
# Spectrum Policy and the EU Digital Single Market: Lessons from the United States

BY DOUG BRAKE | DECEMBER 2015

*We commend the Commission for its vision and effort to achieve a single EU market for mobile communications. But to achieve its goals, Europe must have a regulatory framework more conducive to operations at scale.*

The European Union (EU) has outlined a set of ambitious goals in its Digital Single Market proposals, some of the most challenging of which lie in the proposed reforms to radio spectrum management to create an EU-wide market for mobile communications. But the goal of a single wireless market is also the most promising: The mobile digital economy is poised to have a tremendous impact on growth, productivity, and progress throughout the 21st century. Europe should take this opportunity to achieve a true single market for mobile by centralizing its spectrum management functions, harmonizing regulations, and allowing for industry consolidation to fit the scale of a single market. In this endeavor, the European Union could potentially benefit from some of the policy choices the United States has made in attaining its single market for mobile communications.

## INTRODUCTION AND BACKGROUND

Europe is in the midst of talks about how to achieve a "Digital Single Market" (DSM)—a top priority of the European Commission under Jean-Claude Juncker. Creating a European DSM is a sprawling, ambitious project dealing with fragmentation throughout the Internet ecosystem and beyond. The contemplated reforms involve everything from data protection to copyright, online purchasing to digital geo-blocking. This paper focuses on a core component of the DSM project: harmonization and unification of European

spectrum management to bring greater interoperability and economies of scale to the mobile market.

The European Commission is to be commended for its vision and efforts to achieve a digital single market. But if it is to achieve these goals, Europe must have a wireless market more conducive to operations at scale. Instead of each member country having three-plus operators, the goal should be an EU-wide single market with four to six major wireless carriers. Such scale will reduce costs per subscriber, greatly reduce the need for roaming charges, encourage investment and more rapid transition to 5G networks, and provide larger platforms for others to innovate on top of—a true boon to European businesses and consumers. The European Commission is correct in its calls for a single telecommunications market; the challenge will be in achieving the political support for these comprehensive changes.

Contrasting with the relative fragmentation in the EU, the United States has an effective single market for wireless, with four carriers offering service nationwide. Even though this market generates fewer companies than the EU market, it provides more value for consumers. This is because scale is a key enabler of efficiency in wireless markets, and U.S. wireless legislation and regulatory policy has focused on enabling carriers to obtain national scale.

The balance of this report offers insights on those policies that saw the United States achieve a single market for wireless services and recommendations on how similar results could be achieved in the EU. Of course there are significant political and cultural differences between the EU and United States, and we do not expect the U.S. model to be replicated wholesale. Policy should be tailored to the specific history and context of each region's industry, but 28 different sets of regulations, and 28 different separate spectrum markets is fragmentation in the extreme, and the Commission is right to move toward a more harmonized, unified market.

After examining the current context of the EU market, we briefly describe the history of spectrum policy in the United States. The paper assumes a basic working knowledge of radio spectrum and its management, but Appendix 1 offers a brief introduction to these subjects for the uninitiated. We then offer five specific recommendations—lessons learned from U.S. experience—that we believe should be part of telecom reforms in the EU:

1. Consolidated EU-wide spectrum management and auctions and harmonization of regulations,
2. Permissive merger policy,
3. Reallocation of broadcast spectrum for mobile broadband,
4. Technologically neutral, flexible licenses tradeable on a secondary market, and
5. Neutral auction policy eschewing active market shaping.

## THE VISION OF AN EU SINGLE MOBILE MARKET

The European Commission should aim to achieve a true pan-European market for mobile telecommunications. The key reform necessary to see a single mobile market is centralization of EU-wide spectrum management. By providing centralized spectrum management functions, but keeping all auction revenue with member countries, the Commission can focus on the most socially beneficial allocations and technical rules, while reducing opportunities for misaligned incentives or regulatory capture. The goal should be to see uniform blocks of flexible-use mobile spectrum licenses auctioned across the entire EU market.

True uniformity across Europe will be a challenge given the diversity of incumbent spectrum users from country to country. An EU spectrum management body should look to the upcoming U.S. incentive auction—a two-sided auction with broadcasters giving up their rights to spectrum, and mobile operators buying them—as a model to clear as much spectrum for mobile broadband as demand will support.

*Four to six wireless carriers would provide effective competition and likely supply enough capacity to see an unregulated wholesale market like that in the United States.*

Continent-wide auctions of new spectrum should use "nesting" licenses, where the geographic scope of new licenses mirror existing mobile allocations, but nest within regional or country-wide blocks that can be bid on in packages. This offers a streamlined method for bidders to aggregate spectrum across the continent, supplementing existing holdings as they see fit, as well as a mechanism to see strong auction revenues while ensuring that auction revenues continue to flow to the member countries.

A component of this reform would be to allow considerable consolidation as carriers scale their operations to fit an EU-wide market. Four to six carriers would provide sufficient competition and likely supply enough capacity to see an unregulated wholesale market like that in the United States. A fewer number of larger players will mean consumers will be less likely to be roaming on another network even when abroad, reducing the economic pressure for roaming fees. Perhaps more important is the boon to dynamic competition: Fewer competitors fighting over larger market shares will provide greater incentives for R&D and deployment of breakthrough technologies.

Harmonized regulations and more uniform band plans and technical service rules will allow economies of scale to drive gains throughout the entire mobile value chain. Cheaper per-unit infrastructure cost, a more uniform radio environment, greater interoperability and scale for end-user devices, a larger platform for digital services all contribute to reducing costs throughout the entire mobile ecosystem, the benefits of which will accrue to mobile consumers.

Larger operating footprints will support the economics needed for aggressive investment in 5G deployment. Through the 5G Infrastructure Public Private Partnership (5G PPP), Europe certainly has a jump-start on the 5G standardization process. But advanced standards mean little without a regulatory and economic framework that enables wide-scale investment in that technology.

## EU WIRELESS CHALLENGES

In the 3G era, Europe was considered a world leader in mobile telecommunications. Not so today—most EU countries lack significant mobile coverage with high-speed, data-intensive LTE technology, a situation the Boston Consulting Group characterized by saying "in a few short years, Europe has gone from leader to laggard in advanced digital networks."[1]

In 2012, 86 percent of the U.S. population had access to LTE networks, whereas in Europe, only 27 percent of households had LTE coverage.[2] As of mid-2015, about half of total mobile connections in North America were 4G, compared with about 17 percent in Europe.[3] 4G access has been a driver in the remarkable difference in mobile usage between the two regions, with Americans using roughly five times more voice minutes and downloading roughly twice as much data as Europeans.[4]

Of course, these differences are due to multiple complex factors. Europe's large investments in more advanced 3G technologies, for example, lessened the competitive pressure and muddied the upgrade path for an early transition to LTE, the first wireless standard specifically designed for the Internet era. But more than any particular standards process, European wireless operators are held back by delayed and varying access to spectrum and a hodgepodge of different regulations. EU operators have made great strides in deploying advanced networks since 2012, but significant challenges remain.

