice of Proposed Rule Making, 5 FCC Rcd 4050 (1990).
[20] Federal Communication Commission, *FCC Hits $20 Billion Mark in Total Auction Revenues*, www.fcc.gov/Bureaus/WirelesslNews_Releases/1996/nrwl6015.txt
[21] Thomas Hazlett, "Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years." *Journal of Law and Economics 41, (1998):* 532
[22] Jonathan E. Nuechterlein and Philip J. Weiser "Digital Crossroads" (Cambridge: MIT Press, 2005), 268

developing phones with multiple cellular radio technologies.[23] The policies also created a duopoly system in most cellular markets. According to Noam this system of two cellular providers per market area created a duopoly system which "took many years to establish, and during that time the US lost its original technology head start to the Scandinavians, who still benefit from those early years. It has been estimated that the delay cost the US $20 billion. This is an underestimate, since it counts only lost carrier revenues, not lost consumer welfare, productivity gains, exports, and jobs."[24]

In response to the growing concerns over the duopolistic cellular market and the growing demand for cellular communication the FCC and cellular carriers began attempts to remediate these problems. The cellular carriers and manufactures began to develop new technologies which allowed more calls to be handled by an equal amount of frequency.[25] The FCC, hoping to lower the cost of cellular service and increase cellular user capacity, allocated additional frequencies to cellular service. These new allocations were designed to allow new carriers to enter into the market lower costs through increased competition. The first of these new allocations began in 1995. The FCC assigned frequencies in the 900MHz and 1900MHz ranges for cellular communication. These new frequencies would be classified as Personal Communication Service or PCS and would allow for a greater number of cellular competitors than the currently two

[23] Early cellular telephones used a number of standards which were not compatible. These included AMPS, TDMA, D-AMPS, GSM, CDMA and iDen

[24] Noam "The Next Frontier for Openness: Wireless Communication." Telecommunication Policy Research Conference, 26, Oct. 2001.

[25] When it became apparent the analogue technology of AMPS would be insufficient for the growing cellular demand the cellular companies began to transition their networks from analogue technology to digital technology. Some of the US cellular companies embraced Digital AMPS or D-AMPS which became know as Time Division Multiple Access (TDMA). TDMA allows for three calls per channel by compressing the voice stream and then dividing the channel into time slots.

cellular providers per market area. It was hoped the greater number of cellular providers would increase competition within the cellular markets and drive cellular prices down. [26]

The new policies put in place by the FCC did in fact do as they hoped. The new frequencies allowed for new competition within the cellular market and lower prices for consumers. The new frequencies allowed for five (now four after the merger of Sprint and Nextel) national carriers; AT&T Wireless[27], Sprint, Nextel, T-Mobile and Verizon.[28] These national carriers are in addition to numerous regional and local carriers.

In an effort to further increase competition within the cellular market the FCC also exempted cellular providers from many of the regulations applied to wireline telephone providers. In particular the FCC removed restrictions placed on the bundling of customer premise equipment (CPE) with telecommunication service. Wireline telephone companies are required by the FCC to unbundle the sale of CPE from services. The FCC Second Computer Inquiry stated "[e]xcept as otherwise ordered by the Commission, the carrier provision of customer premises equipment used in conjunction with the interstate telecommunication network may be offered in combination with the provision of common carrier communication services, except that the customer premises equipment shall not be offered on a tariffed basis."[29] Essentially the FCC prohibited the telephone company from bundling telephones with telephone service. However in regards to cellular service the FCC found the high price of cellular CPE imposed a significant barrier on the addition of new cellular customers. In an effort to increase

[26] 47 C.F.R §24—Telecommunication Chapter 1, FCC, Part 24 Personal Communication Services
[27] The history of AT&T Wireless is an interesting one. At its inception the cellular service was referred to as AT&T wireless until it was bought by SBC when it became Cingular Wireless. When SBC purchased AT&T the name was changed back to the original AT&T Wireless.
[28] *Eleventh Annual CMRS Competition Report,* Federal Communication Commission. Para 25
[29] 47 C.F.R. §64.702 Furnishing of enhanced services and customer-premise equipment

usage via lower CPE costs the FCC exempted cellular companies from Computer II and consequently allowed them to bundle CPE with telecommunication service.[30] The reasoning behind the decision to unbundle CPE from telephone service was to increase competition in the cellular market by lowering the upfront cost of the terminal equipment. The FCC was aware of "the possibility that bundling may be used for anti-competitive purposes" but concluded that "it is unlikely that individual cellular companies which operate in local markets possess the market power that could impact the numerous CPE manufacturers operating on a national and international basis.'"[31] As a result of this policy cellular providers began to subsidize the cost of cellular handsets. The cellular provider would subsidize a portion of the cost of the handset at purchase and the customer would pay back these subsidizes through their monthly payments.

On the surface this policy was effective in lowering the cost of cellular handsets by distributing the cost of the handset over the customer's monthly payments. As a result of this the costs of handsets from cellular providers are substantially less than the same models offered by third parties. Cellular carriers often subsidize costs of mobile devices at no cost provided the customer agrees to use the service for a set number of years. The hidden result of these subsidizations are the negative effects they have on the market for third party (non-carrier subsidized) cellular devices. Since carriers do not offer the ability of a consumer with a 3rd party cellular phone to subscribe to a plan which does not include the cost of subsidization there is little incentive for a consumer to purchase a phone at full price. Therefore customers are encouraged through market forces to choose phones which are only offered by the carrier, effectively creating barriers to entry for

[30] Bundling of Cellular Customer Premise Equipment and Cellular Service, Report and Order, FCC 92-207
[31] "FCC modifies bundling of CPE and cellular services policy" http://findarticles.com/p/articles/mi_m3457/is_n10_v10/ai_12286453

providers of 3rd party cellular devices. For example, users of the latest handset the Apple iPhone purchase the phone at an unsubsidized price but are still required to pay the same cellular usage rates charged to other users of the network who are paying for portions of their cellular phones through their monthly payments

The FCC's usage of spectrum auctions for spectrum allocation while arguably more efficient than a lottery system or comparative hearings does not come without its own set of problems. Noam describes the auction system of spectrum licensing to be "much beloved to game-theorists free background in the wireless environment, by property-rights ideologues, and by government officials eager to fill the empty coffers of government with windfall revenues."[32] Spectrum auctions create barriers to entry especially for small companies attempting to purchase spectrum licenses. With the cost of valuable frequencies exceeding a billion dollars it is almost impossible for a small company to establish the required amount of capital necessary for purchase of new spectrum licensees. Wu writes "[w]hile entry is not impossible, all agree that under current conditions, it requires multi-billion dollar investments. The consequence is a spectrum-based oligopoly, not the 'fiercely competitive' market that is sometimes portrayed."[33] While the FCC has attempted to mitigate this criticism through the use of small business credits the cost of entry are still enormous.[34]

The end result of these auctions according to Noam will be an oligopoly of the highest bidders facilitated by a "bidding consortia of companies that would otherwise be

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[32] Eli Noam "The Next Frontier for Openness: Wireless Communication" Telecommunication Policy Research Conference, 26, Oct. 2001.
[33] Wu, Timothy. "Wireless Carterfone." International Journal of Communication. 1 (2007): 393
[34]FCC Auctions: Factsheet: Auction 71
http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=71#Small%20Business%20Bidding%20Credit%20Eligibility%20for%20Open%20Bidding

each other's natural competitors and who collaborate under some rationale of synergy."[35] In addition to these barriers of entry the auctions create budgetary reliance on the revenue generated by the auctions. The revenue generated by these auctions may become part of the normal budgetary structure and become relied upon by government agencies as a steady source of revenue. Noam brings this point up in his paper Spectrum Auctions: Yesterday's Heresy, Today's Orthodoxy, Tomorrow's Anachronism. He writes "[o]nce a certain budgetary dependency on revenues from communication has been created, it will inevitably color substantive policy, such as resistance to new technologies if they threaten auction revenues."[36] According to Noam government agencies will come to rely upon the revenue generated by these auctions. This reliance will make them reluctant to switch to new, potentially less revenue generating, methods of spectrum allocation.

The current state of the cellular industry seems to closely follow the Noam's views that spectrum auctions will lead to oligopolistic markets. The spectrum allocation policies of the FCC have created an oligopoly of four national carriers with a HHI in the mid 2000's as Wu points out in *Wireless Carterfone.* This value, which measures the level of consolidation within an industry, is far above the value the Department of Justice considers to be a monopolistic industry.[37]

A number of academics have suggested the solution to the problems created by spectrum auctions would be to remove the notion of licenses and allow any device to transmit provided it adhere to set standards. Those who support the commons model argue the reason for not adopting the commons model lies with the Federal government

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[35] Eli Noam,"Spectrum Auctions Yesterdays Heresy, Today's Orthodoxy, Tomorrow's Anachronism." *Journal of Law and Economics,* 41 (1998): 776
[36] *Ibid.*,774
[37] Wu, Timothy. "Wireless Carterfone." International Journal of Communication. 1 (2007): 393

who is “proceeding on outdated assumptions about technology. It assumes that interference is a problem that requires individual allocation, whereas new technological developments, such as spread spectrum and ultra-wideband radio, make it possible for many users to use the same broad swath of spectrum simultaneously without interference.”[38]

The spectrum commons model proposed by Buck and others relies upon the development of new radio technologies such as Ultrawide Band (UWB) technology and smart radios. UWB utilizes a large range of frequencies to transmit and receive information and is relatively immune to interference from other transmitters because it uses such a large range of frequencies.[39] Supports of the commons model argue the development of smart radios will negate the need for spectrum management. These smart radios will intelligently shift frequencies based on the level of interference and have the ability to disseminate transmissions destined for them from other transmissions.

These new technologies could potentially change the current policies governing frequency usage if they are given time to grow. However, as this paper will later explain the commons method of regulation is not currently the best option for spectrum management.

An Analysis of 700MHz

Currently the FCC uses spectrum allocation to determine licensees for a number of different services. However, a new range of frequencies are being reassigned with a

[38] Stuart Buck, “Replacing Spectrum Auctions with a Spectrum Commons” *Standard Technology Law* Review,2 (2002)
[39]For more information regarding UWB see http://ieeexplore.ieee.org/xpls/abs_all.jsp?tp=&isnumber=29810&arnumber=1359140

number of stipulations which warrant further examination. Recently the FCC began Auction 73 which will reallocate a large portion of frequencies within the 700MHz band to new wireless services. Many academics and those within the wireless industry are hoping this new auction will address many of the shortfalls of the previous methods of spectrum allocation. This paper will now continue forward to explain how and why Auction 73 has generated so much interest.

