Issues in TECHNOLOGY Innovation

Number 12 August 2011

The Future of Spectrum

Jeffrey Rosen

Issues in Technology Innovation

The Center for Technology Innovation at Brookings has launched its inaugural paper series to seek and analyze public policy developments in technology innovation.

The Center for Technology Innovation

Founded in 2010, the Center for Technology Innovation at Brookings is at the forefront of shaping public debate on technology innovation and developing data-driven scholarship to enhance understanding of technology's legal, economic, social, and governance ramifications.

EXECUTIVE SUMMARY

In recent years, growth in demand for wireless services has sparked a boom in the mobile phone and wireless data sector.[1] During the past four years, the number of mobile phone subscribers tripled,[2] and the number of jobs in the telecommunications field has nearly quintupled.[3] New, better, and faster mobile devices, such as tablets and smartphones, have created multi-billion dollar industries of their own, such as Google Android and the Apple iOS "app stores."[4] And those technologies have contributed to the dawning of an always-on, always-connected culture.

© Reuters/Hyungwon Kang

But this growing demand for mobile Internet access requires a growing amount of wireless radio spectrum, portending serious problems for the future. At the moment, the United States has designated 547 MHz of spectrum to wireless broadband services, but the Federal Communications Commission (FCC) predicts a need for 637 MHz of spectrum by 2013, and 822 MHz of spectrum by 2014.[5] Without more spectrum allocated to wireless Internet connectivity, America risks short-circuiting the mobile broadband revolution.

The National Broadband Plan proposes a solution. It sets forth a detailed plan to make 300 MHz of spectrum available for wireless broadband use within the next five years, and another 200 MHz in the five years after that.[6] It seeks to achieve this freeing of spectrum by auctioning unused spectrum, lifting burdensome regulations to enable wireless broadband service in certain spectrum ranges, and reallocating spectrum from other services – notably broadcast television – to enable such spectrum

to be used for wireless broadband.[7] Though many of these provisions are controversial, the FCC has already done serious work to achieve these goals. If the FCC can achieve its goals to enable the growth of wireless broadband, America will be able to unlock the full potential of the wireless broadband revolution and realize the potential of a new wave of American innovation.

The Opportunity: Narrowing the Digital Divide

Jeffrey Rosen is a nonresident senior fellow in Governance Studies at Brookings. He is also a professor of law at The George Washington University and the legal affairs editor of *The New Republic*.

By assigning spectrum to wireless communication services and enabling the mobile broadband revolution, the federal government has helped create jobs, spur economic growth, provide new services, increase equality, and improve social welfare. Analysts predict continued growth, which – if enabled and fully realized – will continue to help further these goals.

The first cellular networks were created in 1983, when the FCC allocated and auctioned 84 MHz of spectrum to mobile communications services.[8] Cellular phone service grew, but it was limited by the relatively small amount of spectrum assigned to it. A dozen years later, the FCC auctioned the Personal Communications Service (PCS) spectrum, freeing an additional 50 MHz of spectrum allocated to mobile phone service.[9] In the next six years, the cell phone industry boomed, spurring economic growth and investment, and creating the opportunity for mobile broadband Internet service.

Mobile broadband service has helped spur economic growth, jobs, and investment. Cumulative investment in the wireless communications industry more than tripled in six years, from $19 billion to over $70 billion.[10] The number of mobile subscribes also tripled over that time frame,[11] leading to more demand for service and wireless infrastructure; in response to this demand, the industry has since almost quintupled the amount of workers that it employs, increasing wireless communications jobs from 54,000 in 1998 to 268,000 workers today.[12]

The increased amount of spectrum assigned to wireless communications also decreased prices and increased coverage. The PCS auction significantly expanded the number of wireless providers in most markets; as a result of greater competition, the average per-minute price of cell phone service decreased by 50 percent.[13] Coverage and call quality also grew as the number of cell sites quadrupled.[14]

Mobile broadband has also created new economic opportunities. Mobile app stores – marketplaces for applications running on mobile operating systems such as Apple's iOS or Google's Android – have boomed. Analysts believe that customers spent approximately $6.8 billion in app stores in 2010, and forecasters project that the market will continue to grow at a rapid pace, almost quadrupling to $25 billion in 2015.[15] Without mobile broadband, this market would likely not exist.

As mobile broadband continues to grow, it may increase broadband adoption in rural and minority communities. Currently, only 50 percent of rural households have adopted wired broadband access compared to 68 percent of non-rural households.[16] Moreover, minorities have been relatively slow to adopt broadband Internet.[17]

Wireless broadband can help solve both of these problems. For ISPs serving rural communities, it is often less costly to provide wireless broadband access than terrestrial broadband due to savings in infrastructure costs; therefore, encouraging the growth of wireless broadband may decrease the cost of broadband in rural communities.[18] Moreover, minority communities have been especially likely to adopt wireless broadband; a recent study showed that, in the span of two years, the numbers of African Americans using mobile broadband on a daily basis more than doubled, increasing from 12 percent to 29 percent between 2007 and 2009.[19] By accelerating the adoption of broadband access in rural and minority households, mobile broadband can help narrow the so-called "digital divide."

By accelerating the adoption of broadband access in rural and minority households, mobile broadband can help narrow the so-called "digital divide."

The Problem: Limited Mobile Broadband Spectrum

Mobile broadband can only help spur growth and achieve these policy goals if sufficient spectrum is assigned to wireless communication and broadband services to enable reliable service. Unless the FCC reallocates more spectrum to wireless communication and broadband services, the mobile broadband boom could be stunted.