The primary challenge for the European wireless industry is fragmented rules across isolated, national markets. The lack of regulatory consistency from country to country, particularly in the way that radio spectrum is allocated and managed, has resulted in a highly fragmented "market" from an EU-wide perspective. With its own particular spectrum management, license duration, coverage requirements, bidding limitations, etc., each country now functions as an individual market.

This has led the EU to have about 40 facilities-based mobile network operators, many of which are only present in one country and have a tiny percentage of total EU mobile connections.[5] The largest EU mobile operator, Vodafone, has less than one-fifth of all connections, and covers about two-thirds of the EU population. From there the market share reduces slowly, with a long tail of many small, single-country operators with less than 2 percent of total EU connections.

| **Top EU Mobile Operators** | Number of EU Countries Served | % of EU SIM Connections | % of EU Population Coverage |
|---|---|---|---|
| Vodafone | 12 | 19% | 66.2% |
| Deutsche Telekom | 10 | 13.9% | 40.6% |
| Orange | 7 | 10.8% | 37.2% |
| Telefónica | 4 | 10.2% | 38.7% |
| KPN | 3 | 5.4% | 21.5% |

| | | | |
|---|---|---|---|
| TelecomItalia | 1 | 4.9% | 11.8% |
| EverythingEverywhere | 1 | 4% | 12.6% |
| Hutchison | 6 | 3.7% | 30% |
| VimpelCom | 1 | 3.3% | 11.8% |
| SFR | 1 | 3.2% | 13% |
| TeliaSonera | 7 | 2.8% | 14.6% |
| Polkomtel | 1 | 2.2% | 7.6% |
| Telekom Austria | 4 | 2% | 4.4% |
| Telenor; Bouygues Telecom; Play; Tele2; Portugal Telecom; PPF | N/A | Between 1 and 2% of EU SIM Connections | N/A |
| Illiad; Belgacom; TDC; Elisa; WindHellas; Bulgaria Telecom; Optimus; DNA; BITE; RCS-RDS; Telekom Slovenije; Eircom | N/A | Less than 1% of EU SIM Connections | N/A |

**Table 1: EU Mobile Operators by Percentage of EU SIM Connections 2H 2015**[6]

Compare this with the United States, where four companies—AT&T, Verizon, T-Mobile, and Sprint—have over 95% of the market between them, with each of these nationwide companies covering nearly the entire U.S. population.[7] After the big four companies, the size drops off dramatically: US Cellular—the fifth largest carrier—is about one-fifth the size of Sprint, and the next largest publicly-traded carrier another order of magnitude smaller than US Cellular.[8] These are simply two very different markets.

| Top U.S. Mobile Operators | Number of Subscribers (millions) | Market Share by Revenue |
|---|---|---|
| Verizon Wireless | 137.553 | 36.5% |
| AT&T | 126.406 | 32.5% |
| T-Mobile US | 61.220 | 15.5% |
| Sprint | 58.129 | 10.9% |
| US Cellular | 4.807 | 1.9% |

**Table 2: U.S. Mobile Operators by Market Share**[9]

This EU fragmentation negatively impacts operators, and, in turn, consumers, in a number of ways. Telecommunications infrastructure investment is characterized by high fixed costs

that are recouped over a long period of time. In addition to considerable economies of scale, a consolidated market would allow operators a bigger footprint to recoup these fixed costs. This allows companies more revenue to invest in infrastructure as well as the R&D needed to support new access technologies. As Hossein Moiin, CTO of Nokia Networks, has explained, "in the US you have a country of 300 million people and only four operators, but in the EU you have many operators. Such fragmentation does not help the business case for investors. There are no technological barriers, it's just a question of economics and return on investment."[10]

Some commentators point to competition as an important reason to maintain the large number of carriers in Europe.[11] Absolutely, competition is important to preserve consumer choice, ensure competitive prices, and spur innovative new offerings. But many seem to think that having a large number of providers is a cure-all for virtually all telecommunications policy questions, leading regulators to use mechanisms, both explicit—such as limitations on consolidation—and implicit—such as spectrum set-asides—to preserve a high number of competitors.

*Creating a central authority is the only way to attain a true single mobile market. Anything less, such as simply banning roaming charges, is a half measure that will not correct the underlying economic inefficiencies.*

There are several problems with this view. First, as a general matter, competition is not an unalloyed benefit, especially in high-fixed cost industries like telecommunications. As you increase the number of competitors in a particular geographic area, you necessarily see duplicative fixed costs that must each be recouped through a smaller consumer base, with smaller economies of scale. There is no single ideal level of competition in dynamic, multisided markets. However, the desired level of competition in high fixed-cost industries like telecommunications generally follows an inverted U shape (∩), with both too many and too few competitors being problematic.[12]

More importantly in this context, the European Union has ended up with an inefficient market definition, with each of the 28 member nations having separate communications markets. But the relevant measure of competition is not the total number of providers in Europe, it is the number of providers in any particular submarket. In this sense, Europe could see a reduction in the number of wireless providers by a factor of more than five—down to four to six major firms—and have no less effective competition. What matters is the number of providers in any local market, not the total number of providers in Europe.

Furthermore, trends in communications technologies are increasingly rendering artificial boundaries irrelevant. Although approaching platitudinous in these discussions, it remains a fact that radio spectrum does not obey national boundaries. Signals spill over national borders, now requiring costly and complex coordination through bodies like the Electronic Communications Committee (ECC) under the European Conference of Postal and Telecommunications (CEPT), even where band plans are harmonized across regions. However good a job the ECC does, this process is necessarily inefficient—it would be much better if relatively fewer companies internalized the cost of coordinating a far less fragmented system.