The reallocation of the 700MHz began with the Telecommunication Act of 1996 which stipulated the cessation of all analog television broadcasts and their conversion to digital broadcasts. Since digital television broadcasts occupy less frequency per channel than stations using analog technology the upper band of frequencies would no longer be occupied by television stations and could be reassigned to new services. These new services consisted of wireless services for data, voice and public safety communication. The Telecommunication Act of 1996 set no firm deadlines for the transition and in order to accelerate the process of reallocation Congress passed the Balanced Budget Act of 1997 which mandated no new analogue licenses be renewed past December 31, 2006. In effect this forced all analogue broadcasters to switch to digital transmission after December 31, 2006. However this deadline has been extended multiple times. Currently the transition from analogue to digital transmission is February 17, 2009.

The reallocation of the 700MHz frequencies were divided into two auction cycles, the lower 700MHz frequencies and the upper 700MHz frequencies. In 2002 the FCC began reallocating portions of the lower 700MHz spectrum which was previously occupied by analogue television stations 52-59. Section 309(j)(14) of the Communication Act required the FCC to reassign spectrum recovered from these channels via a competitive bidding process which was held in Auction 44 and 49 in 2002 and 2003 respectively.[40] These two auctions generated a net bid of 1.5 billion dollars.[41] [42] The remainder of the 700MHz band auction was completed on March 18, 2008 with a net bid of 19 billion dollars.[43]

What differentiates the upper 700 MHz auction from previous auctions are the rules which govern the licensees usage of the spectrum. There are two regulations in particular to the Block "C" portion of the700Mhz auction which will challenge the current rules which govern cellular networks. The main challenges to the status quo are a set of rules often referred to as "open access provisions" which allow any device to utilize Block "C" of the upper 700MHz range for transmission. The second modification to current spectrum policy is the creation of band managers, licensees with the ability to lease out portions of their licenses to third parties. These new challengers are hoped to increase innovation and competition by allowing those who wish to develop innovative products access to the cellular frequencies.

The first change, the implementation of open access provisions, gained momentum when Google filed a petition with the FCC regarding the regulations placed on licensees of the upper 700MHz. Google recommended the addition of four regulations to the 700 MHz auction which, they argued, would act as incubators for innovation and competition. These four recommendations were as follows:

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[40] Federal Communication Commission, *About Lower 700* MHz, http://wireless.fcc.gov/services/index.htm?job=about&id=lower700
[41] Federal Communication Commission, *Auction 44 Lower 700 MHz Band*, http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=44
[42] Federal Communication Commission, *Auction 49 Lower 700 MHz Band,* http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=49
[43] Federal Communication Commission, *FCC Auction: Factsheet: Auction 73*, http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=73

1. Open applications: "commercial service using 700 MHz spectrum must not block, impair, impede, or otherwise unreasonably limit the ability of end users to download and utilize software applications"

2. Open devices: commercial service using the 700 MHz block must allow any legal device to connect to the network.

3. Open services: "all commercial licensees seeking to provide a CMRS[Cellular]-type commercial service using 700 MHz spectrum must provide wholesale service to requesting resellers, based on reasonably nondiscriminatory commercial terms and conditions

4. Open networks: commercial licensees utilizing the 700 MHz spectrum "must open their networks to interconnect with any third party, such as an ISP or CLEC, at any reasonable point in the wireless network."[44]

Google's four provisions were well received by the FCC and then FCC Chairman Martin. Three of the four provisions they put forward were accepted. Provision 3, the open services provision which stipulated licensees of Block C of the 700 MHz spectrum sell their services wholesale was not endorsed.

FCC Chairman Powell had many of the same thoughts as Google regarding regulation of the 700MHz. In a speech given to the Silicon Glatirons Symposium at the University of Colorado Chairman Powell expressed a number of what he described as "Internet Freedoms"; a number of principles consumers have come to expect from a

[44] Google Inc. "Google Intends to Bid in Spectrum Auction if FCC Adopts Consumer Choice and Competition Requirements" 2007. Nov 12 2007. http://www.google.com/intl/en/press/pressrel/20070720_wireless.html

history of open access on the Internet. He expressed four Internet Freedoms within his speech: freedom to access content, freedom to use applications, freedom to attach personal devices and freedom to obtain service plan information. The first three of his Internet "Freedoms" closely mimic three of the provisions put forth by Google.[45]

Not surprisingly due to Chairman Martin's remarks the FCC agreed with the theory of open access and modified the regulations of the Block "C" portion of the 700Mhz band. These new regulations required the winner of Block C portion of the frequency to "not deny, limit, or restrict the ability of their customers to use the devices and applications of the choice on the licensee's C Block network". Unless the devices was "compliant with published technical standards reasonably necessary for the management or protection of the licensee's network, or as required to comply with statute or applicable government regulation."[46]

The FCC also mandated in addition to allowing access to any device which conforms to set standards, licensees of Block C must

> include technical requirements reasonably necessary for third parties to access a licensee's network via devices or applications without causing objectionable interference to other spectrum users or jeopardizing network security. The potential for excessive bandwidth demand alone shall not constitute grounds for denying, limiting or restricting access to the network … [l]icensees shall establish and publish clear and reasonable procedures for parties to seek approval to use devices or applications on the licensees' networks.

[45]Michael K. Powell. "Preserving Internet Freedom: Guiding Principles for the Industry."
[46] 47 C.F.R. §27.16 Furnishing Network access requirements for Block C in the 746-757 and 776-787MHz.

The second change, the notion of band managers, was initially suggested by Coarse as entities "who would freely sell or lease patches of spectrum in a robustly competitive secondary market." The government would relinquish its current role of management of that portion of spectrum and would only "define the relevant property rights and enforce contractual agreements" but would not "allocate spectrum for particular users on 'public interest' grounds."[47] Band Managers would be able to purchase frequencies located in the guard bands of the 700MHz range. These guard bands are a "total of six megahertz of paired spectrum that was allocated to protect public safety operations in immediately adjacent bands from harmful interference while at the same time promoting the efficient use of this spectrum."[48] Guard Band Managers "will be engaged in the business of subdividing the spectrum they acquire at auction and leasing if for value to third parties including both commercial service providers and private wireless users."[49]

These stipulations represent a new mentality of open access at the FCC in regards to cellular communication. The FCC decision will help break the cellular carriers control on which mobile devices can be used on their networks and reverse some of the practices which developed after the FCC allowed the bundling of cellular customer equipment with cellular service. Ironically these stipulations closely follow those found in the seminal Carterfone decision made over 40 years ago which changed the landscape of wireline telephony.

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[47] Jonathan E. Nuechterlein and Philip J. Weiser "Digital Crossroads" (Cambridge: MIT Press, 2005), 242
[48] 700 MHz Guard Bands. http://wireless.fcc.gov/services/index.htm?job=service_home&id=700_guard
[49] "FCC adopts new rules for Guard Band Manager Auctions", http://www.fcc.gov/Bureaus/Wireless /News_Releaes/2000/nrwl009.html

History of Carterfone

The policies of spectrum management were not the only factor which shaped the technological growth and market structure of the cellular industry. There are also numerous policies which govern the use of equipment on cellular networks. Currently cellular carriers have a significant level of control over the devices connected to and services available over their network. These controls have a similar structure to the wired telecommunication network prior to the seminal Carterfone decision. Prior to Carterfone the telephone providers (primarily AT&T) had complete control over their telecommunications infrastructure from end to end. They controlled the entire network from the handset to the transmission medium as well as the services which utilized the network for communication. Some argue the application of Carterfone led to the development of new innovative devices which used the telecommunication infrastructure for communication. These similarities have led a number of academics and technology corporations to begin discussions regarding the how the application of Carterfone to the cellular industry would affect the industry. They argue the application of these principles would increase competition within the cellular industry and improve innovation in the market for mobile devices. In order to thoroughly and pragmatically analyze their position it is necessary to discuss the genesis of the Carterfone decision. After which a discussion can be held to determine the potential benefits, if any, the cellular industry may experience from the application of Carterfone stipulations.

The birth of the Carterfone decision has its roots in the early development of the telephone industry. Historically the telephone network was considered to be a regulated monopoly. AT&T, the majority owner of the national telecommunication system was regulated by the Interstate Commerce Commission and then the Federal Communication Commission following its creation in 1934. Regulation was preformed through a series of rules called tariffs which sought to keep the price of telephone service low while providing AT&T a reasonable rate of return. From the beginning of service AT&T had enormous control over the telephone network. Initially they could choose which local providers could connect to their national network and before regulation of interconnection could drive local telephone companies out of business by refusing to allow them to connect to AT&T's network and thus all customers connected to AT&T's network.

In concert with their control over network interconnection AT&T also exerted a significant level of control over the devices which could connect to their network. To further their control over end user devices they also owned the manufacturing and research of these devices through its subsidies Western Electric and Bell Labs. This arrangement was accepted until 1956 when AT&T was forced by the Federal Government to divest Western Electric and freely license its patents to other manufactures due to concerns of monopolistic tendencies.[50] Despite the divesture from Western Electric, AT&T still prohibited "equipment, apparatus, circuit, or device not furnished by the telephone company [from being] attached to or connected with the facilities furnished by the telephone company, physically, by induction or otherwise."[51] These regulates were necessary, according to AT&T, to protect the telephone network from potential harm arising from improperly manufactured third party devices. For years these views were taken without question. Henck recounts a story by Phil Loucks, the

[50] Gerald W. Brock, "Regulatory Change in Telecommunication" (1996) 226

[51] 13 F.C.C. 2d 420, "Use of the Carterfone Device in Message Toll Tel. Serv.," 1968

chief staff officer of the National Association of Broadcasters (NAB), which describes the mentality of foreign device attachment during the early half of the 20th century. In the story Loucks attempts to arrange a telephone call from President Hoover in Washington D.C. to a NAB meeting in Detroit. During the days of train travel, he states, it was not feasible to travel from Washington to Detroit for a brief speech so they decided to deliver the speech via a telephone call between Hoover and the conference. Loucks' plan was to amplify the call in Detroit via a public address system in order for it to be audible by all the attendees. When he contacted Michigan Bell and explained his plan they refused to attach the PA system to the phone because it was a foreign attachment. Only by contacting AT&T President Walter Gifford did Loucks eventually persuade AT&T to attach the PA system.[52]

This brief account describes the mysticism surrounding the telephone network during its early history. Users were incredibly concerned about the health of the network and regarded AT&T's statements without question as a pseudo-Gospel of telephone network interoperation. The first serious challenge to AT&T's control over the network was the 1956 Hush-a-Phone decision. The Hush-a-Phone was a device which cupped over the mouthpiece of a telephone handset. The purpose of the device was to help make a conversation more audible by the receiver of the phone call and prevented others from listening to words being spoken by the sender. The device did not interfere with the phones technical operation or the communication between the phone and AT&T's network. AT&T sued for the secession of sales of the Hush-a-Phone device stating "[i]t would be extremely difficult to furnish 'good' telephone service if telephone users were

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[52] Fred Henck and Bernard Strassburg, *A Slippery Slope: The Long Road to the Breakup of AT&T* (1998) 23

free to attach to the equipment, or use with it, all of the numerous kinds of foreign attachments that are marketed by persons who have no responsibility for the quality of telephone service but are primarily interested in exploiting their products."[53] The FCC initially agreed with AT&T views and banned sales of the device. However, Hush-A-Phone appealed to the District Court of Appeals who found in Hush-A-Phone's favor stating customers had the right to "use his telephone in ways which are privately beneficial without being publically detrimental."[54]

The Hush-a-Phone decision paved the way for the second landmark decision which changed the landscape of telecommunication policy, the Carterfone decision of 1960. The Carterfone was a device which attached to the end of a handset and contained a radio transmitter that would communicate with a remote radio device. AT&T prohibited the attachment of the Carterfone to the telephone network for reasons similar to those of Hush-a-Phone. They argued FCC Tariff number 132 prevented the attachment of the device. It stipulated "no equipment, apparatus, circuit or device not furnished by the telephone company shall be attached to or connected with the facilities furnished by the telephone company, whether physically, by induction or otherwise."[55] Despite this claim Thomas Carter, inventor of the Carterfone brought a case to allow attachment of the Carterfone to a Federal court judge in Texas in an anti-trust lawsuit against AT&T. The Federal Court judge believed the FCC was the expert on this material and deferred the case to them.[56] After numerous years of litigation the FCC

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[53] Federal Communication Commission, "In the Matter of Hush-A-Phone Corp. et al., Decision, "20 FCC 391, 415, 1955.
[54] Hush-A-Phone Corporation v. U.S. and FCC, 238 F.2d 266 at 269 (1956).
[55] *Ibid.*
[56] Fred Henck and Bernard Strassburg, *A Slippery Slope: The Long Road to the Breakup of AT&T* (1998) 97-98

decided "as long as the interconnection does not adversely affect the telephone company's operations or the telephone system's utility for others" it is acceptable to connect third party devices to the telephone infrastructure.[57] To further the availability of interconnection presented by Carterfone the FCC created rules which standardized the connection of equipment to the telephone infrastructure. These rules provided for "uniform standards for the protection of the telephone network from harms caused by the connection of terminal equipment and associated wiring thereto."[58]

The FCC's decision had a greater scope than just the Carterfone device. Their decision allowed any device which did not harm the network to connect to the network. In addition they forced the creation of standards so innovators could create new products to connect to the newly freed telecommunications infrastructure. The end result of this decision was the development of new products such as the fax machine and computer modem. The FCC itself determined that the application of Carterfone principles to the telephone network were beneficial.

> We determined in Docket No. 19528 and elsewhere that the public benefits from diversity in the supply of terminal equipment and that consumers for this further reason should have the option of furnishing their own terminals, including main stations. Among these benefits as found in Docket No. 20003 (61 FCC2d at 867), are the public's wider range of options as to terminal devices, competitive stimulus to innovation by telephone companies and independent suppliers, the availability of new equipment features, improved maintenance and reliability, improved installation features including ease of making changes, competitive

[57] 13 F.C.C. 2d 420

[58] 47 C.F.R. §68 Connection of terminal equipment to the telephone network.

sources of supply, the option of leasing or owning equipment, and competitive pricing and payment options. . . . We remain of the opinion that the proven and reasonably anticipated public benefits from the competitive supply of terminal equipment, including primary instruments, take precedence over the considerations urged by the telephone industry. If anything, this judgment is the more firm in light of potential developments in home and small business terminals and the heightened desirability of protecting the consumers' freedom of options in such circumstances.[59]

The application of Carterfone rules led to the creation of an entirely new industry of third party terminal equipment. An analysis of the impact of Carterfone on the third party terminal equipment market exceeds the scope of this paper. In brief these new manufactures began to offer third party telephones, fax machines and answering machines to consumers. Perhaps most importantly these regulations also allowed for the connection of computer modems which allowed individuals to connect to the growing Internet.

A Comparative Analysis: Cellular to Pre-Carterfone

The state of today's cellular industry is strikingly similar to AT&T of the 1950's. Cellular carriers have immense control over their networks and some academics have likened their market structure to an oligopoly. One of the primary reasons for these similarities is the failure of the FCC to extend the tenants of the Carterfone decision, namely foreign device attachment, to the cellular industry. The second is the allowance

[59] Report and Order , 68 FCC2d 1157 (1978) para 68

of bundling CPE with cellular service. In conjunction these two policy failures have created an industry which closes resembles the AT&T monopoly. An analysis of the similarities of the cellular industry compared to pre-Carterfone AT&T will help establish there are in fact significant similarities between the two. If these two industries are so similar would the application of Carterfone rules offer the same benefits of increased innovation to the cellular industry? This paper will discuss these possibilities after an analysis of the similarities between the two industries.

Prior to the application of Carterfone AT&T supplied all CPE through its subsidy Western Electric. Telephones were required to be developed by Western Electric and provided by AT&T. The cellular companies have a similar method of CPE control. While the cellular companies do not control the actual development of cellular devices they do control which devices can connect to their network and are bundled with their services. Because of this control they can deny manufactures access to their network whose phones do not meet the cellular providers business model. Noam explains this point further

> The decision whether to approve a particular handset for connectivity, however, lies within the discretion of the carrier, since that carrier is entirely free, in the US, to select its standard. In Europe, in contrast, any equipment that complies with the GSM specifications will be connected to the network. There is no carrier discretion. In the US, the industry association CTIA often certifies a manufacturer's equipment to the industry, but each carrier can add its own requirements and flavor of specifications. In consequence, large carriers also test and approve equipment for connection to their network. Hence, the mere

adherence by a manufacturer to the standard specifications in the US is not enough. It must also find favor with the carrier.[60]

In addition to restricting the development of devices the carriers also prevent unauthorized devices from connecting to the network which in turn forces customers to purchase carrier sold phones. These restrictions are similar to AT&T's restriction prohibiting non-authorized devices from connecting to the wired telephone network before the application of Carterfone rules. Similarly cellular carriers prevent customers from connecting unauthorized devices to their network. For example, if a customer of cellular provider "A" attempts to transfer their cellular device to a second provider, cellular company "B", they will be unable to access providers "B" network due to these restrictions even if the two carriers use the same protocol for cellular communication. Ironically, the cellular carrier's justifications for these restrictions are identical to those used by AT&T to restrict access to its network. They defend their position by arguing unauthorized third-party devices will hurt the stability of the network and could cause interference for other subscribers.[61]

These restrictions are preformed in a number of ways depending on which of the U.S. cellular standards they employ. Currently the majority of carriers in the United States utilize one of two technologies, Code Division Multiple Access (CDMA) and Global System for Mobile Communication (GSM). CDMA providers use a method of centralized authorization to prevent unauthorized consumer devices from connecting to their networks. Every CDMA device has an Electronic Serial Number (ESN) used to

[60] Eli Noam "The Next Frontier for Openness: Wireless Communication" Telecommunication Policy Research Conference, 26, Oct. 2001.
[61] Cellular Telecommunication and Internet Association. "Opposition of the CTIA the Wireless Association". RM-11361. 2007.

identify itself on the carrier's network.[62] In order for a device to be allowed access to the network its ESN must be present in the carrier's database of authorized devices. If the device is not present in the database it will be unable to connect to the network. The other two national providers, AT&T and T-Mobile, use the Global System for Mobile Communication (GSM) standard developed in Europe as the protocol for their network. GSM uses a removable microchip referred to as a subscriber identity module (SIM) card and software to prevent access to networks. Ironically, these SIM cards were initially designed to allow users to easily transfer their telephone service between devices. In order to circumvent the inherit transferability of GSM providers use software installed on their handsets which prevent competing providers SIM cards from being accessed. From a hardware perspective these handsets would be able to communicate with either provider, it is the software on the phone which prevents access to the competing network. This software utilizes numerous methods to accomplish the restrictions. In general software will check the identity of the cellular network and refuse to connect to the network if it is not the authorized provider. These software locks have become known in popular nomenclature as cell phone locks. Consequently phones which have had their protection removed, or purchased direct from a third party are referred to as unlocked phones.

However, similar to how AT&T used litigation to prevent third party devices, unlocking a phone is not without potential legal consequences. As an example in 2006, TracFone, a U.S. provider of prepay cellphone service, filed a suit against Sol Wireless for unlocking cellular phones sold by TracFone. TracFone argued Sol Wireless violated

[62]"Electronic Serial Numbers (ESN) and MEID"
http://www.tiaonline.org/standards/resources/esn/index.cfm

the provisions in the Digital Millennium Copyright Act (DMCA) which prohibit the circumvention of "a technological measure that effectively controls access."[63] In this case TracFone believed Sol Wireless violated the DMCA because they were circumventing software which prevented users from using an alternative cellular provider.

Similar to the evolution of open access on the AT&T network small inroads are being made to bring open access to cellular networks. In 2006, a small victory against carrier control of handsets was won when the United States Copyright Office exempted the unlocking of cellular phones from the DMCA provided they were for personal use. The Copyright Office stated "[t]he underlying activity sought to be performed by the owner of the handset is to allow the handset to do what it was manufactured to do—lawfully connect to any carrier...The purpose of the software lock appears to be limited to restricting the owner's use of the mobile handset to support a business model, rather than to protect access to a copyrighted work itself."[64]

After the Copyright Office's decision some of the carriers began to slowly allow access to their network to any device which met their standards. Whether this was because of the Copyrights office decision against the DMCA or an attempt by the carriers to increase competition and ease of use is hard to determine from the information available. Currently customers are able to connect third party handsets to three of the four national carriers with the fourth carrier stating they will allow access in 2008. AT&T, Sprint and T-Mobile all allow users to transfer phones from one carrier to another

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[63] 17 U.S.C. §1201 Circumvention of copyright protection systems. Section A paragraph 1
[64] Library of Congress, United States Copyright Office, Recommendation of the Register of Copyrights in RM 2005-11; Rulemaking on Exemptions from Prohibition on Circumvention of Copyright Protection Systems for Access Control Technologies. (2006) 51-52

provided they use the carriers cellular standard. While Verizon does not currently allow third party devices they will allow any device to connect to their network in 2008.[65]

The theoretical end result of this should allow users to chose any terminal device and attach it to any carrier. However, there are still hurdles put in place which complicate the transfer of terminal devices. The first of these deals with the fact the cellular providers in the U.S. use two competing cellular standards. Two of the national carriers, AT&T and T-Mobile, use the GSM standard for cellular communication, while the other two, Verizon Wireless and Sprint, utilize the CDMA standard. These two standards are not compatible and therefore users can only transfer phones between providers with the same standard. GSM devices can transfer between the two providers but users of CDMA devices do not have the same luxury. While Sprint allows a customer to use any CDMA device on their network Verizon will not allow non-Verizon phones on their network. Verizon's lack of support for third party devices effectively reduces the benefits CDMA device transferability since users would only be able to use third party CDMA devices on the Sprint network.

The second hurdle is the practice of locking GSM phones to the issuing carrier. Although, as discussed above, it is legal to unlock a cellular phone it is only legal to do so after the customer has subscribed to a monthly plan long enough to return the cost of handset subsidization to the carrier. Once this stipulation has been reached the customer the customer may contact the cellular carrier to obtain the specific unlock code for their phone.

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[65] "Verizon Wireless to Introduce 'Any Apps, Any Device' Option for Customers in 2008"http://investor.verizon.com/news/view.aspx?NewsID=870

These restrictions on terminal equipment can be easily compared to pre-Carterfone restrictions on terminal connection. Both cellular providers and pre-Carterfone AT&T prevent terminals from connecting to their respective networks. In addition to these hardware restrictions carriers also implement a second set of restrictions which cannot be directly compared to those employed by pre-Carterfone AT&T. These restrictions concern the software and services offered by cellular carriers. Cellular carries often remove abilities of cellular phones which are available when purchased direct from the manufacturer. These features would often have capabilities that would allow a customer to bypass similar, for fee, services offered by the provider. For example, carriers often remove functionality offered by Bluetooth wireless technology. This functionality allows a handset to be wirelessly connected to a personal computer for the purpose of file transfers or other types of data sharing. Often cellular companies will limit these capabilities in order to force customers to use their for fee services which offer the same functionality but at an additional cost to the consumer.[66] For example, users of the Treo handheld were unable to tether (connect two devices for the purpose of sharing data) their devices via Bluetooth to a computer in order to transfer data between the two of them. However, the cellular provider offered a fee based service which accomplished the same task.

A second example is Verizon's restrictions of the Motorola v710 cellular phone. A lawsuit was brought against Verizon Wireless which accused them of advertising full Bluetooth functionality on a Motorola V710 cellular phone when in fact Verizon had disabled the data transfer feature inherent in Bluetooth technology. Instead Verizon offered customers pay services which would accomplish the same functions as Bluetooth

[66] Tim Wu, "Wireless Carterfone" International Journal of Communication (2007)

albeit at a cost. Verizon defended its decision to restrict the abilities of Bluetooth because they "conflicted with contractual agreements it has with content providers participating in its 'Get it Now' application download service offered with the v710." [67] The CTIA expanded the argument further and explained Verizon's decision to remove Bluetooth was for the benefit of consumers because it protected them from data theft and viruses.

> Bluetooth, a short range wireless standard, is incorporated into many wireless devices, enabling the use of Bluetooth enabled earpieces among others. Improperly configured phones and inexperienced users could be exploited through the use of Bluetooth to give out all of the personal data contained within the handset. Different American carriers have taken different approaches to addressing this problem. Most have taken the step of disabling Bluetooth by default and forcing users to affirmatively enable the hardware through the operating system software. However, Verizon Wireless went a step further and removed one of the Bluetooth profiles capable of betraying the users' data from the phones, thus also removing some of the features of Bluetooth. In either case, a customer seeking Bluetooth capabilities has competitive options."[68]

The end result of the lawsuit found Verizon guilty of deceptive advertising. Verizon, along with the other carriers, now state which Bluetooth services are available for each product within its documentation.

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[67] Shelley Solheim, "Verizon Wireless Users Sue Over Disabled Bluetooth Features" http://www.eweek.com/c/a/Mobile-and-Wireless/Verizon-Wireless-Users-Sue-Over-Disabled-Bluetooth-Features/

[68] Cellular Telecommunication and Internet Association. "Opposition of the CTIA the Wireless Association". RM-11361, 68.

Additionally, carriers also often restrict the Wi-Fi capabilities on some of their cellular devices. There is no technical reason for the removal since these cellular devices have identical models in other countries with Wi-Fi capabilities. An example of this feature crippling is found on the Nokia e61/e62 model cellular phone. The e61 and e62 are models of the same cellular phone released in Europe and the United States. The European model, the e61, has Wi-Fi while its comparable U.S. equivalent, the e62, does not.[69]

Under normal market conditions consumers would purchase the cellular phone which offers the best value and manufactures would develop cellular phones designed to fit the needs of the consumers. Wi-FI offers consumers abilities which saves them money and increases the usability of their device. Accordingly it would make sense that Wi-Fi capabilities would be included in cellular phone designs. Carrier control over the handset market allows them to disrupt normal market forces and dictate what technology and corresponding services are available on cellular phones.

In addition to hardware restrictions put in place by cellular providers they often also restrict the services allowed to access their network. Similar to the hardware restrictions on cellular phones mentioned above the services they often restrict are those which the carriers offer at a higher price such as voice calls, picture messaging, email and SMS. An analysis of the cellular carriers acceptable use policies for their data plans reveals they all restrict data services which have persistent and/or streaming connections

[69] Tim Wu, "Wireless Carterfone" International Journal of Communication (2007) 393

despite advertising them as "unlimited" plans.[70] Some services which utilize these streaming or persistent connections include voice over IP and streaming audio or video programs. Below are the acceptable use policies of the three national carriers which restrict certain data services on their cellular networks.

Sprint Acceptable Use Policy:

> Vision/Power Vision.... Services are not available for use in connection with server devices or host computer applications, other systems that drive continuous heavy traffic or data sessions, or as substitutes for private lines or frame relay connections. Except with phone-as-modem plans, you may not use a phone (including a Bluetooth phone) on a plan with unlimited Vision/Power Vision as a modem in connection with a computer, PDA, or similar device. We reserve the right to deny or terminate service without notice for any misuse. Availability of downloadable or streaming content is subject to change.[71]

Verizon Wireless Acceptable Use Policy:

> The Data Plans and Features MAY NOT be used for any other purpose. Examples of prohibited uses include, without limitation, the following: (i) continuous uploading, downloading or streaming of audio or video programming or games; (ii) server devices or host computer applications, including, but not limited to, Web camera posts or broadcasts, automatic data feeds, automated machine-to-machine connections or peer-to-peer (P2P) file sharing; or (iii) as a substitute or

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[70] Jacqui Cheng, "Verizon to pay $1 million over deceptive 'unlimited' EVDO plans http://arstechnica.com/news.ars/post/20071023-verizon-to-pay-1-million-over-deceptive-unlimited-evdo-plans.html

[71] Sprint, "Terms & Conditions", http://nextelonline.nextel.com/en/legal/legal_terms_privacy_popup.shtml

backup for private lines or dedicated data connections. This means, by way of example only, that checking email, surfing the Internet, downloading legally acquired songs, and/or visiting corporate intranets is permitted, but downloading movies using P2P file sharing services and/or redirecting television signals for viewing on laptops is prohibited.[72]

AT&T Acceptable Use Policy

The Data Plans and Features MAY NOT be used for any other purpose. While most common uses for Intranet browsing, email and intranet access are permitted by your data plan, there are certain uses that cause extreme network capacity issues and interference with the network and are therefore prohibited. Examples of prohibited uses include, without limitation, the following: (i) server devices or host computer applications, including, but not limited to, Web camera posts or broadcasts, automatic data feeds, automated machine-to-machine connections or peer-to-peer (P2P) file sharing; (ii) as a substitute or backup for private lines, landlines or full-time or dedicated data connections; (iii) "auto-responders," "cancel-bots," or similar automated or manual routines which generate excessive amounts of net traffic, or which disrupt net user groups or email use by others; (iv) "spam" or unsolicited commercial or bulk email (or activities that have the effect of facilitating unsolicited commercial email or unsolicited bulk email); (v) any activity that adversely affects the ability of other people or systems to use either AT&T's wireless services or other parties' Internet-based resources, including "denial of service" (DoS) attacks against another network host or

[72] Verizon Wireless, "Terms & Conditions", http://www.verizonwireless.com/b2c/store/controller

individual user; (vi) accessing, or attempting to access without authority, the accounts of others, or to penetrate, or attempt to penetrate, security measures of AT&T's wireless network or another entity's network or systems; (vii) voice over IP; or (viii) software or other devices that maintain continuous active Internet connections when a computer's connection would otherwise be idle or any "keep alive" functions, unless they adhere to AT&T's data retry requirements, which may be changed from time to time. This means, by way of example only, that checking email, surfing the Internet, downloading legally acquired songs, and/or visiting corporate intranets is permitted, but downloading movies using P2P file sharing services, redirecting television signals for viewing on Personal Computers, web broadcasting, and/or for the operation of servers, telemetry devices and/or Supervisory Control and Data Acquisition devices is prohibited. Furthermore, plans(unless specifically designated for tethering usage) cannot be used for any applications that tether the device (through use of, including without limitation, connection kits, other phone/PDA-to computer accessories, Bluetooth® or any other wireless technology) to Personal Computers (including without limitation, laptops), or other equipment for any purpose.[73]

The acceptable use policies from the four major national carriers all have similar restrictions, namely peer to peer communication, streaming data connections (such as VoIP and video) and tethering. Ironically the services they prohibit are also offered by the carrier as a fee service. As a comparison a user can make a call on Skype for pennies per minute as opposed to the average cost per minute of a cellular call. Third party streaming video services also fall under this classification of "streaming or persistent

[73] AT&T "Terms & Conditions." http://www.wireless.AT&T.com/cell-phone-service/legal/plan-terms.jsp

connections". Software such as Orb, which streams video from your digital video library on an Orb equipped desktop are prohibited by these terms. However while they prevent Orb from being used on their networks, three of the four national cellular carriers, AT&T Mobility, Sprint and Verizon all offer similar streaming video services for a additional monthly fee.[74] [75] [76]

Freedom of Access: The Application of Wireless Carterfone

If aspects of the cellular industry are analogous to the structure of pre-Carterfone AT&T what would be the ramifications of applying Carterfone to the cellular industry? A number of Academics including Timothy Wu and Laurence Lessig along with Skype, a provider of VoIP, have recently hypothesized the possible outcomes of applying Carterfone to the cellular industry.[77]

Mark Lemley and Laurence Lessig were some of the first academics to propose applying Carterfone principles to cellular networks, separating the natural monopoly section of the infrastructure from the section which can foster competition. That is to say, separating the telecommunication infrastructure from services and devices which utilize the infrastructure. Timothy Wu built upon the concepts put forward by Lemley and Lessig and within his paper "Wireless Carterfone" expresses four areas of concern regarding the current state of the cellular industry:

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[74] AT&T Wireless, "CV Video on your Cellphone" http://www.wireless.AT&T.com/learn/messaging-internet/media-entertainment/video.jsp
[75] Sprint, "Sprint TV" http://www1.sprintpcs.com/explore/ueContent.jsp?scTopic=multimedia192
[76] Verizon Wireless, "VCAST Mobile TV" http://products.vzw.com/index.aspx?id=mobileTV#overview
[77] Mark A. Lemley and Laurence Lessig "The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era." http://papers.ssrn.com/paper.taf?abstract_id=247737

1. Network Attachment: Carriers practice of forbidding foreign device attachment.
2. Product Design and Feature Crippling: Carriers use of control over network attachment to cripple many "consumer friendly" features.
3. Discriminatory Broadband Services: Limitations placed on which applications can utilize data broadband services.
4. Application Stall: Carriers failure to foster a "robust application market."

He builds upon these concerns and formulates four recommendations to remedy the problems he sees within the cellular industry.

1. Wireless Carterfone: Apply the principles of Carterfone to the cellular industry and allow any device which meets certain specifications to connect to the cellular infrastructure.
2. Basic Network Neutrality Rules: Cellular providers would be forbidden from blocking network content or services
3. Disclosure: Cellular providers should inform consumers of any "limits placed on devices" or "limits on bandwidth usage."
4. Standardize Application Platforms: The cellular industry should work to decrease the development hurdles of mobile application development. [78]

In addition to Lemley, Lessig and Wu, Skype, a provider of Voice over Internet Protocol (VoIP) service, has also expressed a desire to have Carterfone principles applied to the cellular industry. In a petition to the FCC Skype argued "carriers are using their considerable influence over handset design and usage to maintain an inextricable tying of

[78] Tim Wu, "Wireless Carterfone" International Journal of Communication (2007)

applications to their transmission networks and are limiting subscribers' rights to run applications of their choosing...Skype requests that the Commission initiate a proceeding explicitly to enforce its *Carterfone* policy in the mobile communication and Internet age. The Commission's *Carterfone* policy allowed consumers to attach any device to the wireline network... [t]hat same principle, applied to Internet applications and other wireless devices, would liberate software innovation and free equipment manufacturing from unreasonable control by carriers, enabling them to incorporate a variety of feature in handset deigns."[79] Applying Carterfone would be "an explicit elaboration of the Commissions broadband policy which establishes that consumer 'are entitled to connect their choice of legal devices that do not harm the network and consumers are entitled to run applications and services of their choice'".[80]

The Consumer Telecommunication Internet Association (CTIA) representing the cellular industry responded to the arguments put forward by Lessig, Wu and Skype with their own petition. Interestingly enough many of the arguments they use are strikingly similar to those used by AT&T 40 years ago. The CTIA argues the cellular industry has robust competition and there is no need to apply Carterfone rules to enhance the level of innovation and competition within the industry. As evidence they point to the number of cellular carriers available to most Americans. They argue "98% of all Americans live in counties where at least three wireless carriers compete for subscribers and 94% of Americans live in counties with four or more wireless competitors."[81] They also point to

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[79] Skype Communication S.A.R.L., "Petition to Confirm a Consumer's Right to Use Internet Communication Software and Attach Devices to Wireless Networks," 6.
[80] Skype Communication S.A.R.L., "Petition to Confirm a Consumer's Right to Use Internet Communication Software and Attach Devices to Wireless Networks," 6.

[81] Cellular Telecommunication and Internet Association. "Opposition of the CTIA the Wireless Association". RM-11361.

decreasing prices of cellular service and new plans which offer unlimited in-network calling as evidence of the robust competition found in the cellular industry.

In response to Wu and Skype's arguments for the application of network neutrality rules to the cellular market the CTIA responded by detailing how these rules will harm the health of the network for all users, an argument almost identical to AT&T's defense against Hush-a-Phone and Carterfone. The CTIA argued,

> In order to maintain maximum efficiency over a wireless connection, some carriers prevent their consumers from using applications that require abnormally large amounts of bandwidth or near-constant connections to the network, such as streaming media and peer-to-peer ("P2P") services. Streaming media, be it audio or video, require large amounts of bandwidth over potentially long periods of time. P2P services also require large amounts of bandwidth to transfer information but are particularly troublesome because peer-to-peer services need to use the connection to the Internet when they are idle as well as when they are active."

In response to Wu and Skype's petition to apply Carterfone type rules allowing foreign device attachment to the cellular industry the CTIA argued the cellular industry would face significant challenges to implement them and their implantation could harm the health of the network. Ironically, again these statements echo AT&T's arguments against the application of Carterfone. They argued the technology which drives the cellular industry is fundamentally different than wired telephony in a way which prevents the application of Carterfone. The CTIA states "wireless is a shared network medium. Thus, unlike traditional wired broadband where each user has a dedicated pipe to their home, the wireless user must share the available bandwidth with all other users – both voice and data users – in their vicinity."[82] That "[p]oor handset performance, both in terms of voice and data service, can result in fewer connections per cell, or the need for increased cells to maintain system capacity."[83] That is to say, cellular technology operates more closely to a party line than a traditional phone line since all users share the same medium to communicate. Carterfone was never applied to party lines since they were a shared medium. If one user of a party line attached a device which would interfere with the line it would impact all users of the line. The CTIA argues cellular should be treated similar to party lines since all users share the same communication medium.

A second argument put forward by the CTIA advocating the continuation of cellular policy is government mandates which force them to maintain services on their mobile devices such as Enhanced 911 (E-911). They argue government mandated services such as E-911, which traces the location of a call when a handset dials 911 and allowing any phone even if it is unactivated to dial 911, prevent them from allowing third party devices from attaching to their network. The CTIA argues

> [n]etwork-based E-911 location systems require precise calculations of field strength and signal timing in the network to accurately estimate the location of subscribers. By operating unknown and uncontrolled devices on a wireless network, this delicate network balance is disrupted and disables the ability of the network provider to ensure that it can locate subscribers with the specified degree

[82] Cellular Telecommunication and Internet Association. "Opposition of the CTIA the Wireless Association". RM-11361, 100.
[83] *Ibid.*

of accuracy. Therefore, more than simply disrupting routine wireless communication, untested and unapproved devices that are not managed by carriers can adversely affect the public safety of wireless subscribers regardless of whether the device is operating as intended or if it is[84]

Will the application of Carterfone to the cellular industry suggested by Lessig, Wu and Skype and others have a significant impact on innovation? The cellular industry believes innovation is already flourishing within their highly controlled structure and the application of Carterfone will do more harm than good. While there is no doubt the cellular companies are correct in stating innovation has occurred could there be substantially more innovation if entrepreneurs were able to harness the full power of the cellular infrastructure through open access? A through analysis of case studies which detail the progression of innovation on open networks will allow a conclusion to be formed regarding the impact of open access regulations.

Case Study 1: The Effect of Open Access on Internet Growth

An excellent case study to analyze the impact of policies which foster an open access environment on a telecommunication network is the growth and development of the Internet. The explosive growth of services available through the Internet and the rate of penetration can be attributed to the policies which allowed third party devices to connect to the national telecommunication infrastructure. Prior to these polices only devices owned and operated by the telephone monopoly, AT&T, were allowed to connect to the corporations national telecommunication network.

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[84] *Ibid*

The Internet began as a research project by the Defense Advanced Research Project Agency (DARPA) to create a computer network which could survive a nuclear attack. The network was named ARPANET and its first two nodes were connected in 1969. In 1983, ARPANET was joined by a second network funded by the National Science Foundation to link university supercomputers together using the same protocols developed by ARPANET engineers.[85] This network was called NSFNET and by 1988 NSFNET interconnected, or peered, with private companies which allowed private consumers to access the growing Internet. This access to the general public led to the rise of Internet Services Providers (ISP's) such as UUNet and CompuServe. The public would connect to these ISP's through modems in their personal computers which utilized the telephone network for communication.

Because these early ISP's used the national telecommunication infrastructure owned predominately by AT&T it can be argued the policy which had the greatest impact on the growth of the Internet was the seminal Carterfone decision. As discussed earlier Carterfone allowed for the connection of any third part device to the AT&T communication infrastructure as long as the device met certain technical specifications. The open access provisions allowed by Carterfone led to an environment where multitudes of developers and manufactures could develop new innovative technologies and products. Lessig writes "[i]nnovation under the old design was thus controlled by AT&T. If a person with a competing conception of how a communication network should be designed wanted to implement that competing conception, he or she would

[85] This suite of protocols happened to be Transmission Control Protocol/Internet Protocol (TCP/IP). The same protocol which is used to transfer data over the current Internet.

have to either work for AT&T, or convince AT&T of the merits of this alternative design. AT&T was, therefore, a bottleneck on creativity in network architecture."[86]

The application of Carterfone to the telephone industry "decentralized innovation: any company or even individual can build to the standards of the phone system, without gaining the permission of the phone company"[87] The consequences of this decentralization led to the widespread development and market penetration of computer modems. Carterfone rules allowed a user to attach a third party data modem to the national communication infrastructure and consequently connect to the Internet. The lack of regulations and AT&T control over customer premise equipment allowed manufactures to quickly develop new and faster modems all of which did not need approval from owners of the telecommunication infrastructure since they used set standards to connect to the telephone network. Without the application of Carterfone to the national telecommunication infrastructure users may not have been able to connect third party modems. Without these third party modems users would not have had the same ability to access the Internet and its explosive growth and pervasive integration into our lives may never have occurred. As Oxman writes "[t]he Internet's 'killer apps,' email and the World Wide Web, developed and flourished by using our nation's phone lines."[88] Phone lines which were freed from carrier control by Carterfone.

While many other factors were involved in the growth of the Internet one can be relatively certain Carterfone rules helped speed its growth. The ability of manufactures to freely create new devices which utilized the telephone network helped transition home

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[86] Laurence Lessig and Mark A. Lemley. "The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era", 48 UCLA L. Rev. 925, 2001. 10.
[87] *Ibid.*
[88] Jason Oxman, "The FCC and the Unregulation of the Internet" (1999), 5.

communication from voice centric communication to the multitudes of communication methods allowed by the Internet.

Case Study 2: Open Access Architecture: The Internet

While the separation of customer premise equipment from control of the infrastructure owner is a perfect example of how open access can stimulate an innovative environment the growth of the Internet itself is an excellent example of how an open infrastructure free of regulation and access controls fosters an innovative environment. An analysis of the foundation of the Internet reveals all of the communication between nodes is based on a single suite of communication protocols, the Transmission Control Protocol and Internet Protocol (TCP/IP). As Farrel writes the architecture of the Internet "reflects the Internet pioneers' conscious strategy that the platform should not anticipate what applications would rely on it, and that no central gatekeeper should decide which applications could be provided."[89] He continues

> The openness of the Internet's logical layer invites diversity in the layers above and below it. The physical layer below includes wired, wireless, satellite, and cable transport facilities. In the layers above, developers can create new applications such as e-mail, the World Wide Web, and Napster without first asking permission of anyone, and in particular a custodian of the TCP/IP standard. In turn, these applications support the content layer and enable consumers to access all forms of information — voice, video, audio, and data. Many

[89] Joseph Farrel "Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age" 90.

commentators suggest that the openness of the logical standard was crucial in spurring the development of applications and content.[90]

That is to say any device is allowed to connect to the Internet provided it can communicate using the standard TCP/IP protocol. This freedom to attach any device to the network has allowed for an explosive growth of technologies which utilize the Internet for their communication. The number of devices which utilize the protocol to communicate is astounding. The most obvious of these is the personal computer but one just has to examine the devices in their environment to discover a multitude of other devices which use TCP/IP to communicate; point of sale systems, security systems, even refrigerators use TCP/IP for communication.[91]

The ability of TCP/IP to allow for a multitude of devices to communicate extends beyond hardware devices. It includes many different software applications which rely upon protocols that use TCP/IP as their data transportation method. The most obvious of these applications is the World Wide Web and its corresponding protocol Hypertext Transfer Protocol (HTTP). In addition to HTTP there are numerous other protocols which rely upon TCP/IP to transfer data between two nodes. Some examples which illustrate the diverse uses of TCP/IP include E-Mail, Usenet, and File Transfer (FTP). Open access to the underlying transport network has allowed individuals and corporations to innovate new technologies like the examples given above.

The end result of this open environment was the development of a diverse array of devices and services. The motivating factor behind this array was the lack of a central

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[90] *Ibid.*,91

[91] Ian Fried, "An ice box with your white box" 2002 http://www.news.com/2100-1040-961619.html

gatekeeper who controlled the development of new devices or services. Without a central gatekeeper any individual was free to create and distribute their inventions as they saw fit. This allowed for more than one entity responsible for deciding which innovations would benefit users most; it was left in the hands of the users to decide which innovations would benefit them the most.

Case Study 3: Open Access and Spectrum Commons: Wi-Fi

The third case study of open access policies which allowed innovation to flourish will examine the impact of open access policies as well as the commons approach to spectrum management. It will focus on the development of the IEEE 802.11 standard for wireless Ethernet, more commonly referred to as Wi-Fi.[92] The first policies which gave birth to these technologies came in 1986 when the FCC began allocating a number of frequencies within the 915MHz, 2.4GHz and 5.7GHz as unlicensed bands for use by any device as long as it followed certain power output requirements.[93] The unlicensed nature of these frequencies allowed manufactures to bypass the licensing process to obtain access to a specific frequency from the FCC.

Hardware manufactures quickly embraced the unlicensed nature of these frequencies and created a host of devices which could be used for personal and data communication. The most obvious of these, cordless phones and wireless data networks, were among the first to utilize these new unlicensed frequencies. In 1997, the IEEE ratified the initial specification for 802.11 which would utilize these frequencies to

[92] The Institute for Electrical and Electronics Engineers (IEEE) A standards granting body for telecommunication standards

[93] 47 C.F.R. §15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

transmit data over the 2.4GHz and 5GHz frequency ranges.[94] [95] Wi-Fi, as 802.11 became known in popular nomenclature, experienced explosive growth. Over 100 million Wi-Fi devices have been sold from 2004-2007.[96] The initial 802.11 specification allowed for a transmit speed of 11Mbps but growing acceptance of Wi-Fi led to the development of an improvement in the standard which increased the speed to 54 Mbps with the ratification of the 802.11g standard and then to over 100 Mbps with the development of 802.11n.[97] [98] The demand for faster wireless was so strong many manufactures released products based on their own specifications before the standards were ratified by the IEEE.

The number of services offered by this technology has experienced an equally explosive rate of growth. Due to the unlicensed nature of the frequency devices could be designed for any purpose as long as they followed the FCC regulations for these bands. As an example of the diverse array of services offered, many private companies and municipalities saw these unlicensed frequencies as a way to introduce a new competitor into the "last mile" of telecommunication infrastructure. This "last mile" is the last mile of telecommunication infrastructure from the telecommunication provider to the customer's location. Due to the large amount of capital required to construct and maintain telecommunication infrastructure to the subscriber's location the "last mile" has been a notoriously anti-competitive market.

[94] Matthew S. Gast "802.11 Wireless Networks: The Definitive Guide" (Sebasatopol: O'Reilly, 2005)
[95] 802.11a and 802.11b commonly referred to as Wi-Fi were ratified in 1999. However 802.11 existed before these two standards were ratified in a form primarily used by corporations.
[96] Jeff Caruso, "WLAN growth fueled by Draft 802.11n" http://www.networkworld.com/newsletters/lans/2007/0820lan2.html
[97] 802.11a was the first standard to reach a data throughput speed of 54Mbps. However, due to the higher cost and shorter range of 802.11a radios they were not accepted as quickly as 802.11b products.
[98] For 54mbps see 802.11g for 100 mbps see 802.11n

Municipalities believed they could break the monopolies held by these last mile providers and believed they could deliver Internet services to all their residents by introducing a new competition to the "last mile" using a wireless network which transmitted on unlicensed frequencies. One of the most prevalent examples of municipal wireless was a project initiated by the City of Philadelphia to provide wireless access to all of its residents and guests. It is especially aimed at providing wireless to low income residents with the goal of "enabling [low-income families] to take advantage of opportunities that before were closed to them."[99] The city began development of a network and partnered with ISP Earthlink to provide Wi-Fi coverage to the entire city.

In addition to municipalities providing wireless Internet access many private companies began using the unlicensed bands to provide Internet service. The advantage of using these bands is that companies do not need to have the capital necessary to acquire rights to spectrum.[100]

A second example which details the innovation present on an open network is a unique convergence of technology which is occurring on Wi-Fi networks that will merge cellular voice technology with Wi-Fi technology. Often referred to as fixed mobile convergence (FMC) this technology has been embraced by many of the large manufactures of wireless equipment such as Cisco, and Arbua.[101] [102] FMC will allow for a cellular user to seamlessly transfer a cellular call from a cellular network to a Wi-Fi network and vice-versa. While the user is on the cellular network they would be billed

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[99] Wireless Philadelphia, "About Wireless Philadelphia" http://www.wirelessphiladelphia.org/about_wireless.cfm
[100] SkyPilot Networks, http://www.skypilot.com
[101] Cisco Systems, "Cisco Demonstrates IMS-enabled mobile Convergence for IP NGN" http://newsroom.cisco.com/dlls/2005/prod_120705.html
[102] Aruba Networks, "Fixed Mobile Convergence is Taking the Enterprise by Storm… What Does This Mean and Will You Be Ready" http://www.arubanetworks.com/applications/mobile_convergence.php

for use by their cellular provider when their phone detects a Wi-Fi network it would transfer the call to a VoIP provider.[103]

While the unlicensed nature of the frequencies has helped foster an innovative environment for development of new devices it has led to a glut of devices over crowding these frequencies. This overcrowding leads to interference between devices similar to what the radio market experienced when it used the commons method of spectrum allocation. In order to overcome this interference manufactures are moving to the less congested 5GHz unlicensed bands. However, as the number of unlicensed wireless devices continues to grow even these will become overcrowded with transmitters. The number of devices operating in these frequencies causes them to become saturated with signals to the point where a device cannot differentiate transmissions destined for it from other transmissions on the frequency. The end result of the saturation is a device which cannot receive signals destined for it due to other, more powerful devices. Similar to the early experiences in radio where stations could not be received due to interference from other stations, devices within these unlicensed frequencies often experience interference from each other.

After analyzing the explosive growth of the Wi-Fi market in both products and services it can be safely said open access to the network infrastructure and wireless spectrum has helped enhance the ability of manufactures to innovate new devices and applications. However, problems faced by devices trying to operate in overcrowded licensed bands demonstrate the current necessity of spectrum management.

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[103] T-Mobile, "Hotspot @Home Talk Forever Mobile" http://www.t-mobile.com/promotions/hotspotathomelearnmore.aspx

Case Study 4: The Development Platforms: Brew vs. Windows Mobile

Open access as an incubator for innovation can also be examined through the rapid development of software on an operating system which allows a developer free access to the operating system compared to one which restricts developers. An examination of the early personal computer market reveals there were a number of different operating systems. These operating systems would act as a bridge between software created by developers and the hardware programs interacted with. Each program a developer would write would have to be written specifically for each operating system. Since there were a large number of operating systems, developers were required to develop multiple versions of a program if they wanted wide spread acceptance of their program. Similarly mobile devices run a number of different mobile operating environments which are analogous to the operating system on a personal computer. Each of these environments has characteristics which define the level of difficulty a developer faces when developing applications for them. These characteristics can be defined on a scale which details the ease of development from open to closed development environments. Within this paradigm of development are three categories which determine the openness of a mobile operating system:

1. Ease of developer access to programming tools.
2. Ease of application distribution.
3. Ease and level of hardware access.

On the left, or liberal, end of the scale is complete access to the hardware on the mobile device, free tools to develop programs and the ability for the developer to distribute the program to a user base of their choosing. On the opposite side of the scale developers must pay to have access to tools necessary to create programs, pay for testing of the program before it is released and have their programs released to a user base chosen by the cellular carrier. This case study will analyze two major mobile programming languages within the United States market, Windows Mobile and the Binary Runtime Environment for Wireless (BREW). These environments represent the two ends of the mobile environment development paradigm.[104] An analysis of the success of each paradigm can be extrapolated to help determine the success of an open software development platform free from carrier control.

Windows Mobile is a mobile environment created by Microsoft for mobile devices such as cellular phones and personal data assistants (PDA's). Along the development paradigm Windows Mobile would be placed at the far left. Tools necessary for the development of Windows Mobile applications are freely available from Microsoft, users of Windows Mobile devices are able to install these applications provided their hardware meets the minimum specifications required by the software, and developers of Windows Mobile applications have access to all hardware functions of the device without restrictions. Essentially, a developer can write any application they desire and a user of a Windows Mobile device can install any Windows Mobile application as long as their hardware meets the specifications required by the application.

On the opposite side of the mobile environment paradigm is BREW a mobile environment developed by QUALCOMM and used by Verizon as part of its "Get it Now" service. It has a number of qualifications placed on applications developed for it

[104] There are many more mobile environments within the United States market these include the Blackberry environment from RIM, Java Mobile Environment (JME) developed by Sun Microsystems, and Symbian OS developed by Nokia.

which must be fulfilled before applications can be installed on mobile devices running the BREW platform. Unlike Windows Mobile developers must pay for the tools necessary to develop applications for the BREW mobile environment.[105] As of this writing the cost of access to development tools was 400 USD. In addition to the cost of purchasing the tools necessary for development QUALCOMM also requires developers to pay for testing of their application in order to verify it meets certain quality standards which guarantee the program will not harm the mobile environment.[106] Once QUALCOMM verifies the application developers must then submit their application to a second round of testing with the cellular carrier, or carriers if the developer wants their application on multiple carriers, who will deploy the application. Once the cellular carrier believes the program to be safe for distribution they will offer a digital certificate which will allow the application to be installed on the mobile device.[107] These requirements have led developers of BREW applications to describe it as "a tarpit of misery, pain and destruction."[108]

The benefits of open development are apparent by examining the number of Windows Mobile application to those offered by BREW on Verizon devices. Windows mobile has over 17,000 applications with many more developed by individuals for their own personal use. [109] Comparatively BREW offers hundreds of applications.[110] Windows mobile also has a diverse set of applications which encompass a broad range of

[105]QUALCOMM, "BREW Developer" http://brew.qualcomm.com/brew/en/developer/getting_started/alliance_developer.html
[106] http://brew.qualcomm.com/brew/en/developer/getting_started/app_dev_process.html
[107] VeriSign, "Authentic Document IDs for BREW." **http://www.verisign.com/products-services/security-services/code-signing/brew-document-ids/index.html**
[108] Tim Wu, "Wireless Carterfone" International Journal of Communication (2007) 2
[109] http://www.handango.com/ lists 17,000 windows mobile applications

[110] Paul Korzeniowski "Qualcomm Brews Up an Intriguing Software System" http://www.technewsworld.com/story/51179.html

features. For example Windows Mobile users can download Voice Over IP (VoIP) applications which will enable users to bypass allow placing calls on cellular networks and using another network (e.g. Wi-Fi) instead.[111] There is no comparable BREW equivalent.

The cost of developing brew applications also deters amateur developers from creating applications for BREW enabled devices. These amateur programmers have had a significant impact within the personal computer industry. For example, amateur computer builders and programmers helped spur innovation in the early computer market.[112]

The lack of innovation within the closed market paradigm can also be accounted for by the level of carrier control over the software distribution chain. Since all applications have to be authorized by the cellular provider it is in their best interest to prevent applications which would harm their business model. VoIP applications are a perfect example of applications which could negatively influence their business model. A VoIP application loaded onto a mobile handset would allow customers to forgo purchasing a voice plan since all voice traffic would be sent over a data plan. The controls placed on closed software development paradigms, such as BREW, allow the cellular carrier to restrict applications which may be beneficial to the consumer but negatively impact the business model of the carrier.

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[111] Skype has developed a version of its VoIP software for Windows Mobile and other platforms. http://www.skype.com/mobile/

[112] There are countless examples of the importance of amateurs in creating innovative and new products. Apple computer was founded by Steve Jobs and Steve Wozniak two computer hobbyists who met at a community group of computer hobbyists. Google was founded by two graduate students and initially was run out of a storage unit.

Are Competition Levels Optimal?

The cellular industry argues they are at the optimum level of competition for the greatest level of innovation to occur in the cellular market. This argument does have merit. An increase in the level of competition within the industry does not necessarily coincide with an increase in the level of innovation. Work by Aghion et. al. describes there is an optimum level of competition which fosters the most innovative environment. An industry above or below this optimum level of competition will not have enough economic incentive to innovate while an industry above this level of competition will prevent new innovation from smaller firms.[113]

Aghion et. al. measure the rate of innovation by the number of patents filed by a particular industry and measure competition through the Lerner index. The broad scope of technology which is utilized in the case studies and the limited scope of this paper make patents an impractical measure of innovation. In place innovation can be measured by qualitatively examining a number of markers which are consistent across case studies. The broad scope of the industries and limited scope of this paper also makes competition difficult to measure. A qualitative examination of growth of a particular industry can give a glimpse into the competitiveness of the industry. The industry examined in case study 1 is highly innovative. The growth of the Internet has continued since its inception. This growth can be shown in part by the increase in Internet traffic. Initially in 1969 Internet traffic doubled every 22 months by 2000 Internet traffic doubled every 6

[113] Aghion, Philippe et al. "Competition and Innovation: An Inverted-U Relationship." *The Quarterly Journal of Economics*(2005):701

months.[114] The industry examined in case study 2 is highly innovative. There are an almost unlimited number of computer applications which utilize the Internet for communication. The industry examined in case study 3 is also highly innovative. Wi-Fi has experienced a large growth since its inception as shown by the number of units sold as well as the types of applications of the technology. Case study 4 is the least innovative of the case studies. However, the operating system with the least amount of controls is more innovative.

By analyzing the similarities between the case studies and the cellular industry we can determine if the cellular industry is at the optimum location on the innovation curve developed by Aghion et. al. There are three markers which are consistent across the case studies. The first is the level of separation between the technology and the infrastructure which it requires. The second is the availability of de facto or de jure standards which govern the technical details of new technology. The third is the presence of gatekeepers who control access to the infrastructure or the technology.[115]

Case Study 1: Open Access on Internet Growth fits all of the above criteria. The infrastructure (communications network) is separated from the technology (modems, mainframes, etc.). There are set standards which govern how the infrastructure communicates with technology (standards published for interconnection by AT&T). The second case study Open Access Architecture: The Internet also follows these two guidelines. The infrastructure of the Internet (computer modems, telephone network) is separate from the technology which utilizes it (applications such as e-mail, web

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[114] Roberts, Lawrence, G. "Beyond Moore's Law: Internet Growth Trends". *Computer*(IEEE Computer Society, 2000)

[115] The concept of a gatekeeper who controls access from a technology to a medium was proposed by Farrell in *Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age*.

browsing). It uses a standard to communicate (TCP/IP). There is no central gatekeeper controlling which applications can harness the Internet for communication. Case Study 3: Open Access and Spectrum Commons: Wi-Fi also subscribes to these three principles. The infrastructure (Wi-Fi) is spate from the technology (Laptops) and follows a set standard to communicate (802.11). There is no central gatekeeper controlling which products can use Wi-Fi. Case Study 4: The Development Platforms: BREW v. Windows Mobile contains two different platforms. One which follows the three criteria of innovation and one which does not. Windows Mobile follows all of the criteria placing it on a more efficient section of the curve. It separates the infrastructure (mobile devices, cellular networks) from the technology (applications). IT follows a set standard (programs must be compiled to a supported language) and does not have a central gatekeeper since anyone with a computer and the knowledge can develop applications. However, BREW does not follow these three principles and is less prevalent than Windows Mobile. BREW does not separate the infrastructure (mobile devices, cellular networks) from the technology (applications). It does have a set programming standard (BREW). It does have a central gatekeeper who decides which applications and services are allowed on the devices.

Where is cellular placed on this model? Judging by the growth rate of mobile devices the cellular market is highly competitive.[116] Cellular does not separate infrastructure (cellular networks) from technology (mobile devices). It does follow set standards (GSM, CDMA) although it does not allow devices to connect without authorization so while manufactures of mobile devices can develop new products based

[116] The number of mobile subscribers has almost doubled from 2002- 2006. *Twelfth Annual CMRS Competition Report, Federal Communication Commission*

on these specification it does not guarantee they will be able to function on these networks It does have a central gatekeeper who controls which mobile devices are allowed on the cellular network and the software which runs on these mobile devices as well as the services which can access the cellular network. Judging from the level of innovation present in other industries who prescribe to more of these markers the cellular industry is not at the greatest level of innovation.

Can Carterfone be Applied to Cellular?

Judging from the case studies above it is clear an open access environment will foster a more innovation than one with closed access. Lessig, Wu and Skype's arguments are therefore valid in their argument that open access on cellular networks will foster a more innovative environment than what is currently available to mobile technology developers. While it can be proven open access will foster an innovative environment, as stated previously in this paper the, CTIA has numerous complaints regarding the application of Carterfone like open access rules to the cellular industry.

These arguments are almost identical to those put forward by AT&T 40 years ago during the Carterfone trial. A pragmatic analysis of these arguments shows an inherent weakness in the arguments put forward by the cellular companies. The core complaints of those opposed to the application of Carterfone are: open access will harm a users experience, government mandates prevent open access and open access will harm the health of the cellular network. An analysis of the first point, open access will harm the service of other subscribers, is simple to dispute. First, users are already able to purchase GSM handsets from third parties and use them on any GSM provider. If untested handsets impacted the quality of service for other users there would be evidence and reports of harm caused by third party devices. European cellular customers have had the ability to purchase third party handsets since the implementation of the GSM standard. They attach these mobile devices to the network of their choice without any ill effects. Secondly, the CTIA argues government mandated E911 standards prevent them from allowing customer provided devices on their networks. Again, if the carriers are willing to allow third party mobile devices on their networks this argument is invalidated in the same manner as the previous argument. The third argument proposed by the CTIA is that streaming data services such as Skype and other "high intensity" services will degrade network performance for all users. However, an examination of the services offered by cellular providers reveals they offer the same service they classify as bandwidth intensive. Three of the four national cellular providers offer streaming video, a bandwidth intensive service as defined by the CTIA, to their handsets as a for fee service.

If there are a limited number of technical challenges preventing the application of open access provisions to the cellular networks they why have cellular providers refrained from establishing these provisions? Noam believes:

> It is not clear why a carrier A would be the first to offer such choice to its customers. After all, it would provide an exit to its own customers, without a potential compensating gain from the customers of the other carriers B and C. The main reason would be to hope for enough users of B and C to switch their subscriptions to A in order to have the choice of not using A. This can hardly be a strong selling point. Furthermore, any choice requires the consent and cooperation of B and C, which might not be forthcoming once they realize that they are opening the door to a mutually destabilizing competition. They will be

concerned with reputation effects if they are blamed in users' mind with poor performance caused by an element not under their direct control. And they might be able to use bundling as a way to price discriminate, as George Stigler has pointed out in a different context. The likelihood of oligopolistic behavior within a small group of carriers is high. As the number of competitors shrinks, each has less to gain and more to lose by maverick behavior. It is also an inhibitor for any software developer to take initiatives for new applications if the market is largely closed, and this further reduces the attractiveness of any non-conforming behavior by a carrier.[117]

It is also possible carriers are uncertain if their current business model will generate the same amount of revenue if they were to allow open access. The communication paradigm of cellular networks is shifting as more users begin to embrace SMS texting and other communication technology. For example Gartner says text messages will surpass 2 trillion messages in Major Markets in 2008.[118] Other sources agree QUALCOM, the developer of BREW, believes

[t]he market for non-voice value added services will continue its upward sales trajectory into 2006. Global spending on mobile data services/products will grow by an average of 26% in 2006 driven by broader penetration of 3G devices, wider availability of services at lower cost, more robust and ubiquitous 3G network access and growing consumer awareness of services through non-operator

[117] Eli Noam "The Next Frontier for Openness: Wireless Communication" Telecommunication Policy Research Conference, 26, Oct. 2001.
[118] Gartner, "Gartner Says Mobile Messages to Surpass 2 Trillion Messages in Major Markets in 2008." http://www.gartner.com/it/page.jsp?id=565124

channels. 2005 saw continued growth in consumer spending on mobile data products and services on a global basis.[119]

As more users embrace these services the majority of users will switch to data centric services as opposed to voice centric services. Currently the cellular companies maintain their business model through the policies they put in place. They force consumers to use services which they offer for a fee while preventing them from using alternate services which are free or cost substantially less. If open access were enabled users would have identical services by utilizing the "unlimited" data service packages offered by cellular providers. Users can use Voice Over IP to make calls and chat programs such as IRC, AOL Instant Messenger and MSN instant messenger in lieu of SMS. Utilizing these technologies users would no longer need to pay for separate packages for voice or SMS. They would only need to purchase an unlimited data plan.

Areas for Further Research

This paper is by no means inclusive of all of the possibilities open access may have on cellular networks nor does it account for ways in which open access could be achieved without regulatory policies. European and Asian cellular markets and their corresponding regulatory structure and affects could yield valuable information about how differences in regulations impact the rate of innovation. Asian cellular markets in particular are ahead of the United States in the number and types of services available. It would be worthwhile to examine the root cause of their rapid innovation. Two potential

[119] QUALCOMM, "Market Research" http://brew.qualcomm.com/brew/en/developer/getting_started/market_research.html

areas of study would include an analysis of policies which fostered innovative policy and how Asian culture impacted the rate of innovation.

Mobile Virtual Network Operators (MVNO's) also warrant a degree of inspection. These network operators lease network access from the national cellular providers and resell it to their own customers. Similar to how Competitive Local Exchange Carriers (CLEC's) leased transmission medium from the Incumbent Local Exchange Carrier (ILEC). What effect would these MVNO's have if they offered open access and would it be possible for them to do so?

Conclusion and Analysis

It is clear policies put forward to regulate spectrum have a direct influence on the level of innovation. In order for cellular technology to reach its full potential some policy changes must be implemented which foster an open access environment for developers who utilize the cellular network for their products. This paper has demonstrated the clear benefits of policies which embrace open access. The Internet, Wi-Fi and Windows Mobile are all examples of open access paradigms which have experienced greater technological innovation than similar technologies which have followed a closed market paradigm. Thus the views put forward by Lessig, Wu and Skype are correct in assuming Carterfone like principles applied to the cellular industry will foster new innovation devices which utilize the cellular infrastructure.

The application of Carterfone will shift the market structure of the cellular industry. Similar to the impact of Carterfone on AT&T the market for third party mobile devices will expand. These trends are already beginning. While the third party market for mobile devices has existed for many years it is beginning to have an increased impact with the introduction of the Apple iPhone. Although the iPhone is available in the United States from its sole carrier, AT&T, it can also be purchased directly from its manufacturer. The iPhone has been praised for its intuitive user interface and functionality. The benefits of purchasing this phone were so great to consumers they purchased millions of iPhones at unsubsidized prices.[120] The demand for open access principles were so great users of the iPhone developed methods to circumvent methods put in place by Apple and AT&T to prevent application development and the freedom to choose any GSM carrier. The process of "jailbreaking" allowed the iPhone to be used on any GSM network and also allowed users to installed 3rd party applications which enhanced the abilities of the iPhone with services such as VoIP and instant messaging which were unavailable on the first generation iPhone.

Open access will also release control of mobile device hardware from the cellular carriers and allow developers to harness the full potential of technologies like Bluetooth. Mobile devices will begin to be treated as personal information terminals which will serve as a repository of information for other devices and as a data connection to the Internet. For example, as this paper previously discussed cellular manufactures will often hamper the abilities of some services, the most notable of which is Bluetooth, on their devices. If the abilities of Bluetooth were permitted manufactures of other technologies could implement features into their devices which utilized Bluetooth to communicate with a mobile device to retrieve an address book and integrate it into its own systems. An in-car communication system could communicate with a mobile device and integrate its

[120] Apple Reports First Quarter Results. http://www.apple.com/pr/library/2008/01/22results.html

address book allowing an occupant of the vehicle to access it through the hand-free system.

The application of open access provisions will bring software standardization which will allow developers to write any type of application they desire. Currently there are a number of different operating systems for mobile devices and software developers must program different versions of their software for each operating system. Already there are a number of efforts to create an operating system which can run on multiple different mobile devices. Apple has created an operating system for the iPhone, an offshoot of their desktop OS. Presumably this operating system and its derivatives will be used to power future Apple devices. Microsoft has also created a mobile operating system. In addition a group of handset manufactures, software providers and carriers formed a consortium to create a new operating system for cellular devices. This consortium, The Open Handset Alliance, has begun development of the Android operating system. As of this writing the software development kit for Android, a key piece necessary for the development of other software, was released to the public.

Eventually open access will be applied to cellular networks either though government regulations or industry self-regulation. Movements by the United States Government as shown by the Copyright's office decision to allow mobile device unlocking and the FCC's decision to impose open access provisions on the 700Mhz auction prove the government agrees with the benefits of open access. The cellular companies have noticed these trends and have begun some self regulation to employee open access provisions. While publicly detailing the problems associated with open access they have begun to quietly self-regulate themselves and allow more devices to freely attach to their networks. Whether these decisions have been from a fear of imposed regulation or a genuine belief open access will truly help them is a matter of debate.

Perhaps it would be counterproductive to forcefully apply these regulations to the cellular industry. The application of forceful government regulation can have unintended consequences unforeseen by legislatures who are unfamiliar with the nuances of a particular industry. It is possible open access regulations would change the cellular industry in ways which make it unprofitable or less competitive. Even with guidance from market experts there is no guarantee their opinions will be correct. The forceful application of government regulation to the cellular market could cause an increase in demand for data services which is unsustainable under current market prices for data equipment. If regulation were to cause new devices to enter the market which relied heavily on data communication cellular companies would need to increase the number of cellular towers serving a particular location. If demand for these new installations exceeded the revenue of the service cellular companies would be unable or unwilling to install new towers to maintain the same level of service. Without additional numbers of towers service would begin to degrade for all customers. Additionally, the forceful application of polices could shift key profit centers for the cellular industry which are used to maintain and develop the cellular infrastructure. For example, according to the 12th CRMS the profit margins from each SMS message sent are 90%. If regulations were imposed which allowed users to bypass the charges for each SMS by using a data plan instead of a traditional SMS plan the cellular industry would loose a large profit center. These profits may be used to pay for increased infrastructure and new technology such as 3G data networks. In response cellular corporations would need to raise prices for their data plans in order to maintain the same level of service.

The application of forced regulations would have the potential to create a "wild west" type of environment where there would be a limited number of standards governing the devices connecting to the cellular network. This in turn would create a market saturated by a myriad of devices, each with its own user interface and operating system. These factors would impose a substantial burden on the consumer who must navigate the maze of products in order to determine which suits their needs. These burdens might be so great consumers would reject the product all together. A complicated market such as this example would also deter manufactures for developing new products and services for the market. The lack of consumer market participation due to the difficulties imposed by a complicated market would deter manufactures from developing new technologies since they would be less likely to sell these technologies. Also, manufactures would be less likely to invest a substantial amount of capital in new innovations due to the uncertainty surrounding their success.

Contrary to the beliefs held by Lessig, Lemley and Wu the walled garden approach has had success in other markets. Asian markets in particular have shown tremendous success with the walled garden approach. Cellular providers in Japan using the walled garden model to offer web services to their customers experienced a growth rate in excess of providers who did not. Some may argue there was a lack of carrier control in the Japanese cellular market over the development and distribution of applications. However the Japanese cellular providers required many of the same restrictions as U.S. providers on application development, profit sharing and application distribution.

While these beliefs may have some degree of truth this paper has analyzed through a series of case studies and analysis of policies there is some advantage to a cellular industry which offers a greater degree of access to the underlying infrastructure. If the history of the Internet is any indication of the impact open access has on a telecommunication network the application of open access provisions to cellular networks will reveal a whole new paradigm of communication which could revolutionize the way we access information and communicate with each other.

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