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# Economics at the FCC, 2011–2012: Spectrum Incentive Auctions, Universal Service and Intercarrier Compensation Reform, and Mergers

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**Abstract** The past year in economics at the Federal Communications Commission covered a broad range of topics in telecommunications policy. This paper highlights the economic issues that are addressed in the following key areas: spectrum management, universal service and intercarrier compensation reform, and merger review. In spectrum management, the FCC received congressional authority to implement an "incentive auction" to repurpose television broadcasting spectrum into flexible-use licenses that will be suitable for mobile wireless service providers. We discuss some important issues in designing the auction. We next address some aspects of the FCC's comprehensive reforms of intercarrier compensation, which mainly involves call termination rates, and of universal service. Finally, we discuss the economic analysis of two major mergers: AT&T-T-Mobile, which the FCC staff recommended should be referred to an administrative hearing, and Level 3/Global Crossing, which was cleared with no conditions.

**Keywords** FCC · Spectrum auctions · Mergers · Universal service · Termination rates

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The work of the Federal Communications Commission (FCC) and its economists spans a broad range of matters. This article illustrates the scope by recapping major FCC activity over the past year in several key areas: spectrum management, universal service and intercarrier compensation, and merger review. We focus on the more economically oriented issues, and flag some specific points where further economic analysis would help to guide efficient policy.

Section 1 discusses efforts to facilitate the repurposing of spectrum—rights to use the radio airwaves—from television broadcasting to mobile broadband through incentive auctions, whereby broadcasters bid to release their spectrum in exchange for an auction-determined payment. In 2012, Congress granted to the FCC the legal authority to conduct such incentive auctions.

Section 2 discusses the FCC's intertwined efforts to reform two flawed and outdated systems: universal service support in high-cost areas, and intercarrier compensation (ICC)—especially call termination rates. In November 2011, the FCC issued a major Order that addressed both systems. Inter alia, the Order re-orients support towards broadband-capable networks, commits to the first procurement auction for universal service, takes interim steps to combat call arbitrage schemes that have been spawned by the current ICC, and adopts "bill-and-keep" as the endpoint of ICC reform.

Section 3 discusses the agency's review of two major mergers and the basis for its different stances: AT&T/T-Mobile would have combined two of the four national wireless competitors. The FCC issued a critical staff report and declared its intention to refer the merger to a hearing. Level 3/Global Crossing involved two leading providers of Internet backbone services. While the FCC placed conditions on prior Internet backbone mergers, its analysis of the facts in this case led to approval of the merger with no conditions.

## 1 Spectrum Incentive Auctions

In February 2012 Congress authorized the FCC to conduct an "incentive auction" as a means of repurposing television broadcasting spectrum to relieve the severe shortage of spectrum for mobile wireless devices (United States Code 2012). The FCC has had the authority to auction initial spectrum licenses since 1993, but could not provide incumbent spectrum licensees an incentive to free up spectrum voluntarily (United States Code 1993). The 2012 legislation ("Spectrum Act") gave the FCC the authority to use auction revenues to pay incumbent licensees to give up spectrum voluntarily. For the first time the FCC will be able to use a two-sided auction to determine which incumbents supply spectrum, how much they supply, and how much they are compensated. The auction will also assign the newly created flexible-use spectrum licenses and determine the total quantity of spectrum traded.[1] The FCC's first formal step in implementing the legislation was the release of a Notice of Proposed Rulemaking

[1] To help design and implement incentive auctions the FCC retained leading experts in auction theory and implementation from Auctionomics and Power Auctions. The auction design team is composed of Professors Paul Milgrom, Jonathan Levin, and Ilya Segal of Stanford University, and Professor Lawrence Ausubel of the University of Maryland. Much of this section is based on their work, although the remaining errors are the responsibility of the authors.

in the fall of 2012 that proposes a framework for an incentive auction of broadcast television spectrum and seeks public comments (FCC 2012a).

## 1.1 Why an Incentive Auction

While incentive auctions may be applied in many situations, the discussion here will focus on the auction to repurpose television broadcasting spectrum for flexible use. The 2012 legislation ("The Spectrum Act") requires the FCC to conduct such an auction, and it will be the first auction of this kind that the FCC has implemented. Equally important, repurposing spectrum from over-the-air television broadcasting to flexible use is likely to produce a large gain in economic value. We present some evidence on this point below, and then explain why a centralized incentive auction has significant advantages over exclusive reliance on secondary markets as a way to facilitate the repurposing of spectrum.