Technology trends that work against geographic boundaries goes beyond the un-contained propagation of radio waves.[13] With the shift toward packet-routed networks, the cost of

backhaul for wireless networks is largely distance-insensitive, meaning there is no technological reason communications over state boundaries must cost more than communications that remain within one state's borders.[14] Networks and services are now modular, with applications largely separated from the underlying network. Furthermore, much of the network functionality, which was traditionally in carriers' central offices, has shifted to the edge of the network, further reducing the importance of location-specific regulation.[15]

The European Commission recognizes the multiplicity of reasons for more uniform, harmonized spectrum policy, and we commend its call for a single EU telecommunications market. The Commission has articulated three main goals for its reforms to spectrum management: (1) harmonization of spectrum access conditions, with the goal of enabling economies of scale; (2) encouraging more efficient use of spectrum; and (3) making available better information about the current and future use of spectrum.[16]

The European Commission understands the problem and has articulated the right goals for this reform. The question is whether the Commission will be able to achieve the challenging feat of pulling spectrum management functions away from individual member states into a central authority. This is the only way to attain a true single mobile market—anything less, such as simply banning roaming charges, is a half measure that will not correct the underlying economic inefficiencies.

## LESSONS FROM THE UNITED STATES

There are a number of complicated factors that go into determining the success of a nation's wireless industry, but regulation and spectrum management play key roles. Some of the differences between EU and U.S. spectrum policy may be able to offer EU regulators a path toward more robust, continent-wide competition that will spur high-speed wireless build-out, reduce market fragmentation, and reduce the need for roaming fees.

### Benefits of scale

One of the fundamental rules of telecommunications is that *scale matters*. Telecom networks are subject to particular economic forces, one of the most important of which are economies of scale, whereby the per-customer cost to a firm of providing services tends to fall with each additional customer added to the network.[17] Economies of scale are one reason U.S. regulators generally prefer effective competition between a smaller set of large firms, rather than a large number of small firms—larger firms can build networks providing service to more customers at a lower cost, which in turn enables lower prices and higher quality.

A simple example of the benefits of effective competition at scale is the way in which U.S. mobile carriers offer packages of voice minutes that cost the same no matter where calls originate in the United States. Contrast this with the EU, where expensive roaming charges are the norm when calling from country to country. The elimination of both long-distance and explicit roaming charges in mobile was not a result of targeted regulation, but grew out of allowing companies to achieve sufficient scale and compete on a national level.

This is not to say regulation plays no role. For example, there are important differences between the United States and the EU in their respective intercarrier compensation regimes.[18] But attempts to simply ban roaming charges would only mask the underlying inefficiencies of market fragmentation. The costs once imposed as roaming fees would likely crop up elsewhere on consumer bills. If, on the other hand, the EU is able to achieve a true single market for mobile operators, users would be less likely to be roaming when abroad, and such charges would most likely be pushed out by competition.

U.S. history is instructive: In the spring of 1998, AT&T was the first to offer a single nationwide rate, known as the "Digital One Rate."[19] This was a time of relative fragmentation in the U.S. market, with considerably more competitors in the wireless market, with rapid deployments, and several acquisitions and partnerships aimed in part at achieving the scale necessary to offer uniform rates.[20] AT&T's introduction of a uniform bucket of nationwide wireless minutes was a bold competitive move that ultimately proved extremely popular with consumers, and other carriers quickly followed suit.[21]

*A centralized spectrum management body can focus on the most socially beneficial allocations and technical rules, while reducing opportunities for misaligned incentives or regulatory capture.*

Moreover, the relatively concentrated U.S. market provides enough capacity to see an unregulated wholesale market. Several mobile virtual network operators (MVNOs) are able to compete on customer service and price without mandated terms for accessing operators' capacity, unlike in many EU countries, where imperfect regulations set the terms for wholesale MVNO access. While there is something to be said for regional variance and allowing different states or countries to experiment in hopes of optimal regulation, given trends in technology and strong benefits from economies of scale, uniformity across regions should be preferred. Simply put, borders make little difference to telecom technology except to introduce artificial inefficiency. Nowhere is this more true than in wireless, where radio emissions travel over borders with ease. This becomes especially problematic at border cities, where extensive international coordination is required to avoid interference.[22]

### National spectrum markets with permissive merger policy

When it comes to mobile providers, spectrum management and the licensing system play key roles in the structure of the industry and the scale these firms are able to achieve. Put simply, regulators should allow companies, especially wireless companies, to achieve scale. Artificial limits on firm size through arcane licensing procedures or limiting the geographic scope of operation will only ensure higher costs and less innovation.

Mobile data services need spectrum to thrive. In turn, the mobile phone industry is dependent on spectrum auctions to thrive. Mobile data also requires large amounts of spectrum to reach higher levels of capacity, but it is also a new entrant where spectrum has already largely been divvied up.

At a bare minimum, band plan harmonization is a must: The way spectrum is divided up and licensed to different services should be as uniform as possible across large regions. Ideally band plans are harmonized globally. The more uniform spectrum band plans are across nations, the larger economies of scale manufacturers of network equipment and end-user devices achieve. Harmonized band plans ultimately have a profound effect on the costs to consumers of devices as well as the network services themselves.

Auction design and implementation is also extremely important—access to this critical input shapes industry and costs for a key segment of the economy that touches several critical verticals. Auctions are not a random mechanism to allocate spectrum like the lotteries of the past. Instead they serve to discover the firm that thinks itself best able to provide the most socially valued business with a scarce natural resource. An incredibly complex set of questions goes into the level of auction participation any company may decide on. Factors like shifting user demand, advances in complementary equipment technology and services, advantages in infrastructure deployment, changing business models, etc., all mean auctions function best as a mechanism to allocate spectrum when free from constraints aimed at achieving particular policy goals or shaping the number of participants.

The FCC has historically been a pioneer in developing spectrum auctions and has learned much over the years about designing a complex auction.[23] Early development of spectrum auctions saw extensive advisement from numerous academic auction theorists, leading the FCC to adopt the simultaneous ascending auction model, which has since been widely used as a tool for large, multiple unit auctions.[24] Most of the FCC's auctions have been successful, with a few notable failures. Usually those failures had less to do with the auction itself, and more with either poorly designed payment schemes or legislative pressure to accomplish non-economic goals.[25]

One of the most important aspects of the FCC's transition from lotteries to auctions as a method to allocate spectrum was the move toward national uniformity in technical rules and band plans, allowing companies to aggregate licenses to match the footprint they saw fit.

The goal of spectrum auctions should be efficiency; spectrum usage rights should be designed to maximize social benefit, not auction revenues. This is widely agreed upon in most developed countries.[26] In fact, both the United States and the EU have recognized that revenues should not be explicitly considered when designing a system of competitive bidding.[27] For the most part, especially where demand exceeds supply (which is usually the case with spectrum), an efficient auction will work toward maximizing revenue.[28] As a part of this, it is important that spectrum managers set reasonable reserves when designing auctions—the goal isn't to raise a certain amount of money or go home, but to use smart mechanisms to discover the market price for a given block of spectrum.

However, there are subtle ways in which an eagerness to see large revenues can work against welfare-maximizing auctions. For this reason, it is important to separate the bidding revenue from those designing the auction. For example, U.S. spectrum auction revenues flow to general funds of the treasury—not to the Federal Communications Commission (FCC) itself—in part to help avoid perverse incentives.

The European Commission has the opportunity to establish an even clearer demarcation between the flow of auction revenue and those who design the auctions, service rules, and band plans. By providing centralized spectrum management functions, but keeping all auction revenue with the member countries, the Commission can focus on the most

socially beneficial allocations and technical rules, while reducing opportunities for misaligned incentives or regulatory capture.

However, auctions are not a perfect mechanism to assign spectrum, and as technologies, demand, and markets shift, it is important to allow a relatively unrestrained secondary market for spectrum transactions. Any EU harmonization and centralization of spectrum management functions should see a corresponding wave of consolidation—as happened in the United States. This will involve trading of spectrum usage rights as firms consolidate on a regional or continental basis.

In fact, the United States started with a very high number of providers—similar to the EU now—in the early days of wireless.[29] Before the advent of spectrum auctioning for mobile services, the service was envisioned as being fundamentally local, with licenses awarded to different companies in essentially every city through a deeply flawed comparative hearing processes.[30]

*U.S. regulators were initially uncertain about the proper market size for mobile; they started small, assuming mobile would be a local service, but were permissive in allowing consolidation.*

Over the first two decades of the mobile industry, beginning in 1981, the FCC assigned through hearings, lotteries, and finally, auctions, nine blocks of spectrum for mobile use.[31] These licenses were held at one point by tens of thousands of owners, many of which were less interested in putting the spectrum to use than benefitting from the sale of the license.[32] Accelerating particularly through the latter half of the 1990s, these licenses were rapidly consolidated.[33] Even since 2003, the FCC has seen a number of large transactions (see Table 3 in Appendix 2).

U.S. regulators were initially uncertain about the proper market size for mobile; they started small, assuming mobile would be a local service, but were permissive in allowing consolidation. Unsurprisingly—though it was unknown in the 1980s—mobile turned out to be a national market. As such, regulators allowed significant consolidation and the emergence of national, as opposed to regional, carriers. However, regulators have shunned further consolidation among the four major carriers, indicating a belief that four is necessary competition to maintain static efficiencies, while maximizing economies of scale and dynamic innovation.

Compared to the United States, EU mobile mergers are relatively rare. Authors of a study of the history of proposed mergers among incumbent mobile operators in Europe over two decades concluded that "in virtually every case, the proposals [for mobile consolidation] failed to come to fruition."[34]

### The U.S. Incentive Auction

The upcoming U.S. incentive auction planned for March 29, 2016, presents a host of policy levers that may interest European spectrum managers.

The incentive auction is an incredibly complex undertaking whereby the FCC will coordinate a two-sided auction between television broadcasters and mobile broadband providers. First the Commission will hold a descending auction to determine how much spectrum broadcasters would be willing to sell and at what price. The FCC will then turn around and auction the spectrum broadcasters are willing to sell to mobile carriers.

The incentive auction is premised on the strong presumption that broadcast TV is no longer the most socially advantageous purpose to which this valuable 600 MHz spectrum can be put. Hopefully, the FCC will succeed in facilitating market forces to repurpose the band, transitioning from technology of the 20th century to that of the 21st. This additional low-band spectrum, likely to be fully incorporated into mobile broadband networks by 2017 to 2020, will be an important component of the 5G access system.

There are a large number of quickly moving parts, and this is the first time such a spectrum auction has been attempted. There has been significant debate over virtually all aspects of the auction as the Commission moves forward with this historic spectrum exchange. But at a fundamental level, the "Coasian" bargain between broadcasters and mobile operators should interest European regulators as a way to rationalize use of low-band spectrum going forward.

The various EU member countries have a diversity of audiovisual and communications industry structures and incumbent spectrum users. In countries where low-band spectrum is more readily available, an EU spectrum management body should move with haste to allocate additional capacity to flexible-use, mobile broadband licenses. In countries with significant incumbent users—most notably broadcast television—incentive auctions should be used to free up as much spectrum as would meet demand. If this process were controlled by one spectrum management body, it could create a much more uniform band plan, and likely a much more socially beneficial and efficient outcome, than 28 countries accommodating varying interests.

Of all the arcane rules and procedures the FCC has developed for this auction, the design of the geographic service areas of the resulting licenses warrants attention in the context of encouraging a single mobile market in the EU.

In the upcoming auction, carriers can piece together licenses that cover a geographic scope of their choice by aggregating smaller licenses that "nest" within the geographic area of existing licenses.[35] This nesting feature could potentially be a useful tool for EU spectrum managers, allowing them to harmonize licenses that have already been allocated with new spectrum auctioned by a centralized body, as well as maintaining existing national boundaries. This will allow carriers to aggregate spectrum as business dictates while providing a convenient mechanism for ensuring auction revenues continue to flow to member states.

For the first time in the United States, the incentive auction will have a small amount of spectrum reserved for carriers with less spectrum below 1 GHz. Spectrum reserves in an auction are relatively rare and somewhat controversial in the United States. Here it was justified as this is the last opportunity for so-called "beachfront" low-band spectrum for the foreseeable future. Such reserves are much more common in the EU, and are frequently used as a mechanism to shape the number of competitors in a market.

As a general matter, spectrum managers should rely on auctions to discover those best able to use spectrum and avoid actively shaping markets through constraints on participation.

### Uniform wireless regulations

Access to spectrum at a national or continental scale plays a critical part in encouraging a less fragmented telecommunications industry, but it isn't everything. It is also important that other various regulations are made uniform. In the United States, this was largely accomplished in the 1996 Telecommunications Act. For example, the 1996 Act explicitly prevented U.S. states and localities from engaging in pricing regulation of commercial wireless services.

In creating a uniform federal set of regulations, the United States has a powerful legal tool the EU lacks: the Commerce Clause. This provision of the U.S. Constitution allows for exclusive federal regulation of economic activity that affects interstate commerce. In practice, portions of U.S. telecommunications regulation have historically been a joint undertaking between state and federal authorities.[36]

*With harmonized regulations and allocations, the overall value generated by the mobile ecosystem will be much larger. Member countries should see more auction revenue going forward than under a fragmented system.*

This so-called "cooperative federalism" is not always an easy process, and the states and the federal government constantly fight over the balance of power in the context of telecommunications policy, but a steady movement toward uniformity and consistency has seen streamlined build-out of communications infrastructure. Generally speaking, wireless policy has been the exclusive province of federal authority.

## RECOMMENDATIONS FOR EU SPECTRUM POLICY

**Consolidate EU-wide spectrum management and harmonization of regulations.**
EU spectrum management should be consolidated within a single body, with the goal of harmonizing allocations, service rules, and regulations as much as possible. By providing centralized spectrum management functions, but keeping all auction revenue flowing to member countries, the Commission can focus on the most socially beneficial allocations and technical rules, while reducing opportunities for misaligned incentives or regulatory capture.

With centralized, harmonized regulations and allocations, the overall value generated by the mobile ecosystem will be much larger, meaning member countries should ultimately see more auction revenue going forward than under a fragmented system.

**Allow a permissive merger policy.**
While there is no single reason for the success of a mobile industry in serving consumer expectations, the EU's fragmented market structure certainly plays a substantial role in its slow adoption of 4G. As a part of the digital single market for telecommunications, the EU should enable considerable consolidation in its mobile industry to allow firms to achieve appropriate economies of scale. The goal should be to eventually see dynamic competition among four to six firms covering virtually all of Europe.

**Reallocate broadcast spectrum for mobile broadband.**
If the EU is going to see a single market for advanced mobile services, it must allocate additional low-band spectrum for mobile services. With the International

Telecommunication Union (ITU) now formally endorsing a globally harmonized reallocation of the 700 MHz band from broadcast television to mobile broadband, it is time to accelerate this transition throughout Europe.

In some EU countries, there is considerably more use of over-the-air broadcast television than in the United States. While there is a wide diversity of reliance on low-band spectrum for broadcast television across member countries, the EU should look to the U.S. incentive auction as a potential mechanism to ease uniform reallocation of spectrum to mobile broadband. Some member countries may transition this spectrum faster than others, but the entire EU would greatly benefit from harmonized band plans and service rules as more and more countries make more spectrum available for broadband.

**Use technologically neutral, flexible licenses tradeable on a secondary market.**
Mobile technologies can shift over time—it is important that spectrum managers use technology-neutral, flexible licenses to allow room for change. Mandates on particular technologies or standards severely stifles innovation, reduces competition in developing new radio technologies, and slows reallocating old spectrum to meet new demands. Regulators should avoid putting controls on the technology used for mobile spectrum licenses; instead licenses should be as flexible as possible. Technology-neutral licenses will be especially important as we move forward with 5G, as a wide array of different technologies are contemplated—regulators should encourage competition to deploy new innovations, even if on a pre-standard basis.

Licenses should also be tradeable on secondary markets to allow the market to develop the most efficient uses of particular frequencies as conditions change over time.

Managers should offer clear certainty about licenses. Radio rights should be offered on longer terms, at least 20 years, with a presumption of renewal. Short license terms reduce certainty and make long-term investments less secure. Vigorous competition with a less fragmented market should eliminate any incentive to hoard spectrum, but if this remains a concern, regulators could rely on a "use it or lose it" mechanism, or flexible build-out requirements, instead reducing terms or other rigid controls.

**Adopt neutral spectrum policy eschewing active market shaping.**
The EU should avoid explicit market shaping beyond protecting a baseline level of competition. Several restrictions and regulations have been put in place with a narrow focus on static measures like number of competitors or consumer prices. Less active market shaping and greater reliance on innovation, capital investment, and the realization of economies of scale will drive better long-term outcomes for users and for the overall evolution of the EU wireless system.

## CONCLUSION

The proposals the European Commission is putting forward to create a single EU market for mobile communications are no doubt aimed in the right direction. Harmonized regulations and centralized spectrum management will create the necessary framework to enable robust competition in deployment of 5G services. General-purpose mobile networks will be strong drivers of growth and productivity for years to come. But the challenge in

enacting these reforms is great, with member countries wanting to retain autonomy and control over industries and inputs. The Information Technology and Innovation Foundation (ITIF) recommends bold action—most importantly in centralizing EU-wide spectrum management—over half measures, and hopes the Commission is successful in these efforts.

## APPENDIX 1: SPECTRUM MANAGEMENT 101

Talk of electromagnetic spectrum can be esoteric and off-putting at first. Although there is a bit of a learning curve, spectrum is a key factor in the 21st century economy and deserves core policy attention.

### What is spectrum?

When discussing telecom policy, the term "spectrum" inevitably comes up—it is an essential input to wireless services, a constraining factor in the growth of mobile broadband, and an exceedingly peculiar type of resource.

In the context of wireless policy, "spectrum" is shorthand for a portion of the broader spectrum of electromagnetic radiation with properties useful for wireless applications. In physics terms, electromagnetic radiation is a self-propagating transverse oscillating wave of synchronized electric and magnetic fields.

Electromagnetic spectrum is the physics behind not just radio waves, but also infrared, visible, and ultraviolet light, as well as x-rays and gamma rays. The waves in radio spectrum management are bigger and repeat less quickly, but they are part of the same physical phenomenon of the light we see.

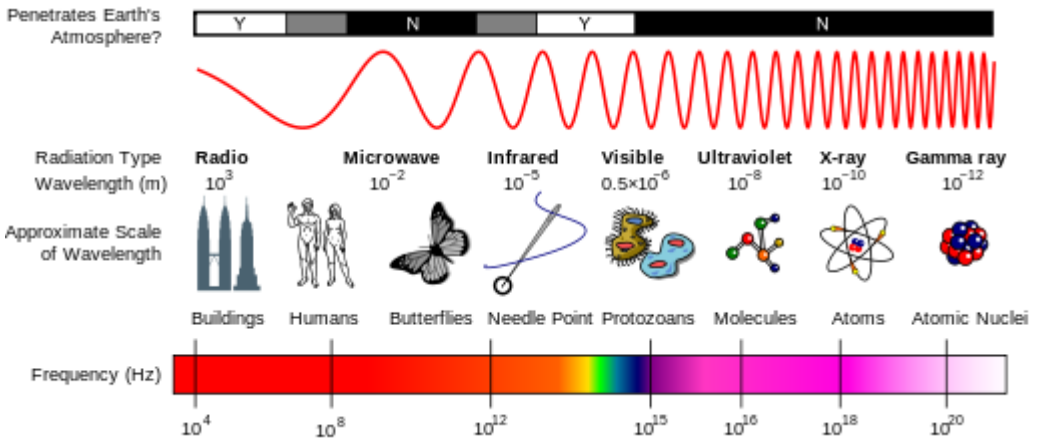


**Figure 1: Different portions of the electromagnetic spectrum have different properties, but are part of the same physical phenomenon. Spectrum management is concerned with the radio portion of the spectrum.**

All radio technologies use spectrum in a similar way. For example, a basic radio communication link is composed of a transmitter and a receiver. The transmitter sends out a wave that is "modulated" to be encoded with information. The wave propagates through the air. The distance and direction the wave travels depends on a number of different

factors, such as the power at which the signal was transmitted, the frequency of the wave, and whether there is any "clutter," such as trees or buildings in the way. The receiver then "listens" to the signal and decodes the message, assuming it is close enough to hear it.

Scientists first proved the existence of electromagnetic spectrum in the late 19th century, with commercialization of radio following soon after in 1897.[37] Since then, the pace of innovation has been astounding.

## Why is spectrum important?

Spectrum by itself is not so important—it's the uses we put it to that bring value. Indeed, the technologies we have built using radio have fundamentally changed the way we interact.

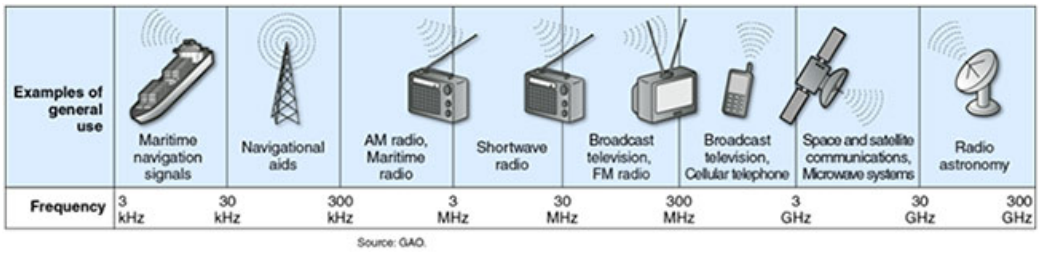


**Figure 2: Examples of radio spectrum use by frequency. Source: U.S. GAO.**

The diagram above shows a handful of the different technologies that rely on spectrum, along with the rough range of frequencies they use. These different radio technologies, such as RADAR, broadcast television and radio, satellite communications, or GPS, have had a profound effect on our lives. These technologies also play a sizeable role in the economy.

Historically, as new wireless technologies were developed, there was plenty of spectrum to go around. Not so anymore. Virtually all the useful spectrum has been claimed, and in most cases significant investment has been made into various types of equipment with reliance on having access to that band.

But technology never stops progressing, and now many of the initial assignments of spectrum are obsolete. The task of spectrum regulation has become one of reassigning already utilized spectrum to new technologies that have more social and economic value than old ones. The greatest example of this tension has been the rise of mobile broadband. The challenge to find the spectrum needed to meet the demand for mobile data is one of the key projects for spectrum managers.

The demand for mobile data is growing rapidly. In the United States, mobile data traffic grew 63% in 2014. It is estimated that in 2019 U.S. mobile data traffic will be equivalent to *210x* the volume of mobile traffic 10 years earlier (in 2009).[38] This demand isn't unique to the United States.

U.S. consumers and businesses value mobile services quite a bit, spending to the tune of $172 billion in 2013.[39] A recent report estimated that this $172 billion generated $400 billion in total spending due to the multiplier effect.[40] Essentially, every dollar spent on

wireless services generated $2.32 in total spending, and one job in the wireless sector generated 6.5 jobs.[41]

Wireless services also touch a number of different sectors, enabling innovation throughout the economy. Take, for example, agriculture. Beyond the regular communications technologies we all enjoy, farmers rely on GPS to guide large-scale equipment through fields. Also, government-operated earth exploration satellites beam down detailed information on environment, atmosphere, and climate conditions. Private companies are also working to create a private satellite network to collect and provide information to improve crop production. Unmanned aerial vehicles will inspect and monitor crops and livestock. The Internet of Things (IoT) will soon be leveraged to monitor many different aspects of agricultural processes. By some estimates, IoT and big data analytics will soon save 50 billion gallons of fresh water a year globally.[42]

All of these technologies require spectrum, and in order for them to work properly, that spectrum use has to be coordinated to some degree. Spectrum management is a key part of enabling efficient industrial organization as well as allowing innovative new spectrum technologies the bandwidth to grow.

### How is spectrum managed?

Spectrum is indeed a peculiar sort of resource. In a sense, it is infinitely renewable, always there, ready to be put to use. The problem with unmanaged spectrum is interference.

If a radio receiver tries to interpret two different signals in the same place, at the same time, on the same frequency, it essentially gets confused, and neither message goes through clearly. This is how we get interference.

To protect against interference, different entities have to work together to ensure that multiple senders don't transmit on the same frequency at the same time in the same place. This is where spectrum management comes in. Spectrum management involves a variety of different rules, such as limitations on the power of signals that can be transmitted, or geographic limitations on where transmitters can be placed, all with the aim of minimizing interference.

One of the most important tools in spectrum management is the license. Licenses are subject to a variety of service rules, but give the license-holder exclusive rights to one operator to a defined band of spectrum in a given area. Many different methods have been used to assign licenses, but today regulators auction spectrum licenses. Spectrum licenses then allow operators a clean environment and some flexibility to build their radio architecture as they think best.

Mobile operators rely on licensed spectrum to run their networks. Operators require interference-free spectrum to provide reliable service. Likewise, all the other operations that rely on spectrum, such as RADAR, broadcast television, GPS, or satellite communications, have to be separated through technical rules to ensure smoother operation. This is the role of spectrum managers.

## APPENDIX 2: MAJOR U.S. SPECTRUM TRANSACTIONS, 2003-2012

| Major Wireless Mergers and Spectrum Transactions | Date (2003-2012) | Assignee-Assignor | Valuation (millions) |
|---|---|---|---|
| Purchase of NextWave spectrum licenses by Cingular (34 markets) | 9/26/2003 | Cingular-NextWave | $1,400 |
| Acquisition of AT&T Wireless by Cingular | 3/18/2004 | Cingular-AT&T | $41,000 |
| Acquisition of Western Wireless Alltel (1.4 million customers in 19 states) | 1/24/2005 | Alltel-Western Wireless | $6,000 |
| Merger between Sprint and Nextel (40 million subscribers) | 2/8/2005 | Sprint-Nextel | $70,000 |
| Acquisition of Midwest Wireless by Alltel (400,000 subscribers) | 12/2/2005 | Alltel-Midwest Wireless | $1,075 |
| Acquisition of BellSouth by AT&T, including consolidation of Cingular Wireless JV | 3/31/2006 | AT&T-BellSouth | $86,000 |
| Acquisition of Alltel announced by TPG Capital and GS Capital Partners ("GSCP") | 6/25/2007 | Atlantis-Alltel | $27,500 |
| Acquisition of Dobson Communications Corporation by AT&T (1.7 million) subscribers) | 7/13/2007 | AT&T-Dobson | $2,800 |
| Acquisition of SunCom by T-Mobile Inc. | 10/1/2007 | T-Mobile-SunCom | $2,400 |
| Acquisition of Alltel by Verizon | 6/10/2008 | Verizon Wireless-Alltel | $28,100 |
| Purchase of Aloha 700 MHz licenses by AT&T (12 MHz covering 196 million people) | 10/29/2007 | AT&T-Aloha | $2,500 |
| Combination of Sprint Nextel spectrum with Clearwire spectrum in new Clearwire JV | 6/6/2008 | Clearwire-Sprint Nextel | $3,300 |
| Acquisition of Rural Cellular Corp. by Verizon Wireless (~716,000 subscribers in 5 regions) | 9/4/2007 | Verizon Wireless-Rural Cellular | $2,670 |
| Acquisition of Centennial Communications Corp. by AT&T (~1,100,000 subscribers) | 11/21/2008 | AT&T-Centennial | $945 |
| Divestiture of Alltel spectrum from Verizon-Alltel acquisition | 5/22/2009 | AT&T-Verizon Wireless | $2,350 |

| | | | |
|---|---|---|---|
| Divestiture of Alltel spectrum from Verizon-Alltel acquisition | 6/16/2009 | Atlantic TeleNetwork-Verizon Wireless | $200 |
| Purchase of Qualcomm spectrum licenses by AT&T | 1/13/2011 | AT&T-Qualcomm | $1,930 |
| Purchase by Verizon of spectrum from Cox and SpectrumCo (a joint venture among other cable companies); a swap between Verizon and Leap wireless, and Verizon's assignment of licenses to T-Mobile, among other transactions | 12/21/2011 | Verizon-SpectrumCo | $3,900 |
| Purchase of WCS and AWS spectrum licenses from Comcast, Horizon Wi-Com, and NextWave Wireless | 8/1/2012 | AT&T-Comcast, Horizon WiCom, NextWave Wireless | $2,000 |
| Acquisition of MetroPCS by T-Mobile | 10/18/2012 | T-Mobile-MetroPCS | $2,250 |

**Table 3: Major Spectrum Transactions 2003-2012 Source: "Avoiding Rent-Seeking in Secondary Market Spectrum Transactions"** [43]

## ENDNOTES

1. "Reforming Europe's Telecoms Regulation to Enable the Digital Single Market" (The Boston Consulting Group, July 2013), https://www.etno.eu/datas/publications/studies/BCG_ETNO_REPORT_2013.pdf.
2. Christopher Yoo, "U.S. vs. European Broadband Deployment: What Do the Data Say?" (research paper no. 14-35, University of Pennsylvania Law School, June 2014). Similarly, almost 19 percent of mobile connections in the United States were LTE in 2012, compared with 1.7 percent in Europe—despite countries such as Norway and Sweden having nearly a 1-year head start over the US operators in offering LTE. Bram Moerman and Tim Harrabin, "LTE Progress in the USA Is a Cause for Concern in Europe," *Analysys Mason*, August 2013, http://www.analysysmason.com/About-Us/News/Newsletter/LTE-USA-Europe-Aug2013/.
3. GSMA, "The Mobile Economy: North America 2015" (GSMA Intelligence, 2015), http://gsmamobileeconomy.com/northamerica/.
4. Erik Bohlin, Kevin W. Caves, and Jeffrey A. Eisenach, "Mobile Wireless Performance in the EU & the US," (GSMA, Navigant Economics, May 2013), http://www.gsmamobilewirelessperformance.com/GSMA_Mobile_Wireless_Performance_May2013.pdf.
5. Mario Mariniello and Francesco Salemi, "Addressing Fragmentation in EU Mobile Telecoms Markets" (Bruegel Policy Contribution, July 2015), http://bruegel.org/wp-content/uploads/2015/08/pc_2015_13-.pdf.
6. "EU-OECD competitiveness overview based on the 20GB-4G-Tethering-€35 threshold," Digital Fuel Monitor, Rewheel, 2015, http://dfmonitor.eu/overview/.
7. Federal Communications Commission (FCC), *Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services, Seventeenth Mobile Competition Report* (Washington, DC: FCC, December 18, 2014), 7, 16, https://apps.fcc.gov/edocs_public/attachmatch/DA-14-1862A1.pdf. ("*Seventeenth Mobile Competition Report*").
8. *See* "How Verizon, AT&T, T-Mobile, Sprint and More Stacked Up in Q3 2015: The Top 8 Carriers," *FierceWireless*, November 12, 2015, http://www.fiercewireless.com/special-reports/how-verizon-att-t-mobile-sprint-and-more-stacked-q3-2015-top-8-carriers.
9. Ibid. Subscription numbers from Strategy Analytics, based on carrier reports; Market share data from *Seventeenth Mobile Competition Report* (FCC).
10. "Nokia Networks CTO: Europe 'Natural Leader' for 5G," *Mobile World Live*, April 2, 2015 http://www.mobileworldlive.com/featured-content/top-three/nokia-networks-cto-europe-natural-leader-5g/.
11. For example, *see* Susan Crawford and Ben Scott, "Be Careful What You Wish For: Why Europe Should Avoid the Mistakes of US Internet Access Policy" (stiftung neue verantwortung, June 2015), http://www.stiftung-nv.de/sites/default/files/broadband.eu_.usa__0.pdf.
12. *See* Robert D. Atkinson, "The Role of Competition in a National Broadband Policy," (Information Technology and Innovation Foundation, October 2007), http://www.itif.org/files/BroadbandCompetition.pdf.
13. For an excellent discussion of these technology trends, *see* Douglas C. Sicker, "The End of Federalism in Telecommunications Regulations?" Northwestern Journal of Technology and Intellectual Property 3, no. 2 (2005), available at http://scholarlycommons.law.northwestern.edu/cgi/viewcontent.cgi?article=1032&context=njtip.
14. Ibid.
15. Ibid.
16. European Commission, Digital Agenda For Europe: A Europe 2020 Initiative, "What Is Radio Spectrum Policy?" last updated February 20, 2015, http://ec.europa.eu/digital-agenda/en/what-radio-spectrum-policy.
17. *See* Weiser and Nuechterlein, "The Big Picture," chap. 1 in *Digital Crossroads: American Telecommunications Policy in the Internet Age*, (Cambridge, MA: The MIT Press, 2007).
18. While there are few areas of regulation that rival the complexity of the winding history of intercarrier compensation, as a general matter the United States has moved toward a regime of Bill-and-Keep for voice calls, while the EU generally favors a Calling Party Pays option. For an excellent, if now dated, comparison of call termination fee regulation, see J. Scott Marcus, "Call Termination Fees: The U.S. in Global Perspective," http://ftp.zew.de/pub/zew-docs/div/IKT04/Paper_Marcus_Parallel_Session.pdf. For

overview of U.S. intercarrier compensation, *see* Weiser and Nuechterlein, "The Spectrum," chap. 7 in *Digital Crossroads*. Wireless carriers in the US are now unable to impose terminating access charges by tariff. *See* Weiser and Nuechterlein, *Digital Crossroads,* 261 citing Petitions of Sprint PCS and AT&T Corp. for Declaratory Ruling Regarding CMRS Access Charges, 17 FCC Rcd 13192 (2002), *appeal dismissed sub nom.* AT&T Corp v. FCC, 349 F.3d 692 (D.C. Cir. 2003); *see also* Declaratory Ruling and Report & Order, *T-Mobile et al. Petition for Declaratory Ruling Regarding Incumbent LEC Wireless Termination Tariffs,* 20 FCC Rcd 4855 (2005).

19. *See* FCC, *Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services, Fourth Report* (Washington, DC: FCC, June, 1999), http://wireless.fcc.gov/auctions/data/papersAndStudies/fc99136.pdf.
20. Ibid.
21. Ibid.
22. As discussed elsewhere, cross-border coordination is one of the many disadvantages of having spectrum managed at the member-state level.
23. *See* Timothy C. Salmon, "Spectrum Auctions by the United States Federal Communications Commission," (Florida State University, December 6, 2002), http://faculty.smu.edu/tsalmon/fccchapter.pdf.
24. Ibid.
25 . Ibid.
26. This has been a more explicit problem elsewhere, for example, with recent auctions in India.
27. 47 U.S.C. § 309(j)(7); European Authorization Directive (2002/20/EC) Recital 32.
28. For discussion, *see* Dr. Dan Maldoom DotEcon, "Collecting Revenue From Spectrum: A Report for GSMA," (DotEcon, February 2012), http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/apac12doteconexecutivesummary.pdf.
29. For an excellent overview of the history of the US mobile industry and the FCC's spectrum allocation process for cellular licensing through 2000, *see* James B. Murray, Jr., *Wireless Nation: The Frenzied Launch of the Cellular Revolution in America,* (Cambridge: Perseus Publishing, 2001).
30. Ibid, 20.
31. Ibid, 289.
32. Ibid.
33. Ibid.
34. Peter Curwen and Jason Whalley, "Merging Incumbent European Mobile Operators: Veni, Vidi, Non Vici," *Info: The Journal of Policy, Regulation and Strategy for Telecommunications* 11, no. 4 (2009) 34–52, at 34.
35. FCC, *Report and Order In the Matter of Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, (Washington, DC: FCC, June 2014) https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-50A1.pdf.
36. *See* Philip J. Weiser, "Federal Common Law, Cooperative Federalism, and the Enforcement of the Telecom Act," *NYU Law Review* 76, no. 6 (December 2001): 1692.
37. James Clerk Maxwell had first theorized the existence of spectrum with the publication of *A Dynamical Theory of the Electromagnetic Field* in 1865. Heinrich Hertz—the namesake of the scientific unit of frequency, the "hertz"—would prove the effects of Maxwell's predictions in a series of experiments from 1886 to 1889. Guglielmo Marconi—credited with the invention of the radio—would build on these achievements. His commercialization of his invention started in 1897 with the founding of The Wireless Telegraph & Signal Company.
38. "Cisco Visual Networking Index (VNI)," Cisco, accessed December 2015, http://www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html.
39. Coleman Bazelon and Giulia McHenry, "Mobile Broadband Spectrum: A Vital Resource for the U.S. Economy" (The Brattle Group, May 11, 2015), http://www.ctia.org/docs/default-source/default-document-library/brattle_spectrum_051115.pdf.
40. Ibid.
41. Ibid.
42. Lance Donny, "Smart Agriculture and the Internet of Things: Transforming Global Food Production," OnFarm,

http://www.liveworx.com/Portals/0/2014%20Presentations/OnFarm_Smart%20Agriculture%20and%20the%20Internet%20of%20Things.pdf.

43. Jeffrey A. Eisenach and Hal J. Singer, "Avoiding Rent-Seeking in Secondary Market Spectrum Transactions," *Federal Communications Law Journal* 65, no. 3 (June 2013), http://www.fclj.org/wp-content/uploads/2013/09/65-3-Singer.pdf.

## ACKNOWLEDGMENTS

The author wishes to thank Robert D. Atkinson and Paul Hofheinz for valuable conversations and comments that assisted with this report. Any errors or omissions are the author's alone.

## ABOUT THE AUTHOR

Doug Brake is a telecommunications policy analyst with the Information Technology and Innovation Foundation. He specializes in broadband and wireless policy, with interests in net neutrality and spectrum rights definitions. Brake holds a law degree from the University of Colorado Law School and a Bachelor's in English Literature and Philosophy from Macalester College.

## ABOUT ITIF

The Information Technology and Innovation Foundation (ITIF) is a nonprofit, nonpartisan research and educational institute focusing on the intersection of technological innovation and public policy. Recognized as one of the world's leading science and technology think tanks, ITIF's mission is to formulate and promote policy solutions that accelerate innovation and boost productivity to spur growth, opportunity, and progress.

**FOR MORE INFORMATION, VISIT US AT WWW.ITIF.ORG.**