The smartphone market is accelerating dramatically. In 2009, approximately 27 percent of the 172 million mobile phones sold in the United States were internet-capable, and analysts expect smartphone sales to soon overtake standard mobile phones.[20] Spurred by the release of the Apple iPhone, data traffic on AT&T's mobile network has increased 50-fold in a three year time period.[21] Moreover, the popularity of air-cards – devices allowing laptop computers to connect to the Internet through mobile broadband networks – has also increased demand for bandwidth.[22] Air-card users consume 56 times the data of a regular cell phone.[23]

The nation's capacity for wireless data transmission is limited, however, by the amount of spectrum assigned to such use. Currently, only 170 MHz of spectrum has been made available for use transmitting mobile voice or broadband services.[24] An additional 377 MHz has recently been made available for this use, [25] but the FCC predicts that even the additional amount will be insufficient to satisfy the growing demand for mobile data transmission. Indeed, though 547 MHz is enough to satisfy current demand, the FCC predicts a need for 637 MHz of voice and data spectrum by 2013, and 822 MHz of spectrum by 2014.[26] To satisfy this demand, the FCC would have to make more spectrum available for mobile voice and broadband services. The National Broadband Plan sets out the FCC's path towards doing so.

A Solution: Flexible Market-Based Spectrum Assignment

The National Broadband Plan aims to solve these problems in two ways. First, the Plan would create a more flexible, more transparent, and more market-based system of spectrum assignment. Second, the plan would make more spectrum available by newly designating 500 MHz of spectrum to mobile broadband within the next ten

years.[27]

Perhaps the most important recommendation in the National Broadband Plan is the recommendation to Congress to expand the FCC's authority so that it can conduct incentive auctions.[28] In most ranges of spectrum, the FCC has imposed guidelines upon the license, requiring that the licensed spectrum be used for a particular purpose. For example, spectrum space between 54 and 60 MHz is exclusively licensed for the licensees broadcasting Channel 2 on television.[29] However, in order to meet consumer demand, the FCC is constantly looking to determine which allocation of spectrum would most satisfy consumer demand. When demand for one wireless service diminishes, consumers would benefit if the licensee controlling that band of spectrum sacrificed its license, allowing the relevant spectrum space to be used for another service that is more in demand. But spectrum is valuable, and there is rarely an incentive for a licensee merely to give up the license with nothing in return. The licensee might make a profit from selling the license, but, if the spectrum has been assigned exclusively to a particular use, the license may only be sold to a licensee that provides the same type of service. In an incentive auction, a licensee of spectrum space would give up the license to the FCC, which could reassign the assigned spectrum to another use – preferably one for which there is more consumer demand – and auction that spectrum range to a new licensee providing the service.[30] And, to offer licensees incentives to give up their spectrum licenses, the FCC would share a portion of the proceeds realized by the auction with the former licensee.[31] The auction, in other words, would accelerate the FCC's efforts to transfer spectrum to fresh technologies.

Another proposal to encourage incumbent license holders to recognize market forces and consider giving up spectrum allocation is a proposal that would allow the FCC and the National Telecommunications and Information Administration to impose spectrum fees on license holders.[32] When a spectrum license is "inflexible," meaning that the spectrum can be used for only one type of service, the licensee does not receive offers from spectrum license seekers who would wish to use the spectrum for another type of service.[33] For example, because a TV broadcasting license is relatively inflexible, a TV licensee would not receive offers from mobile broadband providers to lease the licensed spectrum space. Therefore, holders of inflexible spectrum licenses do not receive market signals about alternative spectrum uses that might have higher value.[34] In order to ensure that spectrum holders adequately consider the value of their spectrum, and in order to encourage these spectrum holders to give up their license to the FCC in exchange for proceeds from an incentive auction, the National Broadband Plan suggests that licenses fees should be imposed upon license holders.[35] These fees would begin low, then increase gradually over time and in response to the relative demand for the use of the licensed service in question.[36] Though both Presidents George W. Bush and Barack Obama requested Congress to authorize the FCC to impose spectrum fees, Congress has not provided this authority.[37]

The FCC also seeks to make the spectrum market more transparent – thereby creating a more informed spectrum market – by launching and improving a spectrum

dashboard. The spectrum dashboard, currently available online at reboot.fcc.gov/reform/systems/spectrum-dashboard, is a web-based application that enables users easily to access national and local information regarding spectrum bands and licenses, including those suitable for wireless broadband deployment.[38] This application would increase transparency in government, both for common consumers seeking to further their understanding of our wireless system and for potential licensees seeking to acquire new spectrum ranges.

To satisfy the growing need for wireless broadband spectrum, the [National Broadband] plan seeks to identify and allocate 300 MHz of spectrum within five years, and another 200 MHz within the subsequent five years.

The second and more detailed portion of the National Broadband Plan's spectrum policy is dedicated to allocating new spectrum to mobile broadband. To satisfy the growing need for wireless broadband spectrum, the plan seeks to identify and allocate 300 MHz of spectrum within five years, and another 200 MHz within the subsequent five years.[39] To achieve this goal, the FCC has identified numerous sources of spectrum for wireless broadband allocation or reallocation, including spectrum that is as yet unassigned, spectrum that is assigned to mobile services but that has been precluded from such use due to burdensome regulation, and spectrum that has been assigned to other use, namely to television broadcasting.

One National Broadband Plan recommendation that has already been adopted is the freeing of 20 MHz of spectrum that had already been assigned to wireless services but that, due to burdensome restrictions intended to protect satellite radio signals, could not have been used to deliver mobile broadband. In 1997, when the FCC created the Wireless Communications Service (WCS) band – two fifteen MHz sections of spectrum at 2305-2320 MHz and 2345-2360 MHz – it intended the WCS spectrum range to be usable by communication systems including cell phones. However, the two sections of the WCS spectrum flank a band of spectrum set aside for Satellite Digital Audio Radio Service (SDARS), which occupies the spectrum ranging from 2320-2345 MHz[40] and which was licensed to the Sirius and XM satellite radio providers, which have recently merged.[41] To protect the quality of satellite radio reception, the FCC imposed strict limitations on WCS devices' power levels and out-of-band emissions, which might have caused interference with the satellite radio signals.[42] However, these strict rules effectively precluded the use of the WCS band for mobile broadband services.[43] The National Broadband Plan recommended modification of these requirements in order to enable the delivery of mobile broadband service in the WCS band.[44]

Acting swiftly, the FCC recently issued an order that enacts this recommendation. The order loosens power and out-of-band emissions restrictions on most of the spectrum range, but maintains restrictions upon the 2.5 MHz bands that are closest to the SDARS band, thereby creating a 5 MHz buffer to protect satellite radio signals while still freeing most of the WCS spectrum for mobile broadband use.[45] Moreover, though the National Broadband Plan expected only 20 MHz to be reallocated through this action, the FCC's order actually frees 25 MHz. This must be seen as a victory for the FCC, as it has swiftly freed a good portion of spectrum in a manner that, according to spectrum analysts, has nonetheless preserved the quality of the signal for satellite radio.