### *1.1.1 Changing Demand and Technology*

With the growth of the commercial deployment of cable and satellite television the percentage of households that rely only on over-the-air broadcasting to view television has declined from 24 % in 1999 to 10 % in 2010 (FCC 2010). At the same time, smartphone subscriptions increased from 27 % of U.S. mobile subscribers in December 2010 to nearly 42 % in December 2011 (comScore 2012). Looking forward, industry analysts expect global mobile data traffic that is generated by tablets to grow at an annual rate of 100 % between 2011 and 2017 (Ericsson 2012). And global mobile data traffic is predicted to increase 18 times between 2011 and 2016 (Cisco 2012).

These long-term trends have resulted in a gap in market values for comparable spectrum used for broadcasting and for mobile data. In 2008 comparable spectrum allocated for wireless use sold for an average of $1.28 per MHz-pop (FCC 2008).[2] In contrast, estimates of the market value of broadcasting spectrum in the bands to be repurposed ranges from $0.11 to $0.15 per MHz-pop (FCC 2010).

Historically, instead of permitting flexible use of spectrum and relying on markets to shift uses as technology and tastes change, the FCC has administratively reallocated spectrum from one specific use to another. This has been the case for UHF spectrum, which is well suited for both television and mobile services. Prior to 1970, a total of 414 MHz of UHF spectrum (channels 14–83, excluding channel 37, which was allocated for radio astronomy) was allocated for television use. In 1970, the FCC reallocated 84 MHz of this spectrum (channels 70–83) mostly for mobile use, and the few broadcasters that occupied this spectrum were given a long transition period to relocate below channel 70.

[2] Net revenue for FCC auction 73 for spectrum in the 700 MHz band was $18.958 billion, and the number of MHz-pops (the amount of spectrum multiplied by the population covered by each license) in the licenses sold was 14.833 billion (FCC 2008).

The development of digital television technology made it possible for the FCC to reclaim an additional 108 MHz of UHF television spectrum (channels 52–69) for mobile use between 1996 and 2009 without any reduction in the number of broadcast television licenses. The switch from analog to digital broadcasting permitted adjacent channels to be assigned to broadcasters that operate closer together, allowing more reuse of the same channels and reducing the total number of channels that were needed to accommodate all broadcasters without causing interference.

In 2010, the FCC set the goal of reallocating additional UHF spectrum from broadcast television to mobile broadband (FCC 2010). In contrast to earlier reallocations, it is no longer possible to clear additional UHF television spectrum nationwide without some broadcasters relinquishing spectrum rights. The UHF television spectrum is tightly packed with stations in high-population-density areas, and no technological solutions as dramatic as the digital television transition are anticipated in the near term.

### *1.1.2 Centralized Incentive Auction Versus Secondary Markets*

A natural question for economists is: Why not rely on secondary markets to reallocate television spectrum instead of having the FCC run a centralized incentive auction? Aside from the Congressional mandate, we believe that the FCC has significant advantages in helping solve the multi-party coordination problem of converting a system of spectrum rights that are suitable for broadcasting into a system of rights that are appropriate for mobile broadband and other higher-value uses. This multi-party coordination problem arises for several reasons described below.

Unlike items that are traded on commercially operated commodity exchanges or stock markets, there is no one-to-one correspondence between what will be sold and what will be bought in the incentive auction for repurposing broadcast spectrum. Broadcast and wireless licenses differ in the way that frequencies are organized into channels and in geographic coverage.

A broadcast license authorizes the use of a single unpaired 6 MHz channel. By contrast, wireless systems have an entirely different channel structure (frequency assignments). For example, LTE mobile systems typically use paired 5 MHz channels (one for base station transmissions, and one for mobile transmissions) that are separated by a gap in frequency (to avoid interference from the transmitter to the receiver of the same device). Therefore, more than one broadcast station would need to sell their spectrum to create paired channels that would be suitable for wireless systems. Moreover, since wireless systems rely on uniform channel separation nationwide, there would also need to be coordination of broadcasters across the country to create a uniform nationwide bandplan that determines the frequencies that are allocated to wireless use and how channels are defined in those frequencies.

Coordination would also be needed to aggregate freed-up broadcast spectrum into broader geographic areas that would be suitable for wireless systems. Broadcasters typically provide service in a 60 mile radius from their antennas, whereas wireless systems are licensed for much larger geographic areas. For example, wireless spectrum is often licensed on the basis of 172 "Economic Areas" (EAs) that cover all of the United

States and its territories.[3] Not only are multiple broadcast stations often encompassed by a single EA, but a single broadcast station's coverage area may extend beyond a single EA. There are also geographic gaps ("white spaces") between broadcast coverage areas that are not licensed to anyone. So to create a single EA license area for wireless use would require clearing multiple broadcasters and obtaining the rights to the white space within the EA. This raises potential holdout problems. Additionally, there would be a collective action problem among wireless providers to coordinate the clearing of a broadcaster that overlaps multiple EAs in which different wireless providers seek licenses.

