Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Service Rules for the 698-746, 747-762, and 777-792 MHZ Bands	)	WT Docket No. 06-150
	)	
Implementing a Nationwide, Broadband, Interoperable Public Safety Network in the 700 MHZ Band	)	PS Docket No. 06-229
	)	
Implementation of the Commercial Spectrum Enhancement Act and Modernization of the Commission's Competitive Bidding Rules and Procedures	)	WT Docket No. 05-211
	)	
Development of Operational, Technical, and Spectrum Requirements for Meeting Federal, State and Local Public Safety Communications Requirements Through 2010	)	WT Docket No. 96-86

***EX PARTE* COMMENTS OF**
THE *AD HOC* PUBLIC INTEREST SPECTRUM COALITION

CONSUMER FEDERATION OF AMERICA
CONSUMERS UNION
FREE PRESS
MEDIA ACCESS PROJECT
NEW AMERICA FOUNDATION
PUBLIC KNOWLEDGE

April 5, 2007

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SUMMARY

The upcoming auction of licenses in the 700 MHz band is extremely important to American consumers. Due to the unique propagation characteristics of the 700 MHz band, license holders will be able to compete directly with the wireline broadband duopoly and provide consumers with their most affordable option for high-speed broadband Internet access, especially in rural areas. The fundamental right of consumers to "go anywhere" on the Internet and "attach any compatible device" without undue interference from the network operator must be maintained for these valuable services. Given that the spectrum to be auctioned is a publicly owned asset to which public interest obligations historically have been attached, operation of broadband services using that spectrum should protect that fundamental right. Moreover, given the potential for wireless broadband providers operating in the 700 MHz band to serve as a powerful third competitor to the broadband duopoly, which is now free to discriminate, it is essential that consumers be given a third broadband option that operates without discrimination.

For the following reasons, the FCC should, in this proceeding, establish a service rule for broadband services operating in the 700 MHz band that protects the consumer's right to use any equipment, content, application or service on a non-discriminatory basis without interference from the network provider:

- The unique propagation characteristics of the 700 MHz band will allow auction winners to deploy high-speed Internet access services at a much lower cost than other wireless services, making them a more affordable option for consumers;
- Wireless broadband is not a niche service, but will increasingly compete directly with wireline broadband services, which are subject to the basic consumer choice and open network principles adopted by the Commission;
- The marketplace is not working to protect consumers; existing wireline and wireless providers currently seek to control or limit the consumer's choice with respect to safe devices, applications and access to Internet content and services. Consumers have no guarantees that they will have access to competitive services that are free from gatekeeper control;
- A service rule to require auction winners to comply with basic consumer choice and openness principle, like the service rule for hearing aid compatibility (HAC), is squarely in the public interest and an appropriate condition to place on a license to make exclusive use of the publicly-owned airwaves;
- The timing is critical; services have not yet been deployed in the 700 MHz band, which means that auction winners have time to incorporate the openness principle into the design of their networks from their inception;
- The Commission has previously indicated that it would take action where, as here, there is evidence of a market failure that limits consumer's choices;
- A service rule will not reduce the value of the licenses and will certainly increase competition and consumer welfare, benefiting the economy overall;
- There is ample precedent in Commission policy for service rules that require interoperability standards for competing services and equipment.

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***EX PARTE* COMMENTS OF**
THE *AD HOC* PUBLIC INTEREST SPECTRUM COALITION

To: The Commission:

Consumer Federation of America, Consumers Union, Free Press, Media Access Project, New America Foundation and Public Knowledge (collectively referred to here as the "Public Interest Spectrum Coalition" or "PISC"), file these *ex parte* comments urging the Federal Communications Commission ("FCC" or "Commission") to condition the award of licenses for the 700 MHz band on the licensees' compliance with a service rule that requires 700 MHz license holders to provide broadband Internet access service on a non-discriminatory basis in a manner that enables consumers to attach any compatible device and to reach any web site, post

any information, provide any service, access or provide any application, without degradation, prioritization or interference by the network operator.

INTRODUCTION

The upcoming auction of licenses in the 700 MHz band is extremely important to American consumers. Due to the unique propagation characteristics of the 700 MHz band, the license holders may be able to provide consumers with their most affordable option for high-speed broadband Internet access, especially in rural areas. The right of consumers to "go anywhere" on the Internet and "attach any compatible device" without undue interference from the network operator must be maintained for these valuable services. The PISC urge the Federal Communications Commission (FCC or Commission) to establish a service rule in this proceeding that protects the consumer's right to use any equipment, content, application or service on a non-discriminatory basis without interference from the network provider. [1]

The timing of this proceeding is critical. Services have not yet been deployed in the 700 MHz band. The Commission can and should adopt service rules for the 700 MHz band now, before the auctions are held, so that the auction winners have time to incorporate these principles into the design of their networks from their inception.

1. The 700 MHz band is uniquely capable of providing high-speed, mobile broadband service at affordable prices for consumers, competing as a potential substitute for wireline broadband access.

Signals in the 700 MHz band have superior propagation characteristics. At a given transmit power level, the signals travel farther and are far more likely to penetrate walls and tree cover compared to higher-frequency spectrum used for most current commercial mobile radio

[1] This rule is sometimes summarily referred to in this document as the "consumer choice and openness principle."

services (CMRS). As a result, fewer towers and base stations are needed to provide service in the 700 MHz band, especially in rural areas.[2] One of the biggest obstacles preventing the nation's more than 3,000 commercial wireless ISPs (WISPs) from reaching more rural households is the difficulty of penetrating dense foliage and cost-effectively covering large, low-population areas with signals that rely on 2.4 GHz and 5 GHz unlicensed spectrum.[3] If WISPs, rural local exchange carriers (RLECs) and other wireless broadband access providers had greater access to low-frequency spectrum, rural customers could be served with better quality coverage and at a lower cost of deployment.

Because of these characteristics, the costs of deploying broadband Internet access services in the 700 MHz band could be far less than the costs of deploying service at higher frequencies. A 2004 study by Intel Corporation concluded that a wireless service with access to spectrum in the 700 MHz band "has significant capital advantages over a carrier operating at higher frequencies." Intel's study showed, for example, that "a 2.5 GHz MMDS licensee in a rural environment will incur capital expenditures over 4 times that incurred by a hypothetical 700 MHz operator."[4]

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[2] Aloha Partners testified before the Senate Commerce Committee in July of 2005 as follows:

> Studies have consistently shown that 700 MHz can provide broadband service in rural areas at half to one third the cost of the 1900 MHz personal communications services frequencies used by the cellular carriers (see Attachment). 700MHz can provide broadband services in rural areas at one fourth to one sixth the cost of the 2400 MHz Wi-Fi and MMDS (now BRS) frequencies used by unlicensed owners and by companies such as Sprint and Nextel. 700 MHz has the advantage of traveling further and being able to penetrate walls, dense foliage and other obstructions without the deterioration of signal experienced with either 1900 MHz or 2400 MHz wireless transmissions. . . . What this means is that rural areas that were previously "unreachable" can now get broadband service on an affordable basis.

Charles C. Townsend, President, Aloha Partners, before the Senate Committee on Commerce, Science, and Transportation, July 12, 2005.

[3] Interview with Marlon Schaefer, WISPA Board Member and FCC Committee Chair, January 26, 2007.

[4] Chris Knudsen and Masul Kibria, "Capital Expenditure Implications of Spectrum Assets in Semi-Rural Environments," Intel Corporation, unpublished study results, Oct. 30, 2004.

These lower costs are likely to translate into lower prices. In addition, wireless broadband services operating on 700 MHz spectrum will be far better able to reach consumers inside buildings, allowing these operators to compete as a direct substitute for DSL and cable wireline broadband access in the home. The combination of lower prices and far better quality coverage – including inside homes and businesses – is expected to be enormously popular with consumers. The 700 MHz band could provide Internet access that is faster and cheaper than existing wireless services, combined with a mobility that provides a significant advantage over existing wireline services. Rather than serving a "niche" market, services in the 700 MHz band could become many consumers' primary source of high speed Internet access and low-cost voice service.

2. The openness of wireless Internet services is increasingly important because of the overall growth in wireless broadband and the efforts of existing broadband providers to control the market.

The trends in both the wireless and wireline market make it even more critical that the FCC adopt a service rule to preserve customer choice and network openness in this proceeding. The entire wireless broadband market is expanding rapidly. The FCC's June 2006 data show that the number of wireless broadband users has grown from 0 to 11 million in just the past two years.[5] While today as much as 90 percent of these "broadband" connections are not potential substitutes for wireline broadband access – since 3G cellular services are extremely asymmetrical and offer customers data rates far slower than most DSL and cable modem services – both the quantity and quality of wireless Internet access services could increase dramatically *if* there is sufficient competition. Wireless voice users number well over 200 million, which indicates that the "head-room" for further growth is much higher. Wireless carriers are rapidly

[5] High-Speed Services for Internet Access: Status as of June 30, 2006; Industry Analysis and Technology Division, Wireline Competition Bureau, FCC, January 2007, Table 1.

deploying 3G data services, such as EVDO and HSPA, while the full suite of 4G services is not far behind.

Despite their growth, both wireline and wireless providers are impeding customer choice and openness. The two dominant providers of broadband Internet access – the cable and telephone companies – control more than 95 percent of the market and are taking steps to extend their control over adjacent markets for Internet applications and content in a manner that violates the principles of consumer choice and openness. They have proposed to prioritize (give preference to) certain Internet traffic over other traffic. They routinely prevent consumers from using their Internet access for certain types of services.[6] Mobile providers, who are largely owned by the dominant wireline providers, routinely prevent consumers from using the equipment of their choice. Furthermore, equipment manufacturers are increasingly marketing network equipment that make it easier for network operators to identify, screen, prioritize, block or impair certain types of traffic.

In short, wireline and wireless broadband Internet access providers are increasingly controlling the user's Internet experience. If left unchecked, the consequences to the Internet, and to consumers, could be disastrous. Unless action is taken now to extend fundamental principles of consumer choice and openness to wireless services, consumers will lose the transforming benefits that the Internet has made possible over the past decade. Implementing non-discrimination requirements for wireless broadband will help ensure that consumers have open and unfettered access to the Internet without gatekeeper control.

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[6] For further discussion of the importance of maintaining an open Internet and the efforts of existing broadband providers to control the user's experience, see "Good Fences Make Bad Broadband," a Public Knowledge White Paper, by John Windhausen, Jr., February 6, 2006, available at http://www.publicknowledge.org/content/papers/pk-net-neutrality-whitep-20060206.

3. **The broadband marketplace, which is highly concentrated, is unlikely to ensure that the openness of the Internet is preserved unless the FCC requires it.**

Consumers cannot be guaranteed that the winners of the 700 MHz band auctions will abide by the consumer choice and openness principle unless the Commission requires it. First, the broadband access market is highly concentrated. As noted above, the dominant providers of broadband access are increasingly putting limitations on consumer choice and openness. The most likely winners of the 700 MHz band auctions are the same incumbent providers who currently impose restrictions on existing wireline and mobile services. In the most recent AWS auction, for instance, the majority of licenses – particularly those covering the most densely populated regions – were won by wireless incumbents (the largest of whom are integrated with wireline providers or have other wireless broadband platforms) and the largest cable incumbents. These providers are likely to exercise the same control over the 700 MHz band services that they currently exercise over their existing wireline and wireless assets. The same incumbent LECs that are the two largest providers of wireline DSL are simultaneously by far the two largest wireless carriers. Their rational business interest is to thwart the emergence of a viable "third pipe" competitor to their wireline broadband offerings – which, in turn, makes it easier down the road to either tollgate or vertically integrate into the applications and content markets that today are generally subject to openness principles.

Second, even if the licenses are won by new entrants in the marketplace, there is no reason to believe that they will incorporate the consumer choice and openness principle into their business plans. The experience in the existing market for cellular and PCS operators demonstrates that, even when there are multiple providers in a market, network providers are placing limits on the ability of consumers to use the devices and applications of their choice. A recent Working Paper issued by the New America Foundation documented how the incumbent

mobile broadband providers typically impose five kinds of restrictions on consumers that violate the principle of consumer choice and openness:

1) Refusing to allow consumers to attach their own devices to the mobile services;
2) Requiring equipment manufacturers to omit or cripple many consumer-friendly features of the devices authorized by the services provider;
3) Prohibiting access to or full use of many Internet-based applications and content services, including terms of use that preclude downloading music, video, games and VOIP services not approved by the carrier;
4) Imposing undisclosed bandwidth limits and usage restrictions on consumers' use of their phones; and
5) Stalling the development of new applications.[7]

The study found that these practices are common among all four of the nationwide providers of mobile services. Even though there are multiple providers in the mobile services market, each of them routinely controls the equipment that customers can connect to the network and builds walls around the applications, services and content that customers can access over the Internet. If the 700 MHz auction licenses are won by brand new entrants into the mobile services marketplace, they will face no competitive pressure from existing providers to abide by the principle of openness. In fact, closing the consumer's experience appears to have become standard business practice in the mobile services marketplace – a tacit collusion aimed at dominating the adjacent markets for consumer devices, applications and paid content.