Another block of spectrum that the National Broadband Plan seeks to liberate for mobile broadband reallocation is a 90 MHz block in the Mobile Satellite Service (MSS) spectrum, which is currently burdened by FCC regulations.[46] Mobile satellite services are services that transmit communications between mobile earth stations – often handheld devices such as cell phones – and space stations.[47] These satellite phone services are particularly useful in rural areas, where building terrestrial infrastructure would be costly, or during periods when terrestrial-based mobile coverage is unavailable, such as during natural disasters.[48] Four bands of spectrum – the Little LEO band, the Big LEO band, the S-band, and the L-Band – have been reserved for MSS.[49] While the spectrum ranges for the Little LEO Band are too narrow to provide mobile broadband service,[50] portions of the Big LEO band, the S-Band, and the L-Band are capable of supporting such service.[51] However, until recently, all of these bands were set aside for voice-only service through satellite; using MSS-assigned spectrum to provide standard mobile broadband service was prohibited.[52] Pursuant to the National Broadband Plan's recommendation, the FCC has already ordered that 40 MHz of spectrum in the S-band located at 2000-2020 MHz and 2180-2200 MHz be permitted to serve multiple purposes; the newly opened range of spectrum may be used either for MSS or for "Fixed and Mobile" services, including mobile voice or broadband service.[53] Moreover, in order to incentivize current MSS spectrum license holders to give up their licensed spectrum to mobile broadband use, the FCC has enabled current licensees to lease their spectrum to other service providers.[54] The National Broadband Plan further recommends opening up 40 MHz of the L-band and 10 MHz of the Big LEO band,[55] though the FCC has not yet acted upon these recommendations.

Another 10 MHz will be made available from the so-called "Upper 700 MHz D Block."[56] The transition of television broadcasts from analog to digital signals freed approximately 100 MHz of spectrum between 700-800 MHz, which previously occupied a portion of television's Ultra High Frequency band.[57] After breaking up the newly freed spectrum into five "blocks," the FCC sold much of this spectrum in a 2008 auction. However, the D block, composed of two 5 MHz ranges of spectrum, was uniquely burdened by an FCC requirement that required the winner of the commercial auction to enter into an agreement to share this spectrum range with another licensee dedicated to operating a nationwide interoperable public safety network.[58] Due to uncertainty in the potential cost of this spectrum sharing, the highest bid for the D Block – a $472 million placed by Qualcomm – was far insufficient to meet the $1.3 billion reserve price set by the FCC.[59] The National Broadband Plan proposes that the FCC try again to auction this spectrum block, this time with clearer standards to ensure that bidders understand the value of the block and the costs of implementing the sharing agreement.[60]

The FCC also plans to auction 40 MHz of spectrum that has already been assigned to mobile broadband but has not yet been auctioned. The FCC has set aside three bands of spectrum exclusively for the operation of Advanced Wireless Services (AWS), which includes mobile broadband. The auction of the AWS-1 band, held in 2006, licensed 90 MHz of spectrum – located at 1710-1755 MHz and 2110-2155 MHz –

for almost $14 billion.[61] The FCC has subsequently announced the designation of two AWS-2 blocks (the "H" Block, pairing 1915-1920 MHz with 1995-2000 MHz, and the "J" Block, pairing 2020-2025 MHz with 2175-2180 MHz) and an AWS-3 band (unpaired at 2155-2175 MHz).[62] The National Broadband Plan urges the FCC to carry out this auction swiftly.[63]

The National Broadband Plan seeks to free 120 MHz of spectrum – currently assigned to broadcast television – to be reallocated to mobile broadband services.

The National Broadband Plan also recommends that the FCC determine whether 20 MHz of spectrum, currently assigned to government use, can be safely assigned to private commercial use. More particularly, the National Broadband Plan recommends that the National Telecommunications and Information Administration should examine the spectrum range between 1755-1850 MHz – currently used by federal law enforcement agencies and the Department of Defense for satellite control systems, air combat training systems, surveillance operations, and other projects[64] – in order to identify 20 MHz of spectrum that could be reallocated to commercial use and auctioned to service providers.[65] This spectrum could be auctioned alone or paired with the as yet unpaired AWS-3 block.[66] Reallocation of spectrum from within the 1755-1780 MHz range would be particularly attractive, as a number of other countries have allocated that band for commercial use, and numerous foreign devices have already been produced to utilize that range.[67]

Finally, and most significantly, the National Broadband Plan seeks to free 120 MHz of spectrum – currently assigned to broadcast television – to be reallocated to mobile broadband services. At present, only 294 MHz of spectrum are assigned to high-power over the air TV broadcasting.[68] However, as satellite and cable TV services have grown in popularity, consumer reliance upon over the air broadcast television is decreasing. While 24 percent of households relied exclusively on over the air broadcasting in 1999, only 10 percent of Americans do so today.[69] Moreover, the market has valued mobile broadband-assigned spectrum at approximately ten times the value of TV-assigned spectrum; when the FCC auctioned the band of spectrum freed up as a result of the transition to digital television, spectrum assigned to mobile broadband use was valued at $1.28 per MHz-pop, while spectrum assigned to TV use was valued at only $0.11 - $0.15 per MHz-pop.[70] Moreover, the "UHF" television frequency, particularly the ranges between 470 MHz and 698 MHz, are particularly well-suited for mobile broadband due to the superior quality, range, and penetration of such wavelengths.[71] These factors indicate that reallocating spectrum from TV broadcast to mobile broadband would be efficient and socially beneficial. In the National Broadband Plan, the FCC presents two potentially lucrative but controversial methods to free up this spectrum: channel sharing and channel repacking.