Most importantly, efficient spectrum use generally requires spectrum users with similar architectures to be grouped together. Wireless systems can operate on frequencies that are adjacent to one another but not on frequencies that are adjacent to high-power broadcasters without guard bands between them. To create large contiguous blocks of spectrum in which multiple wireless providers can be grouped together requires the consolidation of the remaining broadcasters on the minimum number of channels nationwide while meeting all of the interference constraints. Only an auction that operates in conjunction with the FCC's centralized reassignment of broadcasting channels is likely to be able to do this.

Finally, the use of secondary markets to repurpose spectrum will raise no revenue for the government, unless some fee or transaction tax is imposed.

## 1.2 Designing an Incentive Auction to Repurpose TV Spectrum

The two-sided auction can be discussed in terms of each side—the supply side (the "reverse" auction), and the demand side (the "forward" auction). In the reverse auction, broadcasters bid to relinquish certain spectrum rights in exchange for payments, and those broadcasters that remain on the air are assigned channels ("repacked"). In the forward auction, wireless service providers bid for the newly created flexible spectrum licenses. The forward and reverse auctions are connected by a clearing rule that simultaneously determines the number of broadcast channels that are cleared and the number of flexible use wireless licenses that are sold based on bids in both sides of the auction.

### *1.2.1 The Reverse Auction*

Broadcasters participating in the reverse auction bid against one another to supply spectrum. The essential regulatory fact that makes competition among broadcasters possible in such an auction is that broadcasters have a right to a channel in a frequency band but not the right to a specific channel. As discussed above, for spectrum to be most useful for flexible wireless services it must be in large contiguous frequency blocks. If broadcasters had the right to the specific channels that they are using, they would have great market power since their continued presence would block the use

[3] For the purposes of spectrum licensing and competition analysis, the Commission, depending on the particular application, uses the following units of geographic aggregation for the U.S.: Major Trading Areas (MTAs)—47 in the U.S.; Economic Areas (EAs)—172; Basic Trading Areas (BTAs)—487; and Cellular Market Areas (CMAs)—734 (FCC 2011a, pp. 30, 228, 230).

not only of that channel but also adjacent channels. But under the Spectrum Act the FCC has the right to reassign broadcasters involuntarily to an equivalent channel in the same band. So if channel 50 is in the middle of a swath of spectrum that is targeted for clearing and the broadcaster operating on that channel refuses to clear, but the broadcaster operating on, say, channel 14 is willing to clear, the FCC can reassign channel 14 to the broadcaster currently on channel 50.

*Broadcasters' Options for Relinquishing Spectrum.* The Spectrum Act specifies three ways that broadcasters may relinquish spectrum rights in the forward auction:

(1) discontinuing over-the-air (OTA) broadcasting; (2) channel sharing; and (3) moving to the VHF band. A fourth possible way is to accept additional interference. We will discuss each in turn.

(1) Broadcasters would be able to make bids in the reverse auction to discontinue OTA broadcasting. If a broadcaster's bid is accepted, the opportunity cost would be no more than the enterprise value of the station if it continued after the auction plus shut-down costs. To the extent that stations produce their own content or efficiently aggregate content they may be able to sell that content or programming expertise to another television station, a cable provider, or a satellite provider.

(2) Two or more broadcasters may choose to share a single digital broadcast channel and concomitantly relinquish one or more channels. It is not yet clear how channel sharing would be incorporated into the reverse auction. A simple bid to share some fraction of a channel's capacity with any other broadcaster in the same market would not adequately specify all of the factors that matter to broadcasters in a channel sharing arrangement. Most important, it does not specify the specific party or parties that would share.

An alternative to channel sharing bids would be to allow broadcasters to negotiate key elements of a sharing arrangement before the auction, including payments among parties and how capacity would be shared. With a suitable set of contingent payments among parties depending on the outcome of the auction, it may be possible for parties to submit individual bids in the reverse auction that fully reflect their values as part of a channel sharing arrangement.

Licensees that share a broadcast channel would each maintain their "must-carry" rights, the valuable option to obtain free carriage of its primary video stream on cable systems that serve its market (and on a satellite system if it carries any other local stations in the broadcaster's market).

(3) Broadcasters currently occupy both UHF spectrum (channels 14–51) and VHF spectrum (channels 2–13). But only UHF spectrum is valuable to wireless service providers. So a broadcaster that moves from a UHF channel to a VHF channel could free up valuable spectrum for wireless use. Broadcasters could bid in the reverse auction to give up a UHF channel in exchange for a VHF channel. Such a swap would entail a loss for the broadcaster, but not as much as discontinuing OTA broadcasting. A station that chooses to move to VHF would continue the same cable and satellite carriage and have the same capacity (19.4 bps) for OTA broadcasting.