Thus, there is no reason to believe that the marketplace will address the consumer's need for an open platform. The Commission must adopt service rules to ensure that the consumers' right to an open Internet is protected.

[7] See, Tim Wu, Wireless Net Neutrality: Cellular *Carterphone* and Consumer Choice in Mobile Broadband, Feb. 2007, attached as Appendix A, and available at http://www.newamerica.net/files/WorkingPaper17_WirelessNetNeutrality_Wu.pdf.

4. Requiring spectrum licensees to abide by principles of openness is an appropriate condition to place on services making exclusive use of a publicly-owned resource.

It is entirely appropriate for the Commission to exercise its traditional authority to condition a license for exclusive use of the publicly-owned spectrum resource on obligations that promote the public interest, convenience and necessity. Section 309(j) of the Communications Act provides for auctions to resolve conflicting applications for an available license, but it in no way diminishes the Commission's responsibility to ensure that the ultimate use of the public airwaves promotes the general public interest. Service rules predicated on Commission consumer protection policies are nothing new. Conditioning a license on a public interest obligation to ensure basic consumer choice and open network principles is, like license conditions imposing build-out requirements and technical criteria to avoid harmful interference to other licensed services, a traditional and transparent approach that gives bidders explicit notice that use of this public resource must not contradict public policy. At a minimum, we propose that the Commission make explicit in the 700 MHz auction service rules that the Commission's *Carterfone* principles and other open network principles, including those adopted in pending[8] or future proceedings, will extend equally to wireless broadband Internet access services operating on the auctioned frequencies.[9]

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[8] *See Consumer Protection in the Broadband Era NPRM*, 20 FCC Rcd at 14929-35, ¶ 146-59.

[9] *See Declaratory Ruling, Regulatory Treatment for Broadband Access to the Internet Over Wireless Networks*, WT Docket No. 07-53 (March 22, 2007), at ¶ 69-70.

5. **Adopting a service rule to preserve consumer choice and openness is comparable to the HAC rules that the Commission has already proposed.**

Imposing a public interest obligation on licensees to preserve the openness of broadband Internet access services in the 700 MHz band is comparable to the HAC service rules that the FCC tentatively concluded should be applied to these licenses. The FCC tentatively concluded that the HAC rules should be extended to 700 MHz licensees in part because persons with hearing disabilities should have "the social, professional, and convenience benefits" that accrue to other wireless telecommunications users.[10] Similarly, consumers of broadband Internet services should have the same "social, professional, and convenience" benefits as non-broadband services, such as dial-up. Dial-up services continue to be governed by common carrier rules under Title II of the Communications Act, including prohibiting "unjust and unreasonable discrimination."[11] There is no reason that consumers of high-speed broadband connectivity should have fewer "social, professional, and convenience" benefits than low-speed dial-up consumers. Treating broadband customers different than dial-up customers raises the same type of discrimination issues that led the FCC to tentatively adopt HAC rules for the hearing-disabled.

6. **The FCC can reduce or eliminate any costs of complying with an openness service rule by adopting it prior to the auction.**

This proceeding gives the Commission the opportunity to adopt an openness service rule *before* the auctions are held. This timing is important. First, parties can participate in the auction with full awareness of the rules. Second, adopting an openness service rule at this time will ensure that the 700 MHz services and products will be designed from the start to be compatible with multiple handsets and service, application and content providers. The industry

[10] *See Hearing Aid Compatibility Report and Order*, 18 FCC Rcd at 16755 ¶ 4.

[11] See, e.g., Section 202(a) (47 U.S.C. 152(a)).

cannot make the argument at this stage that they have already made a "sunk" investment that should not disturbed. The 700 MHz band services are still in a nascent phase; every auction winner will have the opportunity to design its services and equipment to satisfy the openness regime from their inception. The incorporation of openness into the design phase significantly reduces, if not eliminates, any possible costs of compliance.

7. The Commission has already indicated it would consider imposing a service rule to preserve consumer choice and openness if the marketplace did not operate to protect consumers against blocking or discrimination.

The FCC's Wireline Broadband Order changed many of the requirements for wireline broadband internet access providers. Significantly, however, the FCC expressed concern about the possibility that broadband network operators might engage in blocking or otherwise interfere with the consumers' ability to use the Internet. While it refused to adopt a service rule at that time, it reached this decision only because of the lack of evidence that the network operator would engage in such behavior.

> While we agree that actively interfering with consumer access to any lawful Internet information, products, or services would be inconsistent with the statutory goals of encouraging broadband deployment and preserving and promoting the open and interconnected nature of the public Internet, [footnote omitted] we do not find sufficient evidence in the record before us that such interference by facilities-based wireline broadband Internet access service providers or others is currently occurring.[12]

As set forth above, the evidence that mobile carriers are violating the principles of openness is now clear. New America has already published its study documenting the abuses of openness in the wireless marketplace, and Skype has recently filed a petition documenting the difficulties that consumers have using certain equipment and applications with wireless

[12] *See Appropriate Framework for Broadband Access to the Internet over Wireline Facilities*, CC Docket No. 02-33, Policy Statement, FCC 05-150 (rel. Sept. 23, 2005), para 96.

providers.[13] End users simply do not have the freedom to choose which devices, applications, services and content are best for them.

8. Requiring openness will not reduce the value of the licenses and may increase their value.

As discussed above, the physical characteristics of the 700 MHz band make it extremely attractive for service providers and for consumers. The Congressional Budget Office has projected that the 700 MHz auction should generate more than $10 billion in revenue, while other expert commentators have given considerably higher estimates of $20 billion or more, based on other auctions and private transactions for spectrum with less desirable characteristics. There is no doubt that the 700 MHz band licenses will attract investors seeking to take advantage of the unique propagation characteristics of this band to provide low-cost service to consumers. There is no evidence that an openness service rule will reduce the value of these services because the licenses to operate in the 700 MHz band are tremendously valuable. At least one commentator has recognized that the 700 MHz band is the "best spectrum for wireless broadband because of its propagation characteristics."[14] In fact, an openness requirement may even increase the value of the licenses because consumers will find the services more attractive with the assurance that their ability to "go anywhere" and "attach any equipment." And certainly consumer welfare and the value to the economy overall will be enhanced if the license conditions promote competition in the adjacent markets for equipment, applications and content relative to today's vertically-integrated "closed garden" variety of 3G cellular Internet access.

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[13] See Petition to Confirm a Consumer's Right to Use Internet Communications Software and Attach Devices to Wireless Networks, filed by Skype Communications, S.A.R.L., RM-11361, Feb. 20, 2007.

[14] "The 700 MHz band has long been viewed as the best spectrum for wireless broadband because of its propagation characteristics, particularly its ability to cover larger areas -- which reduces capital expenditures and makes a new-entrant strategy more feasible -- and its ability to penetrate buildings." **700 MHz: A Pivotal Auction:** ***New Blood for Broadband & Video or Telco/Cable Sweep; Stifel, Nicolaus & Company, Inc.; March 2, 2007.***

9. **Service rules to ensure that consumers can obtain access to any content, application and service and can attach any compatible equipment would be consistent with a long line of communications policy decisions.**

The U.S. has a long history of ensuring the compatibility and interoperability of equipment and services. The FCC has for decades ensured that telephone equipment would operate seamlessly with the telephone network (the so-called "*Carterfone*" rules). Both Congress and the FCC require television sets to be compatible with broadcast and cable television signals. Just recently, the FCC took steps to ensure that the newly merged AT&T would not privilege, degrade, or prioritize any Internet traffic. Furthermore, the FCC requires most telephone equipment to adhere to the rules for hearing aid compatibility (HAC). All these requirements have been instrumental in allowing consumers to benefit from competition and a diversity of media and technology sources. For the same reasons, the FCC should establish service rules for two-way broadband services to ensure that 700 MHz licensees do not discriminate against unaffiliated applications, services, content or equipment. Moreover, the Commission should indicate, as part of the service rules, that the licensees will also be subject to any interoperability standards later adopted to facilitate consumer choice and open networks by creating an interface comparable to the standard phone jack that derived from the *Carterfone* principles.

CONCLUSION AND RECOMMENDATION

The genius of the Internet is its promise of unlimited and non-discriminatory access to applications, services and content at the *edge* of the network. The Internet was designed to operate over an open platform and allow any consumer to visit any web site, attach any device, post any content and provide any service. With an Internet connection, especially a broadband Internet connection, ordinary citizens can be producers, not just consumers, of information.

Broadband connectivity allows individuals to “broadcast” their own video programs, operate their own on-line businesses, initiate their own videoconferences, develop their own software applications, and engage in multi-lateral research projects with people the world over. If preserved as it was designed, the Internet can promote freedom of information and expression to a degree never before achieved in human history.

All these benefits – commercial, social, scientific, democratic – depend upon the existence of an open and transparent network that carries Internet traffic without interference from the owner of the underlying network. The openness of the Internet is exactly what has made it so popular and so transforming. Its very success depends on the fact that no one controls it.

This proceeding represents a unique opportunity for the Commission to ensure that consumers of broadband Internet access services in the 700 MHz band have control over their use of the Internet, without interference from the network provider. The Commission should issue a simple service rule and apply it on a prospective basis to all winners of licenses to operate in the 700 MHz band when they provide two-way broadband Internet access services. The FCC need not issues pages of details or engage in a lengthy rulemaking proceeding. Rather, the FCC should simply issue one enforceable rule that 700 MHz license holders must provide broadband Internet access service on a non-discriminatory basis in a manner that enables

- any customer to attach any compatible device to any wireless broadband network in the 700 MHz band using standard and non-proprietary interfaces, subject only to minimal "do-no-harm" requirements; and
- any customer to reach any web site, post any information, provide any service, access or provide any application, without degradation, prioritization or interference by the network operator.

Adoption of this policy will help to create a vibrant wireless broadband market that will make the U.S. the global leader in wireless communications and ensure that consumers are able to maximize the benefits of their wireless broadband connection.

Respectfully submitted,

CONSUMER FEDERATION OF AMERICA
CONSUMERS UNION
FREE PRESS
MEDIA ACCESS PROJECT
NEW AMERICA FOUNDATION
PUBLIC KNOWLEDGE

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Dated: April 5, 2007

APPENDIX A

NEW AMERICA FOUNDATION

WIRELESS FUTURE PROGRAM

WORKING PAPER

Working Paper #17 *February 2007*

Wireless Net Neutrality: CELLULAR *CARTERFONE* AND CONSUMER CHOICE IN MOBILE BROADBAND

By Tim Wu*

Over the next decade, regulators will spend increasing time on conflicts between the private interests of the wireless industry and the public's interest in the best uses of its spectrum. This report examines the practices of the wireless industry with an eye toward understanding their influence on innovation and consumer welfare.

In many respects, the mobile wireless market is and remains a wonder. Thanks to both policy and technological innovations, devices that were science fiction thirty years ago are now widely available. Over the last decade, wireless mobile has been an "infant industry," attempting to achieve economies of scale. That period is over: today, in the United States, there are over 200 million mobile subscribers, and mobile revenues are over $100 billion. As the industry and platform mature, the wireless industry warrants a new look.

This report finds a mixed picture. The wireless industry, over the last decade, has succeeded in bringing wireless telephony at competitive prices to the American public. Yet at the same time, we also find the wireless carriers aggressively controlling product design and innovation in the equipment and application markets, to the detriment of consumers. In the wired world, their policies would, in some cases, be considered simply misguided, and in other cases be considered outrageous and perhaps illegal.

Four areas warrant particular attention:

1. ***Network Attachments*** – Carriers exercise excessive control over what devices may be used on the public's wireless spectrum. The carriers place strong controls over "foreign attachments," like the AT&T of the 1950s. The FCC's *Carterfone* rules, which allow consumers to attach devices of their choice to the wired telephone networks, do not apply to wireless networks. These controls continue to affect innovation and the development of new devices and applications for wireless networks.

2. ***Product Design and Feature Crippling*** – By controlling entry, carriers are in a position to exercise strong control over the design of mobile equipment. They have used that power to force equipment developers to omit or cripple many consumer-friendly features. Carriers have also forced manufacturers to include technologies, like "walled garden" Internet access, that neither equipment developers nor consumers want. Finally, through under-disclosed "phone-locking," the U.S. carriers disable the ability of phones to work on more than one network. A list of features that carriers have blocked, crippled, modified or made difficult to use, at one time or another, include:

- Call timers on telephones,
- Wi-Fi technology,
- Bluetooth technology,
- GPS services,

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* *Tim Wu is a Professor at Columbia University School of Law.*

- Advanced SMS services,
- Internet browsers,
- Easy photo file transfer capabilities,
- Easy sound file transfer capabilities,
- Email clients, and
- SIM Card mobility.

3. ***Discriminatory Broadband Services*** – In recent years, under the banner of "3G" services, carriers have begun to offer wireless broadband services that compete with Wi-Fi services and may compete with cable and DSL broadband services. However, the services are offered pursuant to undisclosed bandwidth limits and usage restrictions that violate basic network neutrality rules.

Most striking is Verizon Wireless, which prominently advertises "unlimited" data services. However, it and other carriers offer broadband service pursuant both to bandwidth limits, and to contractual limits that bar routine uses of the Internet, including downloading music from legitimate sites like iTunes, the use of Voice over IP, and the use of sites like YouTube.

4. ***Application Stall*** – Mobile application development is by nature technically challenging. However, the carriers have not helped in fostering a robust applications market. In fact, they have imposed excessive burdens and conditions on application entry in the wireless application market, stalling what might otherwise be a powerful input into the U.S. economy. In the words of one developer, "there is really no way to write applications for these things." The mobile application environment is today, in the words of one developer, "a tarpit of misery, pain and destruction."[1]

Most of the carriers exhibit similar practices in the areas discussed in this paper. However, in each area, there are variations between the four largest carriers: AT&T, Verizon Wireless, Sprint-Nextel, and T-Mobile. Speaking generally, Verizon Wireless and AT&T have the most restrictive policies; Sprint is slightly less restrictive. The fourth and smallest competitor, T-Mobile, tends to be the least restrictive on consumers and application developers. The reliance on a fourth competitor for serious variation in industry practice must be kept in mind when considering any future consolidation.

The report makes four major recommendations:

1. ***Cellphone* Carterfone** – The basic and highly successful *Carterfone* rules in the wired world allow any consumer to attach any safe device to his or her phone line through a standardized jack. The same rule for wireless networks would liberate device innovation in the wireless world, stimulate the development of new applications and free equipment designers to make the best phones possible.[2]

2. ***Basic Network Neutrality Rules*** – Wireless carriers should be subject to the same core network neutrality principles under which the cable and DSL industries currently operate. Consumers have the basic right to use the applications of their choice and view the content of their choice. Wireless carriers who offer broadband services should respect the same basic freedoms. Carriers can tier or meter pricing for bandwidth without blocking or degrading consumer choice.

3. ***Disclosure*** – Consumer disclosure is a major problem in the wireless world. In addition to the disclosure of areas lacking coverage and rate-plan information, carriers should disclose—fully, prominently, and in plain English—any limits placed on devices, limits on bandwidth usage, or if devices are locked to a single network.

4. ***Standardize Application Platforms*** – The industry should re-evaluate its "walled garden" approach to application development, and work together to create clear and unified standards for developers. Application development for mobile devices is stalled, and it is in the carriers' own interest to try and improve the development environment.

Part I: The State of Wireless

1. Introduction to the U.S. Wireless Industry

In Washington, D.C., the wireless world is sometimes described as a nirvana for consumers brought on by competition and enlightened government policy. Some consumers and groups depict a very different story: a "cell hell" of "dropped calls, dead zones, billing errors, and unexpected fees and charges."[3] The truth lies somewhere in the middle. Relative to its history, the state of the wireless industry is greatly improved.[4] Since the 1990s, when the Federal Communications Commission began to auction wireless spectrum suitable for telephones and other devices, wireless telephony has taken off. But now, a decade later, the industry is no longer an infant. As mobile platforms mature, and as consumer markets reach saturation, the state of the wireless world warrants greater scrutiny.

Some observers argue that the oligopoly structure of the wireless market makes scrutiny of the industry unnecessary, because any anti-competitive or anti-consumer behavior will be self-correcting. In the words of AT&T spokesman Mark Siegel, "this is a fiercely competitive industry," which has grown "almost entirely through the force of competition in the marketplace, [and] more innovative devices and services." Put simply, since there is no single cell phone monopoly, attention to these issues is unwarranted—in Siegel's words, "this whole issue is a giant red herring."[5]

Part IV of the paper addresses these issues directly. In short, the carrier market is simply not an open market. While entry is not impossible, 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. The wireless market may be relatively competitive by the standards of the telecommunications industry and regulated industries like energy generation. But the U.S. wireless market is nothing like the market for blue jeans or vodka, and it is a mistake to so pretend.[6] The behavior of the carriers, moreover, refutes the argument that oligopoly competition is a cure-all. The practices documented in this paper are of manifest concern for consumers and for innovation in the markets adjacent to the carriers. Their pattern of parallel behavior casts doubt on arguments that the limited competition in a spectrum-based oligopoly can be expected to solve all problems.

If it is accepted that the wireless industry warrants attention, several important justifications are usually raised for the industry's practices. It is often asserted that industry practices are made necessary by spectrum scarcity and the need to maintain network security. These arguments are important—no one wants a world of calls that never go through, or widespread identity theft practiced through cell networks. Yet, critically, these arguments cannot be accepted as blanket justification for any and all carrier practices.[7] Just as the network security and quality claims made by AT&T for much of the 20th century were eventually questioned, the claims made by the mobile carriers today must be examined far more closely.

The historic parallel is instructive. Wired voice telephone networks had more or less reached their full potential under AT&T by the 1960s. To reach the next stage, the most important steps were not technological but deregulatory—destroying impediments created by AT&T that restricted innovation and competition. As Eli Noam writes, "in almost all other fields of communications the US is heavily dominant. Why not in mobile wireless? The one different variable is policy."[8] To reach the "next stage" in wireless communications, the most important step may be opening the networks to true competitive entry. This paper specifies how that could happen.

Finally, many readers may be puzzled by the carriers' behavior in this area. The last part of the paper addresses an important puzzle: Why would a carrier want to cripple products in the first place? Companies usually like to sell the best product possible. If a phone with Wi-Fi is a better phone, why not sell that?

This paper introduces three possible explanations. The first is that the carriers are engaging in a form of price discrimination—crippling products so that they might sell the crippled product at a cheaper price to poorer customers. This form of price discrimination, while not uncontroversial, is defensible. The problem with this explanation is that the wireless carriers do not also make available a fully-capable product for a

higher price. Instead, wireless carriers demonstrate an incomplete price-discrimination strategy: offering the crippled product, but not the fully functional one.

That suggests two other explanations. First, the carriers may be acting to protect existing revenue streams. If a feature like Wi-Fi might endanger 3G or voice revenue, the carrier may block it to protect its income, or in industry jargon, "prevent revenue leakage." That behavior is an example of a *negative spillover* or *externality*: behavior that helps the carrier, but hurts society.

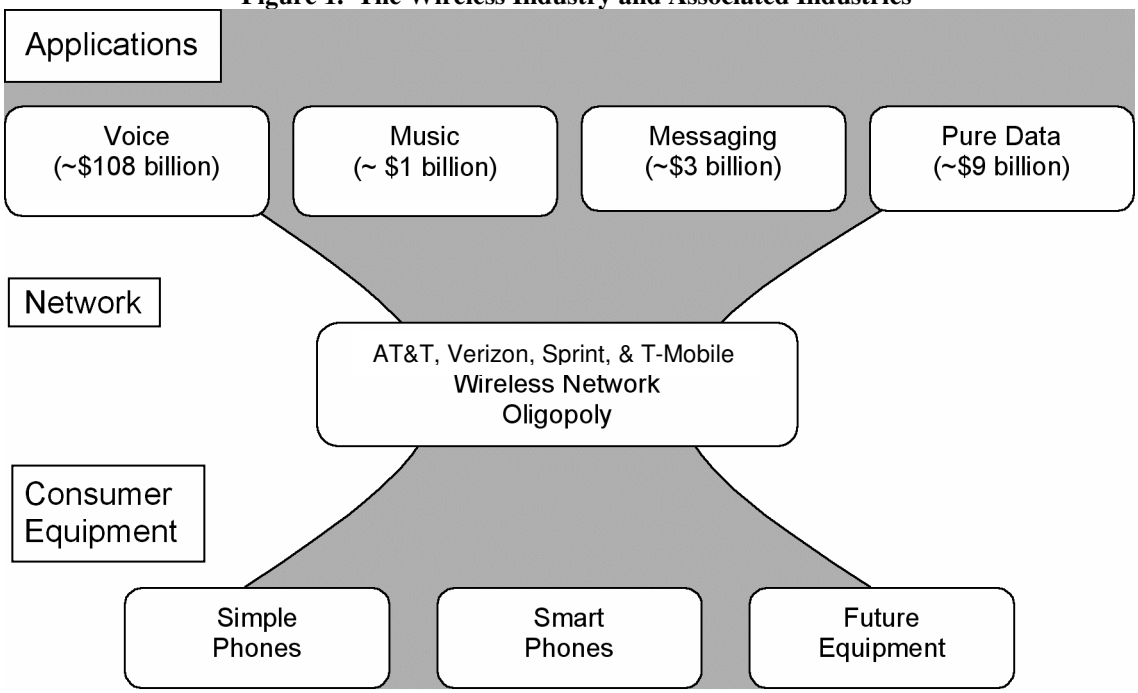
Second, in some instances the carriers may simply be making the wrong decisions. For example, when it comes to software development, the carriers and some equipment manufacturers have pursued a quixotic strategy. They have failed to standardize, and have placed controls on software development that reflect an interest in maximizing control over any new services that may arise. That strategy, according to many developers, has inhibited the growth of a strong mobile software market. Companies and industries do make mistakes, and the carriers' current application strategy may simply be an error.

One point should be clear. This paper is written to examine what carrier practices may be harmful for consumers or society. It is intended to shed light on practices that might, for one thing, be dissipated by consumer pressure and competition, and to raise questions for the carriers themselves. It is absolutely not a call for comprehensive regulation or nationalization of the wireless industry. The perspective is that regulation, if necessary, should be a last resort.

2. Competition Model

The American wireless industry is a classic example of an information platform economy.

Figure 1. The Wireless Industry and Associated Industries[9]



Today, most discussion of the wireless industry is focused on the degree of competition between carriers—the horizontal competition within the carrier market, represented as the "Network" layer in Figure 1 above. The FCC has done important work in this area since the 1990s. The rise of spectrum auctions, the initial imposition of spectrum caps (since repealed), and the number portability rules are important landmarks that have intensified intra-industry competition.[10]

Much less attention has been paid to a different issue: the impact of carrier practices on the vertical markets touched by the wireless industry and its spectrum-based oligopoly—in other words, the effects of the wireless oligopoly on the equipment and application markets, and consequently on consumers.

Part II: Carrier Practices

For various reasons, discussed in Part IV, the oligopoly of carriers, using their power over the public spectrum, are disabling features or paths of development that might be attractive to consumers. We now turn to a more detailed look at carrier practices. We examine four areas: (1) network attachments, (2) product design and feature crippling, (3) data-service discrimination, and (4) application development.

1. The Right to Attach – *Carterfone* Principles

In early 2007, Apple launched the iPhone—its first foray into the world of wireless voice. The iPhone (Figure 2) is beautiful and innovative in design. But it also came with many surprising limitations. Most importantly, to the surprise of many, the iPhone only works on the network of a single carrier, AT&T Wireless. The hundreds of millions of consumers who are not AT&T Wireless customers cannot make use of the iPhone unless they become AT&T customers. The question is, why? Why can't you just buy a cell phone and use it on any network, like a normal phone?

Figure 2. Apple's iPhone

The main reason is the lack, in the wireless world, of basic network attachment rules. Thanks to FCC rules dating from the 1960s and 1970s, usually referred to as *Carterfone* rules, when it comes to wireline telephones, consumers have the right to attach whichever devices they want to their phone lines. That right is made possible by the standard "telephone jack." If Apple wanted to build a wireline telephone, it would simply build one that could plug into the standard household phone jack. It could sell the device directly to consumers—and it would work whether they bought their phone service from AT&T, Verizon or any of hundreds of smaller telcos.

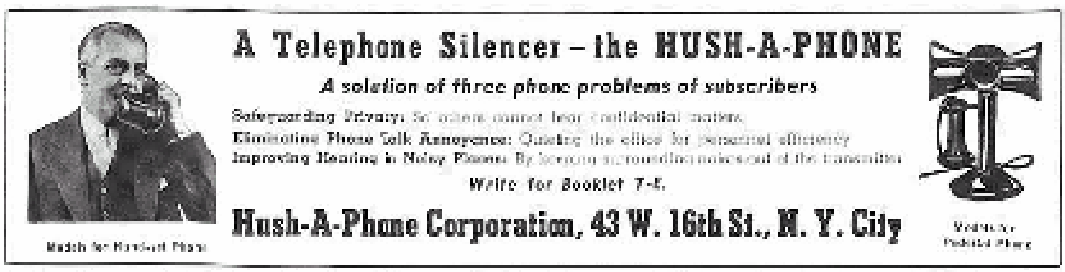
The standardized telephone jack has proved essential to competition in the wireline space. To understand its importance, we must examine where it came from. For much of the 20th century until the 1970s, the AT&T monopoly barred consumers from attaching anything but a Bell telephone to their network. AT&T had a rule (a tariff[*]), which stated,

> 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, physically, by induction or otherwise.[11]

That rule, unsurprisingly, suppressed all competition and most innovation in the making of telephones. A slow change began in 1948, when a company named "Hush-a-Phone" challenged AT&T's rule. AT&T had banned the use of a small device (shown in Figure 3 below) designed to keep phone calls quiet and private. Hush-a-Phone challenged the tariff at the FCC as "unreasonable."

[*] Pursuant to §203(a) of the 1934 Telecommunications Act, AT&T had the right to file tariffs showing charges for its phone service, and also "classifications, practices, and regulations affecting" its phone service.

Figure 3. Hush-a-Phone Advertisement



In litigation, AT&T argued that

> It would be extremely difficult to furnish 'good' telephone service if telephone users were free to attach to the equipment, or use with it, all of the numerous kinds of foreign attachments which are marketed by persons who have no responsibility for the quality of telephone service but are primarily interested in exploiting their products.[12]

After eight years of litigation, the D.C. Circuit Court of Appeals ordered AT&T to allow consumers to attach the Hush-A-Phone to their handsets. The court said that the subscriber has the "right reasonably to use his telephone in ways which are privately beneficial without being publicly detrimental."[13] Subsequent to this ruling, through the 1960s and 1970s, the FCC progressively deregulated network attachments—ordering the local phone companies to allow users to connect any devices that complied with a set of basic rules. These principles are often referred to as the *Carterfone* principles, after the 1968 case by that name.

In the *Carterfone* case, AT&T wanted to prohibit the use of the "Carterfone," a device that facilitated communication between a mobile radio and a telephone. AT&T again argued that control over all equipment on the network was necessary for the telephone system to function properly. As AT&T described in an advertisement, "It takes a totally unified system to make it all work. One system. AT&T."

Figure 4. The *Carterfone*

Despite these arguments, the FCC in *Carterfone* struck down AT&T's rule as "unduly discriminatory." Importantly, the FCC rejected arguments made by AT&T that suggested control over all equipment on the network was necessary for the telephone system to function properly.[14] Full realization of the modularity rule implicit in *Carterfone* took until the late-1970s, but few doubt the historic importance of the decision.[15]

The 1968 *Carterfone* right to attach devices to home networks is perhaps the fundamental consumer right in telecom, and indeed its consequences have been historic. The attachment right is broadly celebrated by policy analysts of every ideological persuasion, who recognize the *Carterfone* principle as a central tenet of a competitive telecommunications policy. However, as described below, AT&T's wireless descendants have shown an interest in resurrecting, one way or another, the pre-*Carterfone* rule.

The *Carterfone* principle has had enormous consequences not only in telecommunications policy, but for the economic prosperity of the United States. The ability to build a device to a standardized network interface (the phone plug, known as an RJ-11) gave birth to a new market in home and business telecommunications equipment. That led, predictably, to competition in the phone market. But it also led, unpredictably, to other innovations. Those have included mass consumer versions of the fax machine, the answering machine, and, perhaps most importantly, the modem. Arguably, the FCC's rules on network attachments—now known as the Part 68 rules—have been the most successful in its history. The freedom

to buy and attach a modem became the anchor of the mass popularization of the Internet in the 1990s. As one observer put it, without *Carterfone*, "the development and broad popularization of the Internet also would not have occurred as it did. The key point of *Carterfone* is that it eliminated an innovation bottleneck in the form of the phone company."[16]

Carterfone is an important innovation policy. It drives decentralized innovation: any company or even individual can build to the standardized telephone jack, without gaining the permission of the phone company.[17] *Carterfone* freed innovators to invent the personal modem, and then ever-faster versions of the personal modem, without seeking approval from the owners of the telephone lines. In the wireless world, the *Carterfone* rule does not exist. Instead, like in the pre-*Carterfone* world, innovative companies must seek the permission and cooperation of the carrier oligopoly.

Consequently, the market for consumer devices is unusual and distorted. As one developer put it, "You just can't sell in this market like you do in others. The carriers have ultimate control over what products reach the market. If they don't like what you're doing, that's too bad."[†]

Current Barriers to Attachment and Marketing

American equipment manufacturers are used to Internet connections and telephone lines that are "plug and play." A firm can design equipment, create whatever features it thinks best, and sell to consumers directly.

In contrast, today, it is *de facto* necessary to obtain the permission of the carrier to market a wireless device in the United States. That fact creates an important bottleneck on innovation and product diversity. To make it to market, any device must "fit" with the business plans of the major carriers.

That has two main consequences. First, the cellular phones widely available in the United States are just a small fraction of the phones available in the world. As Marguerite Reardon of C-Net points out, "even though Nokia introduced roughly 50 new products into the market last year, only a handful were offered by operators in the U.S."[18]

Second, as discussed in subsequent sections, control over attachments has given carriers enormous power over equipment design and over application markets. First, we examine how the carriers control network attachment in the first place.

Retail Barriers

The major carriers have a near-lock on the retailing of mobile wireless devices in the United States. According to analyst estimates, between 90 percent and 95 percent of cell phones in the United States are sold by the carriers. That is nearly the opposite of other markets: in some markets in Asia, for example, about 80 percent of cell phones are sold independently of a carrier.[19]

The primary reason is very well known, and even beloved by consumers: the practice of subsidizing equipment purchases with subscription fees. As Elliot Drucker writes in *Wireless Week*, "by far the biggest impediment to commercialization of innovative wireless data products and services lies in the way mobile handsets are distributed in the U.S. market."[20]

As the main carriers collect a monthly fee from consumers, they are in a unique position to collect the price of the telephone or smartphone over a long period. In effect, they can sell telephones on a "buy-now-pay-later" basis, like an installment plan, as opposed to a lump sum purchase. Typically, a provider like T-Mobile or AT&T will advertise and sell a phone for $99-$199 that retails without subsidies for $300-$600. They consequently collect the full cost of the telephone through higher monthly billing, spread over their entire customer base. The higher fees charged to recover the price of the telephone subsidy program are

[†] Many of the application and equipment developers interviewed for this report requested anonymity, for fear of retaliation. For that reason, some of the sources relied upon cannot be disclosed.

not indicated on phone bills. Since many consumers spend over $1,000 a year for mobile service, collecting the wholesale price of the telephones through subscription fees is practical.

As many sources we interviewed suggest, the subsidy makes trying to sell phones through non-affiliated retailers a losing proposition. As one equipment developer explained, "we always hated it, but if you want to move the needle, you have one choice, and that's selling through the carriers." It is possible to buy handsets from unaffiliated vendors in the United States, but they cost far more because of the lack of the subsidy.

Whether the phone subsidies and other barriers to network attachments are ultimately a pro- or anti-consumer practice we do not address in this paper.[‡] However, their effect on innovation, equipment markets and application markets is undeniable. As the only significant channel for the purchase of mobile devices, the carriers can and do reserve the power to decide what devices will operate on their network.

Technical Barriers

In the United States, carriers rely on two distinct main standards—GSM and CDMA.[§] The CDMA carriers (Verizon and Sprint) have different means of restricting network attachments than the GSM carriers (T-Mobile and AT&T). We shall examine each briefly.

Approved Phones Only. "We only allow devices on our network that have been approved," said Jeffrey Nelson, a spokesman for Verizon Wireless.[21] As Nelson confirms, for Verizon Wireless, the largest CDMA carrier in the United States, only devices specifically approved by the company work on its networks. Technically, how is this accomplished? For CDMA carriers, every device that connects to the network must have an approved ID number—an ESN (electronic serial number) or, more recently, an MEID (mobile equipment ID). The practice of Verizon Wireless is to block telephones that are not sold by Verizon itself.[22] As one Verizon customer representative put it, "all the phones that work are already in our system."

The method of exclusion is a "whitelist" of Verizon phones which, by implication, prevents others from working. Without an approved ID number, telephones not sold by Verizon will not be recognized and cannot be used on the network. This effectively makes Verizon Wireless the gatekeeper of market entry for telephones on their network, like the AT&T of old.

The whitelist is not a matter of technological necessity. Sprint is also a CDMA carrier and its practice is slightly different. Sprint keeps a list of customer ESNs and bars the use of existing ESNs—which can be evidence of a "cloned" or stolen telephone. While Sprint "discourages" the use of non-Sprint phones on its network, and will not offer technical support for such phones, it does not block the use of phones on its network as Verizon does. In other words, a consumer who owns his own phone can call Sprint customer service and have his phone activated on the network.

Phone Locks. The GSM wireless providers (AT&T and T-Mobile) limit network attachments using a different means: "locking" cell phones, or making them incapable of operating on any network other than theirs. It would be strange to have a car that worked on some roads but not others. However, much of the mobile wireless equipment sold in the United States today, unless modified, will only work on one network, for reasons unrelated to technological necessity.

[‡] Notably, if the current low upfront prices made possible by subsidies are important to ensure the affordability of phones for consumers, telephones could be sold on an installment plan, with repayment processed automatically through billing.

[§] GSM stands for the Global System for Mobile Communications and is the world's most popular standard. CDMA stands for Code Division Multiple Access and is used mainly in the United States, South America and Korea.

Figure 5. A SIM Card

Locking works as follows. The GSM standard envisions a standardized interface between the phone and wireless service. For that reason, GSM phones carry a Subscriber Identity Module, or SIM card, designed to make it easy for one phone to be used on various networks simply by plugging in new SIM cards. In addition, the SIM system allows consumers to easily switch telephones by moving the SIM card from one phone to another.

The mobile device itself, however, can be designed to recognize and reject certain types of SIM cards based on information carried on the SIM, creating a "lock." There are several varieties of lock: a "service provider lock" simply prevents the phone from being used on anything but the SIM cards of one service provider. A "full lock" prevents the phone from being used with any other SIM card, period. Most, if not all, of the American GSM phones sold by carriers are locked, disabling the utility of the SIM system.

Just as it is possible to lock phones, it is possible to unlock them. Typically, unlocking a phone requires entering a series of codes, and there are companies that specialize in unlocking telephones and reselling them. The U.S. Copyright Office announced in 2006 that telephones may be unlocked without violating the anti-circumvention provisions of the copyright laws, though of course the rule does not prevent carriers from locking phones to begin with.[23] The GSM carriers, T-Mobile and AT&T, have been careful not to go too far in absolutely preventing the unlocking of phones, perhaps for fear of regulation. Both firms appear to have a policy of agreeing to unlock telephones, on request, so long as the phone has been owned for three months.

What is important, however, is the status quo. Most consumers have no idea what a phone lock is, let alone know how to unlock a phone themselves. New products, like the Apple iPhone, are sent to consumers locked to one network (AT&T, in Apple's case). Consequently, unlike in most of the rest of the world, American devices are usually locked absent user expertise or knowledge.

* * *

Two sets of consequences flow from the control that carriers exert on the marketing and attaching of mobile devices in the United States. One is a loss of *product diversity*. Of the many mobile devices sold even by major providers like Nokia and Motorola, only a fraction effectively make it to the U.S. market. The bottleneck also deters other potential market entrants.

The second set of consequences of the carrier bottleneck on the device market is in product design, an issue to which we now turn.

2. Coercive Product Design and Crippled Phones

As a condition of network access, American wireless carriers are wielding a heavy hand in the design of mobile devices. "We were used to selling PDAs (personal digital assistants). But the wireless market was like night and day. Basically, the carriers have all the power," said the former wireless marketing director of a PDA manufacturer. While they accept that some level of cooperation is necessary, equipment developers complain about two problems: (1) being forced to disable services or features that might be useful to consumers, and (2) being forced to add elements to telephones that the designers do not think are what consumers want.

Call Timers. Developers report that carriers have often forced them to remove or limit "call timers" from their phones. Call timers can keep track of the length of individual phone calls, and can also keep track by month, year, or in total. The carriers, reportedly, are concerned that consumers might easily develop an independent and possibly different record of their mobile phone usage. While it is clear that destroying an independent record simplifies billing practices for carriers, it is less clear how that serves the interests of consumers.

Photo Sharing. As one developer said, "The first thing you want to do with a photo is get it off your phone [and] email it, right? But the carriers wouldn't let us make it that easy." In the early 2000s, when camera capabilities began appearing in telephones, equipment developers and carriers came into conflict.

Developers wanted to make it relatively easy to send a photo to an existing email account, as a product feature. Carriers, conversely, wanted to channel consumers to paid "photo sharing" sites where, for a monthly fee, consumers could upload their photos and then download them to their computers. While results now depend on the device and carrier, many carriers successfully forced equipment developers to make photo-sharing services the only way to get photos off of a camera-equipped phone.

For example, Sprint's "Picture Mail," Verizon's "Pix Place" and AT&T's MediaNet/MMS services, for prices typically ranging from $60-$240 per year, allow consumers to get photos off of their phones and onto a Web "album." An AT&T customer, for example, who wants to get photos off of her phone must sign up for three packages: "MediaNet," "Text Messaging" and "Multi-Media Messaging," each of which has affiliated charges. On many phones, the carriers have made it difficult (or sometimes near-impossible) to get the pictures off of the phones otherwise. That has prompted numerous consumer complaints. As one consumer wrote about Sprint's offering:

> so.. wtf i pay $5/month just for the service
> and i also the .2/.3 cents/kb for a data transfer?? for every single picture??
> wtf kind of bull**** is this?[24]

Consumers also report that Verizon has placed limits on the maximum size of photos that can be uploaded from its phones (300 KB), for reasons that are not always clear. In the words of a Verizon customer:

> Verizon's greed hurts its customers…One phone call to Motorola's dedicated V3C support line (800-657-8909, for those who want that number) verified that the problem was Verizon's own limit of 300 Kb on MMS and email attachments — and led to the Motorola tech expressing extreme exasperation that his company was willing to put its products in the hands of customers via a middleman (Verizon) who crippled those products before passing them on…[25]

Whatever the benefits of a photo-sharing service may be generally, it seems hard to see how consumer interests are served by making it harder for consumers to send photos to themselves.

Web Access. During the early development of wireless-capable PDAs, also known as smartphones, the potential use of phones to access the Web became obvious. However, various carriers strongly opposed the availability of "full" Internet browsers on the devices. Instead, the carriers pushed the development of an alternative to the standard Internet through the "Wireless Application Protocol," or WAP.

There are two ways to approach the challenge of providing access to the Web using a cell phone. The first is to provide access to the existing Internet and simplify sites to reflect the limits of the mobile platform. That was, for example, the approach of the "Blazer" browser developed by Palm systems. The Blazer worked by simplifying normal Web pages to make them appear on a phone, consequently allowing consumers to reach a full, albeit simplified, range of Web content.

The carriers, however, supported a different approach, embodied in the WAP protocol. As opposed to adapting the Internet to the technical constraints of mobile phones, WAP created an entirely new set of protocols, and contemplated, in essence, the creation of an alternative, cell-phone only Web. The carriers pressured manufacturers to offer WAP-compatible browsers only, and then, at least initially, a "walled garden" of WAP-compatible sites. As one developer said, "we thought Blazer was pretty good, while we knew WAP was terrible. But the carriers had to have WAP."

As one critic wrote of WAP:

> They [the WAP Forum] have developed an entire stack of network protocols analogous to, but largely incompatible with, the existing Internet architecture. Not only has this approach required an enormous engineering effort on the part of the protocol designers and implementers, it has also given rise to a number of fundamental design errors. The deficiencies in the WAP specification are glaring, obvious, and readily apparent to any competent data communications professional.[26]

Eventually the carriers relented, demanding only that their site be the first site available on any browser. Ultimately, WAP proved a commercial failure and has been abandoned in the United States.

Bluetooth. The disabling of Bluetooth functionality has been a major sticking point for many consumers and has even prompted a lawsuit. Bluetooth is a protocol designed for very short-range personal communications—to allow communications between devices such as PCs, printers, wireless headsets, etc.[**] Obvious uses of the technology might include transferring photos off of camera-phones, printing information from a telephone, or backing up address books.

In 2004, Verizon Wireless released the Motorola V710 cell phone, advertising "full" Bluetooth capabilities. However, most of the Bluetooth capabilities were, in fact, disabled. The phone was capable only of recognizing headsets and cooperating with a modem to make dialup calls. In statements and interviews, Verizon Wireless stated that the crippling was necessary for "security" reasons.[27] It later defended the crippling as necessitated by its contracts with various content partners. In response, in 2005, subscribers filed a class action lawsuit in California. Verizon Wireless eventually settled the lawsuit.[28]

Figure 6. Verizon's modified Motorola V710

Since then, while it hasn't stopped crippling Bluetooth, Verizon and Motorola more clearly indicate the limits of the Bluetooth features on phones. For example, Motorola's "Phone Tools" website states:

> if you are a Verizon customer, all multimedia and internet connection features in this software will be disabled due to carrier request. Please contact your service provider for further information.[29]

In addition to Verizon's practices, which are notable, Sprint and AT&T have also, at various times, disabled various Bluetooth capabilities—particularly on smartphones like the *Treo* line.

It is important to understand the consequences of Bluetooth crippling. Generally speaking, the treatment of Bluetooth features by carriers is inconsistent and mixed, uncertainty which makes it difficult or impossible for developers to create secondary markets based on full Bluetooth capabilities. For example, it would be easy for mobile phones to communicate better with printers so that users can print phone numbers, addresses or photos. However, the unpredictability of Bluetooth capabilities has inhibited the growth of that or similar markets.

Wi-Fi. Technologically, cellular phones can incorporate Wi-Fi (802.11b) capabilities for a range of potential uses, from email, to web access, to VoIP, to communicating directly with other devices. However, over the last five years, American wireless carriers have strongly resisted and blocked the installation of Wi-Fi capabilities in cellular phones. In some cases, they have forced equipment manufacturers to manufacture specialized American versions of telephones with all Wi-Fi capabilities crippled.

[**] Bluetooth is specified in the IEEE 802.15.1 Personal Area Network Standard.

The Nokia e62/e61 is one example. The Nokia e61 phone is the company's flagship "smartphone"—widely known as its "Blackberry killer." It was released in Europe in the summer of 2006 to enthusiastic reviews. However, in the United States, AT&T is the exclusive vendor of the e62—a crippled version of the e61 that has Wi-Fi and other features removed. In the words of MSN columnist Gary Krakow: "What some carriers fear most is the e61's ability to handle VoIP calls when you're near a friendly wireless network. That's why we won't see Wi-Fi on the e62."[30]

Figure 7. Nokia U.S. e62 (e61 sans Wi-Fi)

As of 2006, there are "pure" Wi-Fi phones being sold in the United States, such as the Netgear SPH101. But these phones do not work on the cellular networks operated by the commercial wireless carriers. They are Wi-Fi phones only—typically only allowing a user to make phone calls using Skype or other VoIP providers within range of a local area or public Wi-Fi network.

Figure 8. Netgear SPH101

In the United States, with a few notable exceptions, it is difficult today to find a Wi-Fi capable cell phone.[††] It is difficult to see how the practice of blocking Wi-Fi in mobile devices is helpful to the American consumer.

3. Discrimination in 3G Broadband Services

Under the general banner of 3G ("Third Generation") services, wireless carriers have begun offering various types of broadband data services using their wireless spectrum. These data services are designed to be used both for smart telephones and personal computers (presumably laptops) through a data-card (typically a modem card with an embedded antenna that plugs into the computer). GSM and CDMA telephones use different protocols for these data services (such as EVDO and HSDPA). While there are important technical differences, we shall refer to all as 3G wireless broadband services.

Verizon, Sprint-Nextel, AT&T and T-Mobile now all offer wireless broadband services of various kinds. These data services, based on licensed spectrum, compete with commercial and public Wi-Fi providers, who offer services for free or for a fee in cafes, airports, and other public facilities, at designated hot spots or hot zones, and in some cases throughout cities.[31]

Wi-Fi is faster than 3G. Under current technologies, Wi-Fi has a capacity between 11 Mbps to 54 Mbps, which means that Wi-Fi usually operates at the maximum speed of the underlying Internet connection (often a home DSL or cable connection), minus whatever is lost through interference or sharing. As for 3G, Verizon and Sprint have claimed average downstream speeds between 500-600 kbps, though some in the industry contest these claims. One independent test of AT&T's broadband network found downstream speeds between 100-300 kbps, and upstream speeds under 100 kbps.[32]

The major advantage of 3G broadband data services over Wi-Fi is not speed but coverage—Wi-Fi networks tend to be offered sporadically, by various providers (or neighbors), while cellular data services are available anywhere that the carrier's network reaches.

In a manner similar to early broadband services, Verizon and AT&T have offered their services pursuant to discriminatory conditions of various kinds.

[††] AT&T will soon offer the Apple iPhone, which has Wi-Fi capabilities. Also, since October 2006, T-Mobile has offered a plan in the city of Seattle whereby consumers can use a hybrid telephone, sold by T-Mobile, in T-Mobile's "hotspots," although this feature also entails an extra monthly fee. In addition, also in October 2006, T-Mobile began to make available the "Dash" smartphone with Wi-Fi capabilities. Users can also buy Wi-Fi phones in Europe or Asia and import them.

Blocks and Bans

The practices of Verizon & AT&T with respect to their data services are most notable. Verizon widely advertises an "unlimited broadband access" offering (see Figure 9 below).[33]

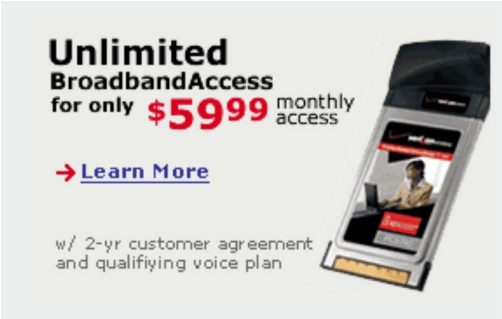


Figure 9. Verizon EVDO Advertisement

However, in practice, Verizon imposes limits on its "unlimited service"—namely by restricting bandwidth and designating certain applications as "forbidden.". AT&T and Verizon have virtually identical Terms of Service contracts. They ban their users from using their broadband connections for any purpose other than:

1. Internet browsing;

2. E-mail; and

3. Corporate intranet access (including access to corporate email, customer relationship management, sales force automation, and field service automation applications).

Verizon limits its "unlimited" brand service as follows:

> Unlimited NationalAccess/BroadbandAccess services cannot be used (1) for uploading, downloading or streaming of movies, music or games, (2) with server devices or with host computer applications, including, but not limited to, Web camera posts or broadcasts, automatic data feeds, Voice over IP (VoIP), automated machine-to-machine connections, or peer-to-peer (P2P) file sharing, or (3) as a substitute or backup for private lines or dedicated data connections.[34]

AT&T takes its restrictions even further:

> Prohibited uses include, but are not limited to, using Services: (i) with server devices or with host computer applications, including, without limitation, Web camera posts or broadcasts, continuous jpeg file transfers, automatic data feeds, telemetry applications, automated functions or any other machine-to-machine applications; (ii) as substitute or backup for private lines or dedicated data connections; (iii) for Voice over IP; (iv) in conjunction with WWAN or other applications or devices which aggregate usage from multiple sources prior to transmission; … except for CONTENT formatted in accordance with AT&T's CONTENT standards, Unlimited plans cannot be used for uploading, downloading or streaming of video content (e.g. movies, TV), music or games. Furthermore, unlimited plans (except for DataConnect and Blackberry Tethered) 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 laptops, PCs, or other equipment for any purpose.[35]

Under these contracts, a computer user who subscribes to Verizon's "unlimited broadband access" is contractually barred from many of the most popular uses of the Internet. The provisions ban, for example, a computer user from downloading episodes of the television show *Lost*, or even music, from Apple iTunes. They also bar downloading user-created content on YouTube, or using VoIP providers like Skype or Vonage.

How are these rules enforced? First, while this is not possible to verify, Verizon or AT&T may be blocking or degrading applications that fall outside its list of "permitted" uses. The limits of this study preclude monitoring any active blocking or degrading.

Second, over the last two years, Verizon has shut down the accounts of people who use banned applications or too much bandwidth. Numerous people have complained about being shut down by Verizon for such reasons.[36] Victims identify two patterns of termination. In the first, users are notified through a letter that they are using too much bandwidth and asked to call a number. When they call, they are asked whether they are downloading games or songs. If the answer is "yes," the user is terminated, and charged a $175 termination fee. In a second reported pattern, the appeal stage is skipped: customers who, according to Verizon, use too much bandwidth, are terminated and charged the termination fee.

An excerpt from a termination letter is below:

> As you know, the terms and conditions that govern your NationalAccess and/or BroadbandAccess account, which were provided to you at the time of service activation and which are posted on VerizonWireless.com, only permit Internet browsing, email and intranet access. All other activities, such as streaming and/or downloading movies and video, are expressly prohibited by the terms and conditions. A copy of the terms and conditions is enclosed.
>
> We recently reviewed your Verizon Wireless NationalAccess and/or Broadband Access account and found that your usage over the past 30 days exceeded 10 Gigabytes. Your usage was more than 40 times that of a typical user. This level of usage is so extraordinarily high that it could only have been attained by activities, such as streaming and/or downloading movies and video, prohibited by the terms and conditions. Based on these facts, your extraordinarily high levels of usage conclusively demonstrate a violation of the terms and conditions, and your account will be terminated on 9/20/2006.[37]

One anonymous user who was terminated documented his complaint as follows:

> I would not object to being billed monthly per gigabyte, or even to being billed at a usurious rate for usage over a prespecified threshold. But in their advertising, 'unlimited' is the big selling point. Nowhere do they reveal the daily usage quota—which with great difficulty I finally discovered to be 166M [Megabits] per day—or any limit of any kind. They kick anyone off who uses more than that and pretend it's because they caught you streaming kiddie porn or something.[38]

In the summer of 2006, the group Consumer Affairs ran tests of the 3G limits and were terminated for using too much bandwidth, despite the fact that they did not violate any contractual limitations.[39] When contacted by Consumer Affairs, a Verizon spokesman, Jeffrey Nelson, maintained that advertising the service as "unlimited" is not misleading to consumers. "[The limits are] very clear," he insisted, "in all the legal materials we put out."[40]

4. Application Stall

In the words of Michael Mace, an observer of the mobile application world:

> There's a collision coming between the wireless world and the Web, and I think it won't be pretty… The river is the torrent of innovation happening in Web apps right now. The dam is the carriers who won't allow that innovation to run freely on their networks. They haven't figured out how to set up spillways and generators, let alone operate them, so the pressure of the water keeps growing as Web innovation gets further and further in front of what you can do on the wireless networks.[41]

In the words of another commentator:

> Developing any kind of mobile application is a tarpit. A tarpit of misery, pain and destruction.[42]

As these comments suggest, all is not well in the world of mobile software development.

Software Development on the Web and PC

The hallmarks of the software development environment for personal computers and Web applications are (1) permissionless market entry, (2) relatively low costs of market entry, and (3) open development standards that make it possible to write to many platforms. It is important to examine how these features work together. Today, a Web or PC developer can develop a new application without seeking the permission of any carrier, the World Wide Web, or any operating system owner. A new Web-based firm can be launched without "clearance" from anyone. Similarly, applications for the major operating systems—Linux, Apple, UNIX and Microsoft Windows—can be written without the permissions of the companies or authors of those systems.

The costs of developing software for these markets, while not zero, have been relatively low. Obviously, a developer needs a degree of computer expertise and computer equipment to write a new application. However, that has not prevented hobbies from becoming multi-national corporations. eBay, for example, was run as a hobby site before becoming a multi-billion dollar concern. The amount of start-up capital required was sufficiently low that the business could be launched as a part-time job. eBay is an extreme example, but the history of the personal computer and the Internet is full of examples of low-cost market entry. Microsoft was a tiny concern when it began to market MS-DOS. Yahoo! was a graduate-student project. Similar examples are legion.

The importance of these facts for software development cannot be overstated. They allow developers to discover, or try to discover, entirely new markets at very low cost, and they give consumers more choice and value. Few in the 1980s would have ever predicted the existence of large markets for search engines, auction goods, online media, and other markets that have been discovered in the software/Web development environment. Not every market that people thought might exist has worked out—consider, for example, the "push" application craze of the mid-1990s. But through trial and error, many new markets have been discovered. In addition, cheap entry for developers creates iterative product development—rapid advances and improvements on products, based on what works and what does not. As it becomes more expensive to roll out a software product, the rate of improvement slows.

Difficulties for Developers

Many application developers believe that the mobile applications market is stalled, or much less active than it might be. Developers describe many reasons, though three are dominant: (1) access to phone capabilities, (2) extensive qualification and approval procedures, and (3) pervasive lack of standards in many areas.

Access to Phone Capabilities. Says one developer, "the bleeding from the neck problem is this: you cannot do anything if you cannot access the power of the hardware. Right now, you just can't get at the phone's capabilities, so you really can't do much." Today, in the mobile device world, there are two dominant development platforms: Java and BREW. Both create a virtual machine that runs on top of the telephone's capabilities. Neither offers application developers full access to the technological capabilities of the telephone.

Developers complain that carriers and even equipment makers do not make available many of the most useful application programming interfaces (APIs), or reserve them for some developers over others. In the words of one developer, "If you are a J2ME [Java] developer you'd be shocked at the number of capabilities that get locked down for no fucking reason. Serial port access, Bluetooth access, location, Internet access with encryption, the list goes on…"

Simple evidence of this problem can be clearly verified by anyone who owns a cell phone. Available applications, if they need processing power, tend to perform very badly. On the Motorola Razr, even simple computer games run at a snail's pace, and can take a long time simply to render graphics on the

screen.[‡‡] As one developer explained, "the guys who work at Verizon or Motorola aren't software developers, so they're just struggling to make things work. And thanks to lack of access for everyone else, the applications on phones are mostly a joke."

Screening Developers. A second problem is the carriers' qualification and approval requirements. Each of the carriers has extensive qualification procedures to become a developer for their cell phone platforms. Becoming a registered developer is expensive, which can obviously impede development by very small or hobbyist developers. While hobbyist developers may not sound important, the history of the computer industry shows how important small developers can be. The work of economists like MIT's Eric von Hippel show how important user-driven innovation can be in fields as diverse as software through surfing. Qualification procedures that make user-driven improvements impossible sacrifice that potential.[43]

For example, most of Verizon Wireless's telephones run the BREW development environment, one of two used commonly for mobile telephones. BREW, as implemented, requires an extensive and expensive three-stage process to develop applications. It requires (1) pre-qualification of individual developers, (2) a rigorous process of testing for all applications, and (3) individual submission of each application to Verizon for approval and a potential contract. In taking this approach, BREW is notable for its apparent rejection of the value of an open development environment. As BREW's promotional materials, directed to carriers, state:

> BREW equals REVENUE… With BREW, your needs come first: You own the relationship with your subscribers, you decide which apps to offer, and you determine the level of interaction you want with publishers and developers.[44]

The consequence of this level of control is much less development of applications for BREW telephones. As David Passmore writes, "software can't be installed in Verizon BREW phones without permission of the operator, who gets to determine whether the resulting services are compatible with its walled garden business model, and then insist on collecting a percentage of the revenues."[45]

Lack of Standards. A third major problem is the costs created by the sheer number of mobile platforms—the variety of cell phones, each with varying operating systems and different implementations of Java and BREW, the main development environments. The lack of standards raises development costs, as developers need to spend considerable resources making sure that even a simple wireless application works on a reasonable portion of the cell phone platforms.

The following diagram (Figure 10), based on the work of Henry Holtzman of the MIT Media Lab, highlights some of the differences between the PC and mobile phone environment:

[‡‡] For example, Iomo's "Gold Club" title takes between 20-22 seconds to render a screen on a Motorola Razr mobile phone.

Figure 10. Differences Between PC and Mobile Phone Development Environments

	PC	Mobile Phone
Service	Google, Yahoo, AOL, Windows Live, YouTube	
Apps	Web browser. All kinds of vertical niche applications.	No Solution
GUI	Common "desktop" paradigm	
Input	Generic: usually keyboard, mouse, and monitor	Specialized: keypad, buttons, and inconsistent (and often limited) screen space
HW	x86 (Intel, AMD, VIA)	Lots of different platforms

As this diagram shows, while developers would like to write software for phones and smartphones, both the variety of standards in some cases, and the lack of a standard in other cases, can be a major impediment.[§§] Some large developers overcome these difficulties, but not without cost. As one developer commented, "yes you can download Google Maps for your Blackberry. But that's because at Google they have a huge team who spends all their time just trying to get a weak version of Google Maps working on all those different platforms. That's about the best they can do, and that's Google we're talking about."

* * *

We now consider several specific areas that, despite great potential, have experienced delayed development, for some of the reasons discussed above.

SMS Crippling

SMS, or short message service, is available on most American mobile phones, and is usually used for sending messages between friends. However, developers point out that SMS could be adopted to a far broader range of innovative and interesting uses. For example, many firms have been interested in using SMS as a means of payment, or, for example, as a means for charities to raise funds. Unfortunately, the carriers have imposed complex controls on the usage of the SMS system that have all but crippled many uses other than the most basic ones.

The following anonymous testimony from a developer describes vividly the challenges in developing an SMS application:

> Almost all cell phones sold in the developed world have the ability to send and receive SMS (short message service) text messages. SMS is gaining popularity in the US, but only as a way to send quick messages to friends. So why aren't there a wealth of amazing and interactive services available for mobile devices? Why is there no MySpace, Craigslist, Amazon, Flikr, or eBay accessible through this network? Why are

[§§] This is not to completely discount the existing efforts to provide a uniform development platform. Sun Microsystems' Java Micro Edition is probably the best known effort to standardize development across mobile platforms, though developers report that it remains inconsistent across platforms and underpowered.

> cell phone payment systems and email systems nearly nonexistent? Why haven't charities raised money or awareness of their causes through this system?
>
> It's simple. Because the cell phone carriers control what services are allowed to use their networks. There is no net neutrality on the cell phone network.
>
> Imagine you want to create a user-moderated news service like digg.com that operates on SMS. On the neutral Internet, you rent a Web server ($7-$100 per month to start), register your name, and start programming. Total time required: less then two hours in most cases. But getting a service on the non-neutral US cell phone network would be a little different:
>
> The first step would be to contact a company known as an aggregator. This company manages your relationships with the cell phone carriers -- and that's carriers, plural, because making an agreement with just one carrier ensures that your service will fail because it cannot effectively spread via word of mouth. The first requirement from an aggregator is a service charge, which starts at $1,000 per month. Then, you must buy a shortcode (which kind of serves as your Web site name) for an additional $500-$1,000 per month. But you're not done.
>
> The next step is satisfying the requirements of the cell phone companies. Many of these steps, such as requiring affirmative opt-in before a subscription can start, are not burdensome, and serve to protect the carriers' customers. Others, however, border on ludicrous. Requirements vary by carrier, but some prohibit operators from offering games or sweepstakes, or require that subscription periods can only be monthly—not daily, weekly, or yearly. Others require that content, such as ringtones, be locked so users can't forward them from their phones to their friends' phones.
>
> Other requirements are outright offensive: as of this writing, Cingular, Sprint/Nextel, T-Mobile and Verizon all prohibit charities from raising money through their Premium SMS services. Too bad for the United Way, Greenpeace, and the Red Cross.
>
> Some carriers also have "decency" restrictions that are so silly and restrictive that they make the production code that governed movies between 1934 and 1967 seem quaint. Verizon is the worst offender in this case: It prohibits dating services, images that are suggestive (the same images would be acceptable if aired on prime-time network TV), and any use of "crude" words, including such shockers as "fornicate" and "genital."
>
> After you make your application compliant to the carriers' requirements, you wait weeks or months for the carriers to approve it, and jump through more hoops if they reject your application, which they can do for any or no reason.
>
> In practical terms, you'd never get approval for your brand new peer-mediated news service. Even if you were able to set up filters to block images and bad words, you'd still be sunk: Verizon prohibits "un-moderated chatting, flirting and/or peer-to-peer communication services."
>
> Even if you could slip your service past the censors, you would already have been set back eight weeks and many thousands of dollars -- and this is just the beginning. Next, the carrier will charge you a fee (a few cents, typically) for every message you send to your users, and charge your users to receive your messages -- and charge them to send you messages. Just imagine where craigslist.org would be if it had to pay a few cents every time someone browsed an ad, and you had to pay as well. It's no wonder SMS services are overpriced and haven't grown beyond a niche market for ringtones and horoscopes.[46]

As the anecdote suggests, the challenges surrounding the development of an SMS-based application are formidable.

Geolocation & Mobile Social Software (MoSoSo)

Thanks to the government's "Enhanced 911" (e911) mandate, all American mobile phones are required to have basic geolocation capabilities, while some have more advanced, full GPS capabilities. This feature can be utilized along with tools like SMS, to create innovative location-based applications—from finding friends to locating lost items or restaurants. So far, such applications have not been developed, to any significant degree, in the U.S.

An example is the effort to develop "Mobile Social Software," or MoSoSo, modeled on successful social networking sites like Friendster and MySpace. The concept behind mobile social networking software is the ability to use your mobile device to find out where your friends are, and to tell them where you are. For example, you might use the software to figure out whether any of your friends are at the café or bar to which you are headed.

Unfortunately, despite the promise of MoSoSo, it has yet to become a widespread phenomenon. It may be that the services simply aren't popular, or haven't yet reached a critical mass of people. But the development challenges just described have certainly held things back. As commentator Danah Boyd explains:

> The next step in social technologies is mobile… Yet, a set of factors have made innovation in this space near impossible. First, carriers want to control everything. They control what goes on a handset, how much you pay for it and who else you can communicate with. Next, you have hella diverse handsets. Even if you can put an application on a phone, there's no standard. Developers have to make a bazillion different versions of an app. To make matters worse, installing [outside applications] on a phone sucks and most users don't want to do it… All around, it's a terrible experience for innovators, designers and users.[47]

Boyd's concerns reflect general problems in this area. Other developers discuss the difficulty of accessing the GPS capabilities of phones. It stands to reason that, without the power to harness the relevant hardware capabilities, the development of useful GPS applications will continue to be delayed.

The OpenMoko Model

One model for how to solve many of these application development problems is something called the "OpenMoko" model. The OpenMoko is a project, backed by various firms and developers, to produce mobile platforms that are as open to development as the Web and major operating systems.

In early 2007, a Taiwanese firm, FIC, Inc., announced the release of a phone called the OpenMoko Neo1973. The phone works on GSM networks, and its distinctive feature is that it runs a standard operating system (Linux) and is completely open to installation of third-party applications. In other words, the OpenMoko telephone comes with basic voice services, and allows a user to install any application she is interested in, downloadable from the Internet.

Figure 11. FIC's Neo1973

As Sean Moss-Pultz, who works for FIC, Inc. and is a leader of the OpenMoko project, explains, "we want to build the first product that actually gets better the longer you own it." According to Moss-Pultz, the essence of OpenMoko is giving developers full access to the capabilities of the telephone. "If you don't have access to the hardware, you really can't do anything."

Whether the OpenMoko model will take off is far too soon to tell. The model depends both on the willingness of consumers to buy an unsubsidized phone and the willingness of third-party developers to write software for a telephone which will, at first, have a small user base. But what the OpenMoko model shows is that the current model of cell phone development is not the only way. Most industry observers bemoan the stagnant nature of mobile phone application development, but there are solutions.

* * *

It is interesting to contrast the present mobile development environment with that of early computer platforms, such as the Apple II. The Apple II of the late 1970s was, like today's mobile phone, a platform with some serious technical limits. However, in many ways, the Apple was better for development than today's mobile devices. It gave its users a native development environment (BASIC and Assembler) that had full access to the (albeit limited) power of the underlying hardware. The Apple II, furthermore, had no particular pre-qualification or approval rules for developers.

It seems strange that today's mobile phones should be a more closed and limited development platform than a computer released in 1977. We might put things this way: if mobile devices are to become a major platform for software innovation, like the personal computer and web, they must become at least as hospitable to innovation as the humble Apple II.

Part III: Analysis & Recommendations

1. Rating the Carriers

Based on the investigation undertaken here, it is easy to rate the carriers on the degree to which they respect *Carterfone*, network neutrality, and open platform development principles. Broadly speaking, Verizon Wireless scores the most poorly across every category, while T-Mobile scores the best. AT&T and Sprint are in the middle.

Verizon Wireless

As documented, Verizon Wireless engages in the broadest range of discrimination and misrepresentational behavior. It violates *Carterfone* by blocking unaffiliated network equipment. It imposes what appears to be the most restrictive crippling of telephones in the industry, crippling Bluetooth and blocking Wi-Fi capable phones, practices for which it has been sued. Its prefered development environment, BREW, is strictly limited. Its wireless broadband services, advertised as "unlimited," come with extensive and sometimes undisclosed usage limitations, violating both consumer protection norms and core network neutrality principles.

AT&T

AT&T is a GSM carrier, and locks its phones to the AT&T network. AT&T's broadband data service is provided with severe restrictions similar to those of Verizon. However, accounts of enforcement are not as common with AT&T as with Verizon. AT&T also cripples its products in various ways. It disables Bluetooth features on its Treo smartphones and, in the case of the Nokia E61, forced the manufacturer to remove Wi-Fi capabilities. On the Apple iPhone, while unconfirmed, many believe that AT&T's pressure led to the iPhone's inability to run third-party applications. It's also too early to tell if the iPhone will have true or crippled Wi-Fi capabilities.

Sprint

Sprint's wireless broadband data services are provided with fairly reasonable restrictions, similar to those historically imposed by dial-up ISP operators. Historically, Sprint has taken chances on new and innovative platforms, like the Handspring Treo. Sprint, however, has led efforts to cripple Bluetooth on various platforms, and has generally consented to the blocking of Wi-Fi.

T-Mobile

T-Mobile, the smallest U.S. carrier (other than regional carriers like AllTel), offers the least restrictions. It, like AT&T, locks its telephones. It will allow customers who are aware of what "locking" is to request

unlocking after owning their phones for three months. T-Mobile is not a major player in the broadband wireless market, so its practices in that area are not easy to assess. T-Mobile seems to offer the most open Bluetooth capabilities in the industry. Along with AT&T's Apple iPhone, T-Mobile is also the only known carrier, as of January 2007, to have publicly made available Wi-Fi-capable telephones, although (as noted above) this comes at an extra cost to the consumer.

2. RECOMMENDATIONS

Recommendation 1: *Cellular* Carterfone

As described above, *Carterfone* was and still is among the most fundamental rules in telecommunications policy—the *Magna Carta* of telecommunications competition. Of the various potential actions, adapting *Carterfone* to the mobile world is likely to have the greatest positive consequences and the minimum negative side-effects.

In light of existing practices, what *Carterfone* means for the mobile industry is fairly clear. It means, first, that two existing carrier practices must stop:

- on CDMA networks, blocking the registration of non-carrier-affiliated telephones; and
- on GSM networks, "locking" of equipment to single networks.

A second reform is more ambitious yet more important. The industry or the FCC should, as in the Part 68 rules, define a basic interface to which any equipment manufacturer could build a mobile device and sell to consumers. As Eli Noam put it, "while the carrier could still offer and market its preferred equipment, it could not exclude other equipment, as long as it conforms to certain technical specifications pertaining to the RF transceiving function and non-discriminatory industry specifications for air interfaces standards. These specifications could not close equipment third-party applications or access to other network protocols offered by other types of providers, as long as it conforms to the FCC's software defined radio rules."[48]

Some may argue that a standard interface for mobile networks would be highly complex or impossible. This report, obviously, cannot address the full set of technical issues involved. However, there are reasons to think that impossibility is an over-statement. The wireless world already has standardized interfaces—for example, the GSM standard contains the standardized SIM card (though its function is usually crippled by U.S. carriers). A standardized interface would work like any other in the phone or electric industry. Spectrum bandwidth is a commodity, and the interface would provide the user with a fixed maximum bandwidth and, like an electric meter, bill the consumer for the amount of bandwidth actually used.

The ramifications of such a rule are extremely important. Today, the mobile world is fixated on telephones, and to a lesser extent, messaging. However, given a standard interface, and the ingenuity of the electronics industry, we might expect major leaps forward in:

* ***Mobile video.*** Right now, large-scale deployment of mobile TV or video services, especially independent of the cell phone model, is perpetually stalled in "carrier trials." Companies in this sector are completely subject to the carrier's plans for mobile TV. To take one example, Crown Castle International's *Modeo* product has been thrown into jeopardy for want of carrier cooperation with its plans.[49] A consumer's ability to buy a hybrid device, or even a "pure" IP device, that could simultaneously access other services on other frequencies could drive further innovation and development—and not just for video.

* ***Mobile geolocation tools.*** Presently, the technical possibilities of geo-location are highly underutilized. For example, an electronics company could sell a small device, using a tiny amount of wireless bandwidth, that could broadcast its location, making it possible and cheap to keep track of pets, vehicles and other highly mobile entities on a global scale. The limits on developing both devices and software that might inter-operate with wireless networks have so far made such products scarce in the market.

* ***Mobile functions built into more devices.*** There are telephones with cameras, yet it is hard to find a camera with mobile functions—that is, a camera that can download location-specific information, or upload photos it has taken. Cameras are one example, but given a standardized mobile interface, wireless communications might be built into cameras, refrigerators, e-Books, and other devices. In the 1990s, many spoke of the refrigerator that might call the grocery store to order more milk. Access to even tiny amounts of low-frequency wireless spectrum could make that a possibility, yet the ability of devices to inter-connect between these applications and commercial networks is a critical limiting factor.

* ***Phone variety.*** While the carriers do carry a wide variety of telephones, if phones were generally unlocked, we could expect see even greater product diversity. As detailed above, major companies introduce dozens of cell phones each year, only a handful of which are sold in U.S. markets. Devices like the Danger "Sidekick" barely made it to market under current conditions—and are sold by one carrier only (T-Mobile). We know that a better variety of phones is available outside of the United States. But we have no idea how many devices are dying on the drawing board for want of carrier approval in the United States.

The full implementation of *Carterfone,* would, over time, transform the wireless industry. Rule 68 is arguably the most successful rule created by the FCC. Its success should be exported, for it could create the same explosion of innovation that the wireline industries experienced in the 1970s and 1980s.

Recommendation 2: *Network Neutrality*

Wireless carriers should be subject to the same core network neutrality principles under which the cable and DSL industries currently operate.

In the early 2000s, the use of discriminatory terms of service and blocking of applications were strongly condemned by Chairman Michael Powell and the Federal Communications Commission. In a 2003 speech, Powell outlined the following "four network freedoms":

1. ***Freedom to Access Content.*** First, consumers should have access to their choice of legal content.
2. ***Freedom to Use Applications.*** Second, consumers should be able to run applications of their choice.
3. ***Freedom to Attach Personal Devices.*** Third, consumers should be permitted to attach any devices they choose to the connection in their homes.
4. ***Freedom to Obtain Service Plan Information.*** Fourth, consumers should receive meaningful information regarding their service plans.[50]

At a minimum, regulators should use the same basic general scrutiny for the broadband services of wireless carriers. At issue, in particular, are the contractual bans on the use of wireless connections for perfectly legitimate purposes, such as buying music from iTunes or downloading videos from YouTube. Such restrictions, even if enforced unevenly, risk warping application development by discouraging the use of some applications over others. If the carriers' true goal is managing bandwidth, they should make that goal explicit. Metering of bandwidth is far more conducive to innovation, competition and consumer choice than is blocking.

Recommendation 3: *More Disclosure Rules*

Competition depends on information to work. Consumers cannot make wise decisions unless they know, for example, the daily or monthly bandwidth limits on wireless broadband services. Advertising "unlimited bandwidth" while maintaining secret limits is not acceptable. Consumers must receive truthful and meaningful information about their service plan.

Today, under agreements with states, the carriers have agreed to disclose information relevant to billing and coverage. However, much relevant information remains missing or buried. Wireless carriers should be required to disclose the following limits placed on devices and services:

- Locks placed on devices, and how to remove them, if possible;
- The disabling of standardized protocols, such as Bluetooth; and,
- If Internet access is provided, accurate and prominent information on bandwidth limits, if any; and prominent disclosure of any limits placed on Internet services.

Recommendation 4: *A Standardized Development Environment*

It is clear that the mobile application environment is not what it could be. Calling it "a tarpit of misery, pain and destruction" may be a little strong, but it captures the sentiments of many developers.

The problems include failure to give developers access to phone resources, over-demanding developer qualification requirements, too much inconsistency among platforms, inconsistent operating systems, and overly restrictive controls on developers. The combination of these factors has made what might be a flourishing jungle of mobile applications much more of a desert.

It is doubtful that government can play a useful role in this area. Instead, this report recommends that mobile carriers and equipment manufacturers should fundamentally rethink their approach to the development of software and applications for mobile platforms. Working with developers to liberate and standardize mobile application development may well yield great dividends for all parties involved, including both carriers and consumers.

In addition to the OpenMoko model already discussed, there are many existing models for better industry cooperation in this area. They include the Internet Engineering Task Force and IEEE for major Internet and communications protocols, and the CableLabs initiatives for cable Internet standardization. The emphasis must be on giving developers access to the power of mobile platforms in a standardized way. Given tools, the potential for new and innovative applications for mobile platforms is hard to estimate.

Part IV: Economic Analysis

This final section addresses several difficult economic questions that are implicated by this paper. First, given many instances of product crippling, we must ask what motivates such behavior and whether crippling products might, in fact, ultimately serve consumer interests. Second, many may argue that the competitive nature of the wireless industry makes the scrutiny of the industry in this paper unnecessary. Third, some of the recommendations in this paper, particularly the *Carterfone* recommendation, will yield important objections based on scarcity and network security. We address each issue in turn.

1. Why Cripple Products?

Some of the behavior described in this report presents a paradox. Why would carriers disable functions, or block development, that might be useful for consumers? Does crippling ultimately serve consumer interests?

A familiar framework for understanding the behavior discussed in this paper is to view it as an *infrastructure* problem, or as a problem of *vertical integration*.[51] The carrier oligopoly controls an important part of the national infrastructure, namely the public's licensed spectrum that carries digital wireless signals. The relevant question is how the spectrum caretakers interact with related vertical markets: namely, the equipment and application markets which depend on the wireless spectrum.

Given these premises, the wireless carriers have an obvious interest in exercising control over vertical markets: maximization of revenue. Usually, but not always, maximizing revenue is a useful motive, for it

suggests making the wireless networks and wireless services as useful to consumers as possible. Vertical integration or controls placed on the equipment and applications markets may represent efforts to maximize the utility of the overall platform for consumers. For example, in some instances, careful "hand-in-glove" cooperation between the carrier and equipment may yield a better product or service. That's arguably the case, for example, for the voice services that are the carriers' main offering. Each carrier works carefully with handset manufacturers to make sure its voice service is carried efficiently on the spectrum it controls.

In other instances, however, what the carriers want can be at odds with what is good for consumers. As we have seen in this report, the carriers often control or cripple product features that might be useful for consumers. At various times, different carriers have, as detailed above, blocked, delayed or conditioned the following features on mobile platforms:

- Wi-Fi technology,
- Bluetooth technology,
- Call timers on telephones,
- Photo transfer capabilities,
- Sound transfer capabilities,
- Email clients, and
- Internet Browsers.

Why do so, if, for example, Wi-Fi capabilities might make a smartphone more useful? Logically, a more useful platform, if better for consumers and developers, should ultimately be good for the carrier too. Here we develop three explanations for this behavior—one that suggests that crippling serves consumer interests, and two suggesting it does not.

Price Discrimination. Crippled products can sometimes form part of a price discrimination (or market segmentation) strategy that in some instances can, on the whole, be socially beneficial. Companies will sometimes cripple a product so as to sell it at a lower price to those with less money. Industries routinely segment markets, by quality and by price, a practice that generally enhances overall consumer welfare. For example, the IBM Series E Laser Printer was a fast printer that was deliberately slowed down and sold for less to home users. Similarly, Microsoft in 2004 released a crippled version of Windows, named "Windows Starter XP," that was substantially less capable than Windows XP—for example, capable of only running three applications at any time.[52] The idea was to produce a weaker version of Windows to sell in developing countries and sell it for less, thereby serving consumers who cannot afford the full Windows XP.

Some of the behavior described in this paper looks like a partially-implemented price discrimination strategy. For example, if AT&T prevents Nokia from marketing the Wi-Fi capable e61 Smartphone in the United States, it may be crippling the product so as to be able to sell it cheaper.[53] Similarly, if 3G broadband services are limited to web browsing only, it may represent an effort to offer less capable products for poorer consumers.

Whether price discrimination in high-tech markets is on balance socially beneficial remains an open question. But the oddity of the facts discussed here is that while the crippled product is made available, no full-featured and higher priced version of the product is made available. Verizon will sell a Bluetooth-crippled phone, but not a Bluetooth-capable phone. Most carriers will not sell a Wi-Fi phone at any price. In other words, the other half of the price discrimination strategy is missing. Out of Superman is made Clark Kent, but without retaining Superman. That fact seems to raise doubts as to whether what the carriers are engaged in what can properly be called a price discrimination strategy.

Protecting Revenue Sources. A more plausible explanation for the behavior seen here is this: carriers believe it makes sense to block a feature to protect an existing revenue source, or to keep their own costs low, even if that behavior is bad for actors in the equipment and application markets and hurts innovation. For example, again, many carriers cripple Bluetooth's media transfer capabilities. Bluetooth makes it easy to communicate between a computer and cell phone, so blocking helps preserve an existing revenue source—the prices the companies can charge for songs, ringtones, wallpapers, and other content. In other

words, with a more open system, a consumer could get what she wanted without passing the carrier's "tollbooth."

Unfortunately, protecting such tollbooths comes at a price. Crippling Bluetooth also retards any market for Bluetooth-compatible devices, and makes it much more difficult for users of cell phones to move data between their phones and computers. This kind of problem is a *spillover*, or *externality* problem. It may be that the money a carrier makes on ringtone downloads is more than it can expect to make from providing consumers with fully functioning Bluetooth. For that reason, it may narrowly make sense for a wireless carrier to block Bluetooth. But the carrier will not be taking into account the externalized costs of such action—the costs to consumers and equipment manufacturers who would like to make Bluetooth-compatible devices other than headsets.

Cultural Explanations—the Bell Model. A different explanation for the behavior seen here is that the carriers are simply acting to maximize their control and power over their networks. They have adopted a strategy that prevents the development of business models or revenue streams that depend on their network, yet over which they would lack significant control. We can call this the Bell model, after the same patterns of behavior exhibited by the pre-breakup Bell Company.[54]

Interestingly, the strategy may be a mistake. The carriers may, in some cases, block the development of services that might make the cell phone platform more valuable, and therefore are ultimately good for the carrier. The industry sometimes appears to prefer that a new service or application not exist at all rather than develop into a lucrative industry whose pricing and conduct it might not be able to control.

The major example of this kind of behavior is the strategy adopted in the area of mobile software development. Given standardization and more openness, software developers might develop a range of applications at the rate seen in Web development. But the carriers seem hesitant to allow such development to occur, possibly out of the idea that if any new services come into existence, the services should be "theirs." Analyst Andrei Jezierski describes the carriers' behavior as follows: "It's not clear if the carriers will make money from these value-added services. So if the economic model is still unclear, why give away more control earlier than you have to?"

While this strategy makes a certain amount of intuitive sense, it may be a mistake. The industry, or parts of it, appears obsessed with the fear of becoming "just a pipe" or selling "a commodity," and thereby giving up control over what happens on the pipe. But obsessions come at a cost, and may lead, in some instances, to outcomes contrary to the interests of the carrier.

2. Regulating Under Conditions of Oligopoly?

Some of the recommendations in this report, particularly the *Carterfone* recommendation, may lead to the response that the wireless industry is generally unsuited for *Carterfone*-style rules. There are two main reasons. The first is based on the argument that the wireless industry is highly competitive, unlike AT&T in the 1950s.

The AT&T monopoly in the 20th century was accepted and even maintained by government action. By contrast, it is often said that the wireless mobile market is "fiercely competitive," as if a competitive cell phone company were as easy to start as a hot dog stand. That claim, oft repeated, does not stand up to closer examination.

Structurally, the mobile wireless industry has a natural and major barrier to entry—acquisition of sufficient spectrum. Under today's conditions, that means spending hundred of millions at a minimum—and more likely billions or perhaps even tens of billions of dollars—to acquire sufficient spectrum to enter the market. For example, T-Mobile announced in 2006 that it would enter the 3G broadband wireless market. It also announced it would use $4.2 billion of spectrum to do so. The oldest fact in broadcast, spectrum scarcity, is a physical fact that cannot help but affect the conditions of competition in the wireless world.

It is important to point out that, in one respect, the justifications for regulating AT&T were, to some degree, on weaker theoretical ground than in today's wireless environment. The basis was a theory of natural monopoly in the local loop, which has subsequently undergone much criticism.[55] On the contrary, there is less doubt that, using today's technologies and the federal government's outdated spectrum allocation policies, spectrum suitable to support a wireless mobile phone company is scarce. That scarcity, in turn, has obvious market effects.

The future of the industry, of course, is hard to predict. There is a chance that ongoing spectrum auctions may lead to greater market entry. Smaller firms, like Clearwire Communications, which offers wireless broadband services in some markets, may attempt to provide services that compete with the major carriers. Yet the current trend is in the opposite direction. The industry is a textbook oligopoly—premised on a bottleneck resource—with four major players. While no one should discount the possibility of new entrants, we must also look at the facts as they are, not as how we might imagine them to be.

Whatever we might expect from oligopoly competition, there are also some reasons to believe that even competition between the carriers may not eliminate certain anticompetitive practices. Many of the practices described in this report are beneficial for an individual company to pursue, yet impose negative spillovers on adjacent markets or society at large.[56] Those practices will not necessarily be eliminated by oligopolistic competition.

That may particularly be the case where the feature in question is not well understood by consumers, and not often a relevant decisional factor. For example, say a wireless firm can narrowly make more profit by crippling Bluetooth and protecting some of its ringtone revenue. Unless consumers are aware of the crippling and its implications, it will be difficult for a firm to differentially compete by *not* crippling Bluetooth. It is relatively easy for consumers to compare firms by metrics like price and network coverage. But taking the time to do comparisons on the basis of whether the carrier cripples technological feature sets is something only a select group of consumers have the time or expertise to do.

That leads to a final reason that the existence of competition cannot be a reason not to examine carrier practices. As just described, for competition to work, consumers must know what is going on. To say that competition can then be a reason not to examine industry practices and mandate as much disclosure as possible is exactly backward. For it is such information that is necessary to make competition work in the first place.

3. Spectrum Scarcity, Network Security and Other Arguments

A different objection to *Carterfone* rules is the argument that the scarcity of wireless spectrum and network security make any such rules infeasible.

Spectrum Scarcity. While spectrum scarcity affects market structure, it also may affect the kind of rules that can be effectively maintained in the wireless space. To take *Carterfone,* for instance, how can carriers allow devices they have not approved on a network of scarce spectrum?

The problem with this argument is that scarcity is an economic feature of not just wireless networks, but wireline networks as well. Both wireless and the local loop are last-mile networks of limited available bandwidth, and, in fact, the bandwidth available on a copper local loop is considerably less than on some of today's wireless networks. For both products, it can be claimed that third parties cannot be trusted to make products that respect the shared needs of the network. In the *Hush-a-Phone* case, for example, AT&T claimed that third parties would bear "no responsibility for the quality of telephone service, but [be] primarily interested in exploiting their products." Similarly, local carriers for years complained that modems abused the scarce resources of the phone network (by maintaining long connections). But as Judge Robert Bork argued in another context: "All economic goods are scarce… since scarcity is a universal fact, it can hardly explain regulation in one context and not another. The attempt to use a universal fact as a distinguishing principle necessarily leads to analytical confusion."[57]

Does the fact that the local loop is reserved bandwidth (about 64 kbps), while wireless users share a far larger pool of bandwidth, make a difference? Yes, to a degree. You can leave your phone off the hook all day with little effect on the telephone network as a whole. However, a wireless connection left open would affect other customers.

The fact of shared bandwidth is important and true of wireless mobile networks. However, that is also true of most networks, including all Ethernet networks, the cable broadband networks, Wi-Fi networks, and other network designs. One advance over the last forty years of telecommunications technology and policy is a better understanding of what is possible using shared-bandwidth networks, and in fact many of the pieces of handling shared spectrum are already very well understood.

What is needed are private and sometimes government standards that allow a network to be shared. That's how, for example, Ethernet and DOCSIS cable networks work. That is also, crucially, how many of the cell phone networks *already* work, through the GSM and CDMA standards. These standards already control and standardize how individual devices make use of scarce spectrum—making strange the argument that scarcity is unmanageable as a technological issue. The second necessary element for addressing scarcity is pricing that reflects the scarcity of the resource, which is also already partially implemented by current cell phone pricing.

One thing should be clear from this. The answer to scarcity that has been rejected is the insistence that one party need to have total control over all aspects of the network to make possible usage of shared and scarce bandwidth. The issue of scarcity is not, by first principles, as completely different on wireless and wireline networks as is often maintained. For that reason, the thinking on network attachments from the wireline world is properly considered here.

Network Security. Customer representatives for the various companies defended practices as varied as phone locking, whitelisting, Bluetooth crippling, and other practices as necessitated by the demands of scarcity or to protect network security. For example, Verizon Wireless originally justified crippling Bluetooth on its telephones as a means of preventing "fraud" and virus infections. AT&T made similar claims in opposing the *Carterfone* principles.

There are valid and important security concerns on wireless networks.[58] The point here is similar to the point just made about bandwidth scarcity. The question that must be asked is whether the issues of network security on wireless networks are fundamentally different from similar concerns on other networks. Jonathan Zittrain's work is the starting place for the debate over network security and what it should and should not justify.[59] As he points out, any allowance of open entry and competition is likely to lead to greater abuses. Yet it is also essential to remember that the abuses are a cost that comes with a benefit: innovation, flexibility and diverse social function.

Spam, viruses, junk mail and telemarketing are different names for problems that every information network faces. What this suggests is that network security must be taken seriously, but also cannot become a blanket answer to any scrutiny of carrier practices.

All Regulation of Access is Doomed. A final argument is that any public effort and perhaps any private effort to promote greater access to wireless networks is a bad idea. Drawing a comparison with UNE-P line sharing, Scott Wallsten of the Progress and Freedom Foundation writes that "regulating how wireless carriers allow their networks to be used would represent another version of regulating network access, and the history of such regulation does not bode well for its impact."[60] Oddly, most believe that the *Carterfone* rules, which "regulate network access," are among the successful in the history the FCC. Before *Carterfone*, the interconnection requirements of the early 20th century, critical to the growth of a national phone network, were also the "regulation of network access." In fact, nearly all telecommunications regulation is some version of regulating network access. The important question is not whether access is regulated, but whether it is done well. The line-sharing rules were a failure, while *Carterfone* was a smashing success.

The comparison of the *Cellphone Carterfone* proposal with the line-sharing rules of the 1990s is the wrong one. The rules urged here are, as the name suggests, a version of *Carterfone* rules. They were never an effort to provide a price-fixed access to the Bells' phone lines. Instead, they center on a consumer's right to attach the devices of his choosing to the Bell network, and their time has come in the wireless world.

Conclusion

In many respects, the mobile market is and remains a wonder. But the infancy of the wireless market is now passing, making greater public scrutiny of industry practices more appropriate and important. In the words of analyst David Passmore, "At some point, I think Americans are going to put their foot down and say, 'We won't tolerate this anymore.'"

* * *

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