Channel sharing relies on the premise that – since the transfer from analog to digital television broadcasting – licensees of television broadcasting spectrum possess more spectrum than they need. Under current FCC rules, each television broadcasting licensee is assigned a 6 MHz range of spectrum.[72] This 6 MHz standard was established before the transition to digital television broadcasting; analog stations, which could carry only one audio and video feed per station, needed 6 MHz in order to broadcast a standard definition (SD) image and stereo sound. However, the

transition to digital television signals enabled broadcasters to transmit high definition (HD) images and surround sound using this same 6 MHz; in fact, a typical HD video signal can be broadcast using only 6 megabits per second (Mbps) of bandwidth, but a 6 MHz signal is capable of digital data transfers of up to 19.4 megabits per second of bandwidth.[73] In other words, a typical HD broadcast rarely uses the entire 6 MHz range of spectrum, which the broadcaster has licensed. Considering the relative economic value of mobile broadband and broadcast television, and considering the increasing demand for mobile broadband and the decreasing demand for over the air television, reassigning this frequently unused spectrum space seems reasonable.

To enable more efficient use of this spectrum, the FCC recommends the creation of a licensing framework that would allow multiple television spectrum license holders to share one broadcasting license of one 6 MHz block of spectrum.[74] For example, the broadcasting station currently licensing Channel 5 and broadcasting its HD station might agree to use its leftover bandwidth to also broadcast the HD content of Channel 7; in return, the broadcaster owning the license to Channel 7 would give up its license to the FCC and would share, with the owner of the Channel 5 license, the proceeds of the incentive auction.[75] If the video streams were in SD rather than HD, the FCC believes that one station could comfortably broadcast six streams simultaneously.[76] As yet, there have been no such agreements between licensees to share a 6 MHz spectrum space, but some stations are already broadcasting multiple HD streams simultaneously without significant degradation in quality.[77] FCC analysts have predicted that channel sharing, combined with channel repacking, could help clear 60-120 MHz of contiguous spectrum,[78] which could then be reallocated to mobile broadband.

Channel repacking is the method whereby unlicensed television channels and unnecessary spectrum allocation would be converted to other purposes. Currently, the FCC has set aside sufficient spectrum for 49 full-power TV broadcasts in each media market.[79] However, most markets have fewer than 10 licensed full-power TV broadcasters.[80] The FCC has therefore considered reducing the number of licensed broadcast TV stations per media market by 7, thereby freeing 42 MHz of spectrum for other purposes – namely, for wireless broadband. In order to enable reallocation of the TV spectrum, the FCC would first identify those blocks of spectrum, which it sought to reallocate. Then, in any media market where TV broadcasting licensees are occupying any of those blocks, the FCC would "repack" that market by reassigning those licensees to other 6 MHz channels that are unlicensed in that market.[81] The FCC estimates that only 10 percent of channels would need to be repacked in this manner.[82] After the FCC shifts all broadcast TV licensees from the blocks of spectrum designated for reallocation, the FCC would package the new blocks of spectrum for mobile voice and broadband service and would auction those blocks to mobile service providers.[83] A recent FCC analysis assures consumers and broadcasters that this repacking process would not dramatically decrease the amount of viewing customers served.[84]

The Politics: Support and Opposition

Many of the National Broadband Plan's spectrum recommendations have been controversial. Trade and lobbying organizations have been swift to indicate their support or opposition for the recommendations. Most notably, wireless communications providers have universally praised the spectrum reallocation plan, while television broadcasters have been wary and highly critical of the proposals to reallocate television spectrum to be used for mobile voice and data services.

The plan to re-auction the 10 MHz "Upper 700 MHz D Block" as a shared public/private enterprise has led to a minor skirmish in Congress. Most visibly, a bill introduced by Senator Jay Rockefeller would assign the block to exclusively public use by public safety officials and first responders only.[85] The bill is identical to a bill that Rockefeller introduced last year;[86] it is being co-sponsored by the same five Democratic senators as last year,[87] and it is again being supported by the Public Safety Alliance, an association composed of Verizon, AT&T, and the "Big 7" public-safety organizations,[88] including the International Association of Chiefs of Police, the International Association of Fire Chiefs, and the National Sheriffs' Association. Opposing Rockefeller's bill and supporting the public/private enterprise auction of the 700 MHz D Block is Connect Public Safety Now, a coalition including the Fraternal Order of Police, the International Association of Firefighters, T-Mobile, Sprint, and other public safety organizations and telecommunications firms.[89] At the moment, it is unclear how the conflict will be resolved, but the debate is over only 10 MHz of spectrum, an important but not integral amount of airspace. Perhaps the best resolution would be to put the block up for auction yet again; if the block again fails to garner sufficient support to meet a reasonable minimum bid, then the FCC could assign the block exclusively to public safety.

Though the 40 MHz of the Mobile Satellite Service spectrum has already been auctioned, there is still opposition to auctioning the remaining 40 MHz of the L-band and 10 MHz of the Big LEO band. The most vocal opponent of the auction is Boeing, which argues that using MSS spectrum for standard mobile broadband services ignores the original purpose of MSS spectrum: to ensure that rural areas and areas suffering from disasters maintain the ability to communicate.[90] Perhaps more important to Boeing, however, is its assertion that Boeing itself obtained an MSS license intending to develop a next generation system of air traffic management to replace the outdated radar technology currently used by air traffic controllers.[91] Boeing claims that only MSS spectrum can be used to operate such a system, and that such a system is essential to the future of aviation.[92] However, neither of these arguments is likely to persuade the FCC to delay or cancel the transition of MSS spectrum to dual-purpose MSS and mobile broadband spectrum. As the FCC explained in its order repurposing the S-band, the transition does not compromise the purposes of MSS service because the spectrum licenses still preserve that function as one of their dual purposes.[93] Moreover, even if both the L-Band and the Big LEO Band were repurposed and licensed to mobile broadband use, the Little LEO band – which is too narrow to provide mobile broadband services – would remain a range of spectrum assigned exclusively to MSS

services.[94] Finally, Boeing's argument that the MSS band can be the source of a new air traffic control system is perhaps called into question by Boeing's own actions; though Boeing had acquired an MSS license, it has since returned that license to the FCC.[95]

The FCC's recommendation to enable incentive auctions of spectrum has generally been approved by economists and incumbent licensees... However, television broadcasters have not supported the recommendation of allowing the FCC to impose spectrum fees.

The FCC's recommendation to enable incentive auctions of spectrum has generally been approved by economists and incumbent licensees. Economists have expressed support for the proposal on the basis that it would enable efficient redistribution of spectrum; indeed, 112 economists specializing in telecommunications or auction theory addressed a letter to the president to indicate their support, declaring that the system would create a centralized market, thereby decreasing transaction costs and enabling more efficient spectrum allocations.[96] Moreover, broadcasters have tentatively supported the proposal on the basis that the auctions would be optional; the National Association of Broadcasters recently announced that "the NAB does not oppose incentive auctions, [but] it does oppose any element of a spectrum reallocation plan that would not be completely voluntary."[97]

However, television broadcasters have not supported the recommendation of allowing the FCC to impose spectrum fees. Indeed, the same NAB announcement expressly opposed "new spectrum fees, which could be designed to force broadcasters to relinquish their licenses."[98] Indeed, the NAB has opposed spectrum fees for three decades, when a less complex version of spectrum fees was first proposed.[99] Though the FCC and the president have requested the authority to impose fees, Congress has consistently refused.[100] It seems unlikely, therefore, that this proposal will be enacted any time soon.

Some television broadcasters have entirely rejected the premise that mobile broadband demands more spectrum. The NAB recently filed with the FCC a study, conducted by a former FCC official, that is filled with notably conspiratorial rhetoric and that argues that there is no spectrum crisis.[101] The white paper argues that it is unclear how much spectrum will be necessary to fulfill the demands of mobile broadband, that mobile service providers should utilize "marketplace solutions" before demanding spectrum reallocation, and that other sources of spectrum are more readily available.[102] Though the white paper provides some innovative methods to decrease bandwidth demand – upgrading network technology, migrating voice to internet protocol, and edge caching[103] – the paper ignores the most reliable indicator of demand: that spectrum assigned to mobile broadband is highly valued even though these methods have been considered and pursued.[104] Enabling a more adaptable spectrum licensing regime may create a more effective market-based allocation of spectrum, which will allow demand to govern spectrum assignment rather than old decisions made upon faulty predictions about which technologies would become popular

Unsurprisingly, television broadcasters have also resisted the premise that TV spectrum should be reallocated to mobile broadband use. Opposing the reallocation, broadcasters have highlighted the uniqueness of local over-the-air television. Immediately after the publication of the National Broadband Plan's spectrum

recommendations, Dennis Wharton – the Vice President of the National Association for Broadcasters (NAB) – argued that "as a one-to-many transmission medium," broadcast television is a public good and a uniquely efficient user of spectrum.[105] Responding to a study by the Consumer Electronics Association indicating that spectrum would be more valuable in the hands of wireless broadband services than television broadcasters, Wharton declared that the CEA was ignoring "the immeasurable public benefit of a vibrant free and local broadcasting system that is … reliable as a lifeline service in times of emergency."[106] Other broadcasters have highlighted the importance of broadcast television as a public service. Leading up to the release of the National Broadband Plan, representatives from PBS reminded the FCC of their educational value, declaring that "PBS and its member stations … ensure that virtually every household has access to robust, educational content and services, regardless of financial ability or geographic location."[107]

However, the National Broadband Plan does not compromise these important values. Most of the recommendations put forward in the National Broadband Plan – all except license fees, which seem unlikely to be authorized, and repacking, which is relatively harmless – are optional rather than mandatory. Broadcasters are not mandated to give up their licenses for auction; rather, they may choose to give up their licenses for auction, which they would be more inclined to do if they believed that the proceeds from the auction would exceed the potential profits from the broadcasting license.[108] Though the National Broadband Plan's recommendations might give public broadcasters an incentive to give up their licenses, it would not threaten public education programming unless the licensee is motivated more by profit than public benefit.

Broadcasters have also objected to the proposal on the basis that encouraging a reduction in TV broadcasting spectrum allocation at this point might decrease signal quality and stunt innovation during a period in which broadcasters are still discovering the benefits of digital broadcasting. After hearing of the National Broadband Plan's proposals, Timothy Busch, COO of Nexstar Broadcasting Group, exclaimed "My God, we all just got through shutting off analog and going through to digital, didn't we? … We need to figure out the potential future of that before they go harnessing some of that back in-house."[109]

One such opportunity might be exploring new advertising revenue arising from alternate uses for the spectrum freed up as a result of the switch to digital. Some TV broadcasters have broadcast additional "subchannels" – often including an SD version of the primary broadcast or basic channels playing music or displaying a constantly updating map of local weather or traffic conditions – in addition to their primary HD feed.[110] These subchannels can air entirely new content and target entirely different demographics from the primary channel, thereby opening up new opportunities for advertising revenue.

Additionally, broadcasters have begun to examine the opportunities available for the use of currently assigned TV spectrum to broadcast a TV signal for Mobile Digital Television (MDTV) devices. These MDTV devices are mobile devices – either

standalone units or multipurpose devices such as smartphones or laptops – that could receive a live local television signal specially broadcast for display on a small screen.[111] The technology has been strongly supported by the Open Mobile Video Coalition, an organization of over 900 broadcast TV stations, 70 of which are already broadcasting MDTV signals even though few MDTV-compatible devices have reached American store shelves.[112] This would provide yet another opportunity for broadcast channels to reach out to consumers and to capitalize on enhanced advertising revenue.

Another concern is that channel sharing might compromise video quality and limit the ability of broadcasters to adopt new video technologies.