Nevertheless, VHF spectrum is considered inferior to UHF spectrum for digital broadcasting for two reasons. First, the VHF band is more subject to interference from electrical devices such as electrical motors, which results in a smaller viewing area.

Second, a larger antenna is needed to receive a VHF signal optimally. Such antennas are more costly and may need to be mounted on the roof. With current technology, the large antenna size also makes mobile broadcasting impractical on VHF spectrum. These two effects are significantly more pronounced for lower VHF (channels 2–6) than upper VHF (channels 7–13).

Another possible way to clear spectrum on a voluntary basis in an incentive auction would be for individual broadcasters to bid to accept additional interference in exchange for compensation. Television stations that operate on the same channel (co-channel) and on adjacent channels must be separated geographically to prevent unacceptable interference between them. If some stations agreed to accept more interference, the channels assigned to those stations could be reused at closer geographic spacing, thus reducing the total number of channels that are needed to accommodate all remaining stations and potentially lowering clearing costs.

*Bidding Procedures.* The FCC could collect bids in a single round or in a dynamic descending price auction. In a single-round auction, broadcasters would submit bids that indicate the amount they would be willing to accept to relinquish spectrum in one or more of the ways that are described above. A dynamic auction could be a series of rounds in which bidders submit bids; or it could be a clock auction in which prices are called out for each relinquishment option by the auction software, and bidders would indicate whether or not they are willing to relinquish their rights at the current prices. A decision to relinquish would be irreversible. Broadcasters that indicate that they are not willing to relinquish any rights (reject all of the options) would be assigned channels to continue broadcasting in their current band. If a bidder in a dynamic auction wishes to submit its bids just once, as in a single round sealed bid auction, it could submit a "proxy bid" that indicates the minimum payment that it would be willing to accept in exchange for relinquishing various rights. The auction process would use the proxy bid to submit bids in the dynamic auction on behalf of the bidder.

From the point of view of bidders, a dynamic auction may be preferred to a single-round sealed-bid auction. A dynamic auction does not require broadcasters to determine an exact bid at the beginning of the auction. They need only to be able to determine their willingness to relinquish rights at the prevailing price. A dynamic format can also be designed to give bidders additional feedback about how other bidders value the spectrum usage rights. And with the option of making proxy bids, a bidder can submit its bids as if it were a single round auction. On the other hand, the sealed-bid auction may be easier for the FCC to implement than conducting a multiple-round or a descending-clock auction.

*Assignment Rules.* The reverse auction assignment rules determine which bids are accepted: who is paid to discontinue OTA broadcasting; or move to upper or lower VHF; or accept additional interference; or, if there are separate channel-sharing bids, channel share. The auction must also assign a channel to each station that remains on the air, including stations that did not participate in the auction. The auction can reject a bid to discontinue OTA broadcasting only if it is feasible to assign the broadcaster a channel and thereby allow it to continue broadcasting.

Determining whether it is feasible to assign a channel to a station in a way that meets all of the interference constraints among broadcasting stations is a difficult technical problem. Optimally assigning channels is an even more difficult problem. Finding a fully optimal assignment of channels may not be feasible. It may be possible, however, to calculate a close approximation in a reasonable amount of computing time.

One approach to the assignment problem is to use integer programming optimization software that operates on the bids that are submitted in a single round sealed bid auction. Based on broadcasters' bids to relinquish spectrum rights, the optimization software seeks to find the least costly way to clear various amounts of contiguous spectrum. The software would simultaneously determine which set of offers to accept and determine an approximately optimal assignment of channels within the same band to the remaining broadcasting stations.

Another approach to the assignment problem is to use a heuristic to determine sequentially which stations are assigned a channel.[4] Stations are considered in order of their scored bids,[5] starting with the highest, and checked for feasibility of assignment using optimization. Optimization software is also used to determine specific channel assignments of all of the stations that remain on the air, including those that did not participate in the auction. Those stations that cannot be assigned a channel are paid for relinquishing their spectrum rights. The general concept of the heuristic is to first assign channels to the stations that are the most expensive to clear, and only pay to clear those stations that are the least expensive. This approach is computationally less intensive and provides a natural way to determine payments under a second-price rule (see below). It can be implemented with bids that are submitted in either a single round or in a descending dynamic auction.

*Payment Rules.* A critical element of the reverse auction design is the rule for determining the amount that is paid to winning bidders for relinquishing their spectrum rights. The two basic alternatives are: (1) paying the bid amount ("pay-as-bid" or "first-price"); and (2) paying winners the opportunity cost of selecting them ("second-price"—the Vickrey pricing rule being the best-known example). Under the second-price payment rule, broadcasters that are cleared are paid the maximum amount they could have bid and still be cleared. This makes it optimal for them to bid their true valuations regardless of the bids that are submitted by others (Milgrom 2004, pp. 47–51). Eliminating the need for bidders to make complex calculations about other bidders lowers the cost of participating in such an auction and should increase participation. It also reduces the chance of bidders' making mistakes due to faulty estimates of other bidders' valuations and assumptions about their bidding strategies.