Another concern is that channel sharing might compromise video quality and limit the ability of broadcasters to adopt new video technologies. Though most HD video streams average a bitrate of approximately 11 Mbps, videos of highly detailed images or sudden movement – such as sport games or action sequences – may require up to 17 Mbps to transmit.[113] If HD signals sharing a channel were both airing particularly detailed or action-packed programs, the broadcasts might bleed into each other, thereby diminishing the quality of each signal. Moreover, if broadcasters begin to provide 1080p video quality – a form of high definition picture that provides more detail than the more frequently used 720p or 1080i standards – they would need to utilize a significantly higher bitrate. It is highly unlikely that two separate 1080p video signals could share the same 19.4 Mbps bandwidth without severe degradation of image quality. Also, 3D TVs are becoming less expensive and more popular; four million were sold in 2010 and analysts foresee 15 million sales by the end of 2012.[114] As 3D video signals require two video images instead of one, they will similarly require a dramatically higher share of bandwidth. If broadcast stations begin broadcasting in 3D, half of a 6MHz spectrum range will not likely be enough.

However, a closer examination of these criticisms softens their bite. Though many stations have launched ancillary subchannels, the revenue deriving from multicast channels has been unimpressive, accounting for only 1.5 percent of revenue for broadcast TV stations in 2011.[115] Viewership for these secondary channels is also likely quite low.[116] These incremental ad revenues would likely be outweighed by the financial and societal benefits that could be realized by sharing in the proceeds of an incentive auction of highly valuable spectrum that is reallocated to mobile broadband use.

Criticisms regarding the potential of Mobile DTV are harder to analyze. The devices have not yet hit stores in America, so measuring demand for the product is difficult. However, where MDTV is available – particularly in Japan and South Korea, where more than 90 percent of MDTV users reside – viewership is high but there is as yet no sign of financial success.[117] Though more than 69 million Korean and Japanese consumers combined are current MDTV users, high infrastructure costs have thus far outweighed advertising revenues directly attributable to MDTV users.[118] On the other hand, America's National Association of Broadcasters predicts that advertising on MDTV would generate $1.1 billion in revenue to broadcasters.[119] Clearly, this is an uncertain revenue stream. However, it is important to remember that, under the National Broadband Plan, channel sharing is entirely voluntary, and it would not be necessary in most media markets. Indeed, a white paper prepared by the Consumer

Electronics Association and CTIA projects that, in all but the most crowded thirty media markets, channel sharing will not be necessary in order to free sufficient bandwidth.[120]

Finally, video quality is unlikely to be greatly compromised due to the advances realized in "statistical multiplexing," a technology that allocates bandwidth based on each stream's bit rate in near real time; using this technology, a channel's bitrate would increase for one video feed when a highly detailed or fast-moving image was displayed, during which period the bitrate of the other channel would automatically and temporarily reduce.[121] In effect, the more bandwidth-intensive video stream would borrow bandwidth from the other.[122] Moreover, stations can minimize picture quality degradation by pairing a bandwidth-intensive program, such as a sports game, a cartoon, or an action movie, with a program that demands less bandwidth, such as a talk show or game show.[123] And, though a 1080p broadcast or a 3DTV broadcast would be more bandwidth-intensive, it is again important to recall that channel sharing would be entirely voluntary. If a station believed that it could derive more economic value from broadcasting super high quality or 3D-enabled video than from sharing in an auction of valuable spectrum, then that station should not volunteer to share its channel.

Though many of the political and bureaucratic battles ahead will be difficult, the FCC has proceeded swiftly, in the face of strong opposition, in carrying out its National Broadband Plan. It should persevere.

The Center for Technology Innovation
The Brookings Institution
1775 Massachusetts Ave., NW
Washington, DC 20036
Tel: 202.797.6090
Fax: 202.797.6144
http://www.brookings.edu/techinnovation

Editor
Christine Jacobs

Production & Layout
John S Seo

Tell us what you think of this *Issues in Technology Innovation*.

E-mail your comments to techinnovation@brookings.edu

Endnotes

[1] FEDERAL COMMUNICATIONS COMMISSION, CONNECTING AMERICA: THE NATIONAL BROADBAND PLAN 78 (2010) [hereinafter NATIONAL BROADBAND PLAN].
[2] *Id.*
[3] Lawrence H. Summers, "Remarks on the President's Spectrum Initiative As Prepared for Delivery." (June 28, 2010).
[4] Robin Wauters, *Report: Mobile App Market Will Be Worth $25 Billion By 2015 – Apple's Share: 20 percent*, TECHCRUNCH.COM, January 18, 2011. Available at http://techcrunch.com/2011/01/18/report-mobile-app-market-will-be-worth-25-billion-by-2015-apples-share-20/.
[5] FEDERAL COMMUNICATIONS COMMISSION, MOBILE BROADBAND: THE BENEFITS OF ADDITIONAL SPECTRUM 18 (2011) . Available at http://download.broadband.gov/plan/fcc-staff-technical-paper-mobile-broadband-benefits-of-additional-spectrum.pdf (hereinafter BENEFITS OF ADDITIONAL SPECTRUM). [hereinafter BENEFITS OF ADDITIONAL SPECTRUM].
[6] *See* NATIONAL BROADBAND PLAN, supra note 1, at 84.
[7] *Id.*
[8] *Id.* at 78.
[9] *Id.*
[10] *Id.*
[11] *Id.*
[12] Lawrence H. Summers, "Remarks on the President's Spectrum Initiative As Prepared for Delivery." (June 28, 2010).
[13] NATIONAL BROADBAND PLAN, supra note 1, at 78.
[14] *See id.*
[15] Robin Wauters, *Report: Mobile App Market Will Be Worth $25 Billion By 2015 – Apple's Share: 20 percent*, TECHCRUNCH.COM, January 18, 2011. Available at http://techcrunch.com/2011/01/18/report-mobile-app-market-will-be-worth-25-billion-by-2015-apples-share-20/.
[16] The White House, "Fact Sheet: President Obama's Plan to Win the Future through the Wireless Innovation and Infrastructure Initiative" (2011). Available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/Wi3-fs.pdf.
[17] See NATIONAL BROADBAND PLAN, supra note 1, at 23.
[18] *Fact Sheet*, *supra* note 16.
[19] *Id.*
[20] NATIONAL BROADBAND PLAN, supra note 1, at 18.
[21] *Id.* at 76.
[22] *Id.* at 77.
[23] BENEFITS OF ADDITIONAL SPECTRUM, *supra* note 5, at 5.

[24] *Id.* at 15.
[25] *Id.*
[26] *Id.* at 18.
[27] NATIONAL BROADBAND PLAN, supra note 1, at 84-93.
[28] *Id.* at 81.
[29] See "NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION, UNITED STATES FREQUENCY ALLOCATIONS: THE RADIO SPECTRUM" (2003). Available at http://www.ntia.doc.gov/osmhome/allochrt.pdf.
[30] NATIONAL BROADBAND PLAN, supra note 1, at 81.
[31] *Id.*
[32] *Id.* at 82.
[33] *Id.*
[34] *Id.*
[35] *Id.*
[36] *Id.* at 83.
[37] *Id.*
[38] *Id.* at 80.
[39] *Id.* at 80.
[40] FCC, IN THE MATTER OF AMENDMENT OF THE COMMISSION'S RULES TO ESTABLISH PART 27, THE WIRELESS COMMUNICATIONS SERVICE ("WCS") (1997), available at http://wireless.fcc.gov/auctions/14/releases/fc970112.pdf.
[41] Amy Schatz & Sarah McBride, *FCC Commissioners Will Approve XM-Sirius Deal*, WALL STREET JOURNAL, July 24, 2008. Available at http://online.wsj.com/article/SB121683130281477651.html.
[42] See NATIONAL BROADBAND PLAN, supra note 1, at 85.
[43] *Id.*
[44] *Id.*
[45] Operation of Wireless Communications Services in the 2.3 GHz Band; Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310–2360 MHz Frequency Band, 75 Fed. Reg. 45058 (proposed 2010 Aug. 2) (to be codified at 47 C.F.R. pts. 2, 25, and 27).
[46] NATIONAL BROADBAND PLAN, supra note 1, at 87-88.
[47] *Id.* at 87.
[48] *Id.*
[49] *Id.*
[50] The Little LEO Band occupies 137-138 MHz, 148-150.05 MHz, and 400.15-401 MHz. *See* 47 C.F.R. § 25.202(a)(3) (2011). The band is unsuitable for the provision of terrestrial broadband service. Fixed and Mobile Services in the Mobile Satellite Service Bands, *Notice of Proposed Rulemaking*, FCC RCD 9481, 9482, ¶ 4 n.5 (2010).
[51] NATIONAL BROADBAND PLAN, supra note 1, at 87.
[52] *Id.*

[53] "Report and Order, In the Matter of Fixed and Mobile Services in the Mobile Satellite Service Bands," FCC 11-57, 5 (2011). Available at http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db0415/FCC-11-57A1.pdf.
[54] *Id.* at 7.
[55] NATIONAL BROADBAND PLAN, supra note 1, at 87.
[56] *Id.* at 86.
[57] Chris Ziegler, *The FCC's 700MHz auction: what you need to know*, ENGADGET.COM, January 24, 2008. Available at http://mobile.engadget.com/2008/01/24/the-fccs-700mhz-auction-what-you-need-to-know/.
[58] NATIONAL BROADBAND PLAN, supra note 1, at 86.
[59] W. David Gardner, *700 MHz Auction Keeps U.S. Public Safety Network In Limbo*, INFORMATIONWEEK.COM, April 16th, 2008. Available at http://www.informationweek.com/news/mobility/business/207400019?cid=tab_art_tele.
[60] See NATIONAL BROADBAND PLAN supra note 1, at 86.
[61] *See* Federal Communications Commission, "Auction 66: Advanced Wireless Services (AWS-1)." Available at http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=66.
[62] *See* NATIONAL BROADBAND PLAN, supra note 1, at 86.
[63] *Id.* at 87.
[64] U.S. DEPARTMENT OF COMMERCE - NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION, "FEDERAL OPERATIONS IN THE 1755-1850 MHZ BAND: THE POTENTIAL FOR ACCOMMODATING THIRD GENERATION MOBILE SYSTEMS – INTERIM REPORT" (2000). Available at http://www.ntia.doc.gov/osmhome/reports/imt2000/imt2000.pdf.
[65] NATIONAL BROADBAND PLAN, supra note 1, at 86-87.
[66] *Id.*
[67] *Id.* at 86.
[68] Federal Communication Commission, "SPECTRUM ANALYSIS: OPTIONS FOR BROADCAST SPECTRUM (OBI TECHNICAL PAPER NO. 3) , 29" (2010). Available at http://download.broadband.gov/plan/fcc-omnibus-broadband-initiative-percent28obi percent29-technical-paper-spectrum-analysis-options-for-broadband-spectrum.pdf hereinafter OPTIONS FOR BROADCAST SPECTRUM].
[69] *Id.* at 7.
[70] NATIONAL BROADBAND PLAN, supra note 1, at 89. *See also* OPTIONS FOR BROADBAND SPECTRUM, supra note 68, at 7.
[71] OPTIONS FOR BROADBAND SPECTRUM, supra note 68, at 6.
[72] NATIONAL BROADBAND PLAN, supra note 1, at 90. These 6 MHz bands are themselves contiguous, but groups of channels are assigned to different groups of spectrum. For example, TV channels two through four are assigned to the 54-72 MHz range, while TV channels five and six are assigned to the 76-88 MHz range, with each

channel receiving six MHz of spectrum. See "NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION, UNITED STATES FREQUENCY ALLOCATIONS: THE RADIO SPECTRUM" (2003). Available at http://www.ntia.doc.gov/osmhome/allochrt.pdf.

[73] NATIONAL BROADBAND PLAN, supra note 1, at 90.

[74] *Id.*

[75] *See id.*

[76] *See* OPTIONS FOR BROADBAND SPECTRUM, supra note 68, at 15.

[77] NATIONAL BROADBAND PLAN, supra note 1, at 90.

[78] See OPTIONS FOR BROADBAND SPECTRUM, supra note 68, at 16.

[79] *Id.* at 29.

[80] *Id.*

[81] It should be noted that, though these reassigned TV broadcasters would technically be assigned to a different channel, the viewer could still tune to the same channel in order to watch the station; this is because digital broadcasts decouple the tuned channel from the actual radio frequency over which signals are broadcast. *Id.* at 17.

[82] *Id.* at 18.

[83] *Id.* at 17-18.

[84] *Id.* at 18.

[85] Donny Jackson, *Rockefeller Introduces 700 MHz D Block Bill*, URGENT COMMUNICATIONS, January 25, 2011. Available at http://urgentcomm.com/policy_and_law/news/rockefeller-reintroduces-dblock-bill-20110125/.

[86] *Id.*

[87] *Id.*

[88] Mary Rose Roberts, *Former FEMA head Witt holds Capitol Hill meeting on D Block*, URGENT COMMUNICATIONS, Jan. 25, 2011. Available at http://urgentcomm.com/policy_and_law/news/witt-lobbies-dblock-auction-20110125/.

[89] *Id.*

[90] "Report and Order, In the Matter of Fixed and Mobile Services in the Mobile Satellite Service Bands," FCC 11-57, 5 (2011). Available at http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db0415/FCC-11-57A1.pdf.

[91] *See id.*

[92] *See id.*

[93] *See id.* at 6.

[94] Fixed and Mobile Services in the Mobile Satellite Service Bands, "Notice of Proposed Rulemaking," FCC RCD 9481, 9482, ¶ 4 n.5 (2010).df

[95] "Report and Order, In the Matter of Fixed and Mobile Services in the Mobile Satellite Service Bands," FCC 11-57, 6 (2011). Available at http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db0415/FCC-11-57A1.pdf.

[96] "Letter from 112 Economists to President Barack Obama," (April 6, 2011). Available at http://siepr.stanford.edu/system/files/shared/Letter_to_obama.pdf.
[97] National Association of Broadcasters, "Promoting Spectrum Policies that Serve the Public," (2011). Available at http://www.nab.org/documents/advocacy/spectrumManagement/Spectrum_issueSheet.pdf.
[98] *Id.*
[99] *See* Milton Mueller, *Spectrum Fees vs. Spectrum Liberation*, REGULATION 22 (1983).
[100] *See* NATIONAL BROADBAND PLAN, supra note 1, at 83.
[101] ONYEIJE CONSULTING LLC, "SOLVING THE CAPACITY CRUNCH: OPTIONS FOR ENHANCING DATA CAPACITY ON WIRELESS NETWORKS," (2011). Available at http://www.nab.org/documents/newsRoom/pdfs/042511_Solving_the_Capacity_Crunch.pdf.
[102] *See generally id.*
[103] *See id.* at 7-15.
[104] *See* NATIONAL BROADBAND PLAN, supra note 1, at 89. See also OPTIONS FOR BROADBAND SPECTRUM, supra note 68, at 7.
[105] Matthew Lasar, *TV stations asked to yield 500MHz of spectrum for broadband*, ARSTECHNICA.COM, February 25, 2010. Available at http://arstechnica.com/tech-policy/news/2010/02/tv-stations-asked-to-yield-500mhz-of-spectrum-for-broadband.ars.
[106] NAB, "Press Release: NAB Counters CEA-Funded Spectrum Study," October 27, 2009. Available at http://www.nab.org/documents/newsroom/pressRelease.asp?id=2101.
[107] John Eggerston, *Public Broadcasters Want To Hold On To Spectrum*, BROADCASTING & CABLE, November 16, 2009. Available at http://www.broadcastingcable.com/article/389175-Public_Broadcasters_Want_To_Hold_On_To_Spectrum.php.
[108] See John Eggerton, *FCC's Bellaria Says Broadcasters Lobbying Against Scenario That's No Longer On Table*, BROADCASTING & CABLE, January 18, 2010. Available at http://www.broadcastingcable.com/article/444575-FCC_s_Bellaria_Says_Broadcasters_Lobbying_Against_Scenario_That_s_No_Longer_On_Table.php.
[109] John Eggerton, *Broadcasters Defend Their Spectrum: FCC's Levin approaches industry in search for settlement*, BROADCASTING & CABLE, November 12, 2009. Available at http://www.broadcastingcable.com/article/367021-Broadcasters_Defend_Their_Spectrum.php.
[110] *See* Eric Taub, *More Channels Are Coming. Will Anyone Be Watching?*, NYTIMES.COM, June 9th, 2008. Available at http://www.nytimes.com/2008/06/09/business/media/09channels.html. See also OBI Technical Paper No. 3, supra note x, at 31.

[111] *See* Mike Melanson, *CES 2011: Mobile DTV Coming to an iPhone, iPad Near You*, READWRITEWEB.COM, January 4, 2011. Available at http://www.readwriteweb.com/archives/ces_2011_mobile_dtv_coming_to_an_iphone_ipad_near.php.

[112] *Id.*

[113] *See, e.g.*, "OPTIONS FOR BROADBAND SPECTRUM," supra note 68, at 2.

[114] Don Reisinger, *Survey: 3DTV adoption to hit 15 million next year*, CNET NEWS, March 7, 2011. Available at http://news.cnet.com/8301-13506_3-20040089-17.html.

[115] "OPTIONS FOR BROADBAND SPECTRUM," supra note 68, at 31.

[116] *Id.* at 32.

[117] *Id.*

[118] *Id.*

[119] *Id.*

[120] "CTIA: THE WIRELESS ASSOCIATION & CONSUMER ELECTRONICS ASSOCIATION, BROADCAST SPECTRUM INCENTIVE AUCTIONS: WHITE PAPER 1" (February 15, 2011). Available at http://files.ctia.org/pdf/CTIA_CEA_TV_Spectrum_Whitepaper.pdf.

[121] "OPTIONS FOR BROADBAND SPECTRUM," supra note 68, at 21.

[122] *Id.*

[123] *Id.* at 22.