### *1.2.2 The Forward Auction*

The forward auction will determine who wins which flexible-use wireless licenses and how much the winners pay. The first step in describing a forward spectrum auction

[4] This auction design (using a heuristic algorithm to select stations for assignment and "threshold" pricing) was originated by the Auctionomics design team.

[5] The cost of clearing may be reduced by considering factors in addition to bid amount in the ranking (scoring) of bids.

design is to define the licenses to be sold. While the license structure, both in frequency and geography, has not yet been determined, to make the discussion concrete we will assume that wireless licenses will be sold in pairs—5 MHz for uplink (mobile transmit) and 5 MHz for downlink (base station transmit)—with some frequency separation. Spectrum that is cleared in the reverse auction must be transformed to create these paired channels.

We also assume that licenses will be divided into geographic areas that are no smaller than the 172 Economic Areas (EAs) that have been used in previous FCC auctions. It is possible that the same amount of spectrum cannot be cleared in each license area because of interference constraints on the Canadian or Mexican borders or because of the cost of clearing in certain markets. Band plans can be created to allow for this contingency.

In contrast to previous FCC auctions, in this auction the FCC might treat licenses within each geographic area as part of one or more "generic" (homogenous) categories. Using generic licenses could simplify and speed the bidding process in an ascending auction with a single price called out for bids on licenses in each category. Instead of bidding on specific licenses in a geographic area, bidders would indicate their demand for a number of generic licenses in each category at the current price. This process could be designed to award contiguous blocks to winners of multiple licenses within a geographic area, and to the extent feasible, award licenses on the same frequency to winners of licenses in multiple geographic areas. To the extent that bidders have preferences for specific frequencies (they do not consider all licenses within a category fully equivalent), a second auction stage might be used to assign specific licenses to winners of generic licenses in the first auction stage.

Various auction formats could be used in the forward auction. The FCC could employ its traditional auction design, simultaneous multiple round (SMR) auction. If generic licenses are offered, the SMR auction design could be slightly modified to speed up the auction. Alternatively, the FCC might use a clock auction where there is a single price for all licenses within a generic category and that price rises as long as there is excess demand (Milgrom 2004, pp. 265–295).

Both formats could allow for limited package bidding to permit bidders to make all or nothing bids on packages of licenses. Package bidding avoids the risk that a bidder may face of failing to win all of the licenses that it considers to be highly complementary and paying too much for the remaining licenses that it does win. But package bidding may disadvantage bidders that are bidding for subsets of licenses in a large package of another bidder. The feasibility of package bidding depends on the number of items in the auction, and the number and structure of permitted packages (Milgrom 2004, pp. 296–337).

### *1.2.3 Integrating the Reverse and Forward Auctions: Determining how Much Spectrum is Cleared and how Much is Licensed*

The reverse and forward auctions must be integrated to determine how much spectrum is cleared and how much is licensed. The reverse auction could be run first, followed by the forward auction. Alternatively, the FCC could run the reverse and forward auctions in parallel in a series of stages. At each stage the FCC would specify a provisional

quantity of spectrum that would be cleared and the corresponding quantity of newly created wirelesses licenses. Running the incentive auction in this way would allow both broadcasters and wireless service providers to bid based on the provisional quantity target at that stage. It would also take less time than determining the full supply and demand curves before ending the auction.

Whether the auctions are run sequentially or in parallel, the FCC must have a stopping or clearing rule to determine the amount of spectrum that will be repurposed. In all of the previous auctions the Commission has explicitly established in advance of the auction the conditions under which the auction would stop. Such an explicit stopping rule could be established for the incentive auction. It is also possible that the decision with respect to when to stop the auction could be left to the discretion of the Commission to exercise during the auction.

## 2 Universal Service and Intercarrier Compensation Reform

Capping a multi-year effort, in October 2011 the FCC adopted its weighty USF/ICC Order (FCC 2011c). The Order takes important steps to reform both the portion of the federal Universal Service Fund (USF) that supports telephone companies in high-cost areas, and intercarrier compensation (ICC)—the system of per-minute payments between telephone carriers for handling circuit-switched calls that cross their networks. The issues are linked because both sources contribute revenue to local telephone companies in high-cost areas.[6] Reaching a consensus on reform entailed interrelated adjustments to the USF and ICC, as well as the permissible fixed charges to telephone customers in rural areas.[7] As with many regulatory transitions, this one left no interest group entirely satisfied; and much of the heavy lifting lies ahead. Nonetheless, the Order is a significant milestone in improving the efficiency of the USF and ICC and adapting them to a radically changed industry landscape.

### 2.1 Reforming Universal Service Support to High-Cost Areas

#### *2.1.1 Overview of Reforms*

Promoting universal service is a longstanding goal of U.S. communications policy. By law, the FCC and a Federal-State Joint Board must follow a principle that "Access to advanced telecommunications and information services should be provided in all regions"—a goal that requires ubiquitous deployment of infrastructure. Additionally, "Consumers in all regions, including low-income consumers and those in rural, insular,

[6] Rural carriers that are subject to rate-of-return (ROR) regulation, which are typically small and mid-sized local phone companies, on average derive about 30 % of their revenue from their end-user customers, 35 % from the USF, and 35 % from ICC—the latter, mainly in the form of access charges for terminating calls of carriers from other areas.

[7] Some carriers (primarily ROR carriers, rather than larger carriers that are regulated under price caps) are unable to recover all of their eligible lost-access revenues that are attributable to the ICC reforms through their allowable increased charge to end users (the "access recovery charge [ARC]). They may recover the remainder through the Connect America Fund that will be discussed below.

and *high-cost areas*, should have access to …services that are reasonably comparable to those provided in urban areas …at *rates that are reasonably comparable* [emphasis added]" (United States Code 1996).

Reflecting these principles, the federal Universal Service Fund has four components, that in 2011 disbursed the sums indicated in parentheses: Lifeline supports basic telephone service for low-income consumers ($1.75 billion); E-rate supports Internet connections to schools and libraries ($2.23 billion); Rural Health Care supports reduced rates to rural health care providers ($81.5 million); and the High Cost Fund supports service to all consumers (residential and business) in high cost, rural, and insular areas ($4.03 billion) (USAC 2011). The USF/ICC Order targeted the largest of these programs, the High Cost Fund (HCF), and adopts the following important reforms:

*Support for Broadband.* The HCF subsidized carriers' networks to enable lower rates for local voice service. That focus is clearly outdated given the vital role of Internet access and broadband connections. The new system requires that supported networks—whether fixed or mobile—be capable of delivering voice *and broadband* services.[8]

*Budget.* The HCF grew from $2.1 billion in 2001 to a projected $4.5 billion for 2011 at the time of the Order. For the first time, the FCC's Order adopts a budget for the high-cost programs within USF, averaging $4.5 billion annually for the six years 2012 through 2017. It also creates the Connect America Fund (CAF) that will ultimately replace all support mechanisms for high-cost areas. The annual $4.5 billion target includes funding to high-cost areas from all sources, both legacy programs and the CAF during the transition to the latter. Some highlights are described below.

- *Price Cap Areas*: Phase I of the CAF seeks to provide up to $300 million in expedited one-time funding to extend broadband to unserved locations in areas where the incumbent carriers—mainly large and mid-sized carriers—are regulated by price caps.[9] Phase II provides up to $1.8 billion per year through a process that we describe below.
- *Rate-of-Return Areas*: $2 billion per year is allocated to ROR carriers. Although price-cap areas account for about 15 of the 19 million Americans that lack access to robust residential fixed broadband, the higher funding to ROR areas partly reflects the higher cost of serving those areas.[10]
- *Remote Areas*: At least $100 million per year is authorized for promoting broadband in the highest-cost areas of the country.

[8] Generally, networks that are eligible for support must under the new system provide "robust" broadband, which involves actual speeds of at least 4 Mbps downstream and 1 Mbps upstream ("speed benchmarks"), and latency appropriate for real-time applications.

[9] Carriers are eligible to receive $775 per additional location, up to a total amount based on the unserved areas in its territory, with an overall cap of $300 million across all carriers. Phase I of the CAF also includes $1 billion in ongoing support until implementation of Phase II.

[10] In a reflection of the higher cost of service in these areas, ROR carriers also are not required to offer broadband ubiquitously but only upon a customer's reasonable request.

- *Mobility Fund*: Phase I of the Mobility Fund provides up to $300 million in one-time funding to extend mobile voice and broadband to unserved areas. Phase II provides $500 million per year to extend such service further to unserved areas and maintain service in areas that otherwise may lose it as other High Cost Fund support for wireless carriers is phased out. The Mobility Fund represents the first time that universal service funds are designated for mobile services. We will elaborate on this point below.

*Targeting Support to Unserved Areas.* The funding for mobility and for price-cap areas will support infrastructure where unsubsidized carriers are not expected to operate. Similarly, funding to ROR areas will be phased out in study areas that overlap completely with an unsubsidized facilities-based competitor. The general approach is to target funds towards areas that otherwise would not be served and to avoid funding multiple providers of fixed and mobile services in a given area.

Correspondingly, the Order eliminates the Identical Support Rule that encouraged multiple wireless carriers to provide service in a given area by granting competitive eligible carriers the same per-line support from the HCF as the incumbent local exchange carrier.[11] The FCC adopted the rule in 1997 to foster local competition, a central goal of the 1996 Telecommunications Act, expecting the typical competitor to be a wireline carrier. In reality, over 95 % of support—exceeding $1 billion in 2010—went to mobile wireless carriers, with multiple such carriers supported in a given area and at a level that was based on the cost of the wireline incumbent.[12] At times, multiple subsidies were awarded for the same household because many households subscribe to both wireline and wireless service or have multiple wireless phones. Repealing the identical support rule and using the Mobility Fund to support wireless carriers will advance universal service, by targeting funds to foster mobile coverage in areas that otherwise would lack it.

*Competitive Mechanisms and Other Cost Effectiveness Measures.* The Order takes several steps to address inefficiencies in the High Cost Fund that have been noted by many economists (e.g., Wallsten 2011). For rate-of-return carriers, it tightens the reimbursement rules for various expenses, e.g., by benchmarking a carrier's costs against comparable carriers and by reducing support to carriers that set particularly low voice rates to their end users (relative to the "reasonably comparable" standard). For price-cap carriers, the Order offers Phase II support that is based on an FCC-developed cost model and proposes competitive mechanisms in areas where incumbent carriers reject the offer. All other support—to Remote Areas and Mobility—will be allocated through competitive mechanisms.

[11] "Eligible telecommunications carriers" (ETCs) qualify for universal service support by accepting certain conditions. Competitive (rather than incumbent) ETCs may be wireline carriers or wireless providers.

[12] Another example of unintended regulatory consequences in the wireless industry involves arbitrage of the LinkUp program, which provides one-time support for hookup charges to low-income individuals. Some wireless providers profitably gave away phones without adequate verification of income eligibility (e.g., to students), and often gave multiple phones per household. The USF/ICC Order terminated the LinkUp program.

### *2.1.2 Mobility Fund Phase I*

The most fleshed-out competitive mechanism is the Mobility Fund Phase I (MF I). We first discuss its key features, and then note some complexities that may arise in later competitive programs for distributing support.

The FCC has long employed auctions to assign spectrum usage rights. To award the MF I support, the FCC adopted its first procurement auction ("reverse auction") for universal service.[13] The auction will distribute up to $300 million in one-time funds for wireless carriers to expand their networks and provide mobile services at 3G quality or better (i.e., also support Internet access) in unserved areas and where no carrier has committed to expand.[14] Unserved areas are identified at the level of the census block, which is the smallest geographic unit for which the Census Bureau provides data.

Within eligible census blocks, coverage is measured according to road miles.[15] The auction's goal is to maximize the number of additional road miles that will receive coverage across all eligible areas nationwide, given the $300 million budget. Conducting a nationwide auction instead of earmarking funds for specific regions has an important advantage that has been stressed by numerous economists (e.g., Ackerberg et al. 2009): It induces competition among bidders across regions even if there is little scope for competition within particular areas.

Some geographic aggregation beyond census blocks was needed because census blocks are far smaller than the average area that is covered by a single cell tower—which is the smallest area that a bidder likely would consider for expansion. At the same time, to facilitate participation by smaller carriers, the FCC limited the regions over which a bid could be placed to lie within a Cellular Market Area (CMA).[16]

The FCC considered two main alternative geographic aggregation procedures: bidder-defined areas and predefined areas. With bidder-defined areas, carriers specify a set of census blocks that they propose to serve (within a CMA) and a total price for that set. Giving bidders such flexibility lets them tailor their bids to reflect geographic economies of scale or scope and other carrier-specific factors that affect the

[13] The commitment to an auction was made in the USF/ICC Order (FCC 2011c). The Public Notice that was released May 2, 2012, designated the auction as Auction 901, announced its procedures, and set its date for September 27, 2012. The Public Notice and other relevant information, including maps of areas that are eligible for MF I support, are posted on the FCC's website for Auction 901 (FCC 2012b).

[14] A commitment could stem from a regulatory obligation, funding received from a federal agency, or a public announcement by the carrier that it will deploy service in the area.

[15] This choice of metric reflects pragmatic considerations: The support is for mobile services, and verifying coverage will be based on drive tests. Weighting road miles unequally according to relative traffic may be desirable in principle, but there was a lack of comprehensive and consistent traffic data across areas. To facilitate bidding, the FCC posted an interactive map that shows the number of road miles in each eligible census block, as well as an online tutorial (FCC 2012b).

[16] The preliminary list (which was issued in February 2012) of census blocks that are eligible for support contained approximately 491,000 blocks, with an average area of about 1.8 square miles. Of the 734 CMAs that cover the US and its territories, 603 CMAs contain at least one potentially eligible census block, which implies on average 815 potentially eligible census blocks per CMA. Larger than a census block but smaller than a CMA is a census tract. The 491,000 eligible blocks are contained in approximately 6,200 tracts, which implies on average 79 blocks per tract (FCC 2012b ¶¶s 28, 31, 40). As will be discussed below, the FCC adopted the census tract as the geographic unit for bidding.

economics of expansion. The flexibility may also lower the cost of participating in the auction because carriers could rely on existing or easily developed business plans for expansion.[17] Under this approach, the set of bids that maximizes the number of new road miles that will be served given the budget constraint is determined using a combinatorial optimization algorithm.

The FCC ultimately chose the alternative approach of predetermining the census block aggregations over which bids can be placed. It adopted an intermediate unit between census blocks and CMAs: census tracts (except in Alaska, where census blocks are much larger than elsewhere). A carrier may bid to cover multiple eligible census blocks in a tract, not individual blocks, and specifies a per-mile price for all of the road miles that it plans to serve in that tract. Winning bids are those with the lowest per-mile bids, with at most one winner per tract.[18]

An important advantage of this approach is the simplicity of selecting winners, as compared to a combinatorial algorithm under bidder-defined areas. Given the expedited schedule of the MF I auction, the FCC opted for predefined areas due to the advantages in speed and simplicity of implementation. These considerations—and the heightened importance of transparency for bidders in this first reverse auction for universal service—informed further decisions about the auction design, such as its single-round, sealed-bid format. Reserve prices (here, maximum prices) were not adopted, as the risk of paying unacceptably high bids was deemed low given that the $300 million budget is allocated through competitive bidding across numerous areas nationwide, and would be unlikely to be exhausted by all of the bids.

### *2.1.3 Future Competitive Mechanisms*

The MF I auction was a test bed. The FCC has proposed using auctions to distribute universal service funds in further settings that will raise additional complexities. Phase II of the Mobility Fund will provide up to $500 million annually for five years to extend 3G or better coverage in areas that lack it and maintain coverage in areas that may lose it as funding to wireless carriers is reduced by phasing out the Identical Support Rule. One issue will be how to weight the importance of extending coverage versus maintaining it in current areas.

Phase II of the CAF in price cap areas will provide up to $1.8 billion annually for five years to support deployment of robust fixed broadband networks. The process will proceed as follows. The FCC's Wireline Competition Bureau will first develop a model for estimating the cost of deploying broadband networks in the relevant areas. Based on those estimates, in every state, each incumbent price-cap carrier will then be made an all-or-nothing support offer to provide broadband in all of its service areas in that state whose estimated cost is above some "high-cost" threshold and below an

[17] A potential risk with bidder-defined areas—that bidders may strategically propose areas to handicap local competitors—is muted here by the auction's nationwide aspect: bidders compete for funding against numerous bidders from other regions, not primarily against local rivals.

[18] A bidder is required to cover at least 75 % of the eligible road miles within the tract, and is paid based on the total number of miles served. In the likely event that this method of selecting the winning bids based on the price-per-mile does not exactly exhaust the budget due to "lumpiness," the remaining funds will be distributed among those next best bids that don't exceed the budget.

"extremely high" threshold, but excluding areas where unsubsidized competitors offer such services.[19] If a carrier accepts the state-level offer, it receives support for five years, after which competitive bidding will be used to distribute any universal service funding that may be needed in those areas.

In areas where the incumbents reject the state-level offers, the FCC stated it will distribute support through competitive bidding to maximize the extent of robust broadband service given the budget, but important issues remain to be determined. As with MF I, one issue will be the choice of geographic areas over which bidding will occur.

Another issue concerns the quality attributes that are required of bidders. In the statewide offer, the FCC specifies performance levels for speeds, latency, and capacity (the allowable monthly data usage) that the wireline incumbents must meet. Where incumbents reject that offer, one might consider relaxing somewhat the minimum performance levels and score bids based on their quality attributes.[20] This should allow the budget to fund greater coverage, for two reasons: the lower cost that is enabled by reduced performance, and the intensified bidding competition that results from expanding the pool of eligible bidders to include technologies such as satellite and cellular that may be ineligible if higher performance is mandated.

## 2.2 Reforming Intercarrier Compensation

### *2.2.1 Distortions from Termination Rates*

Intercarrier compensation denotes payments between carriers to originate, transport, and terminate calls that traverse carriers' networks. Historically, for local calls, the local exchange carrier (LEC) originating the call paid the destination LEC a termination rate called *reciprocal compensation*. For long-distance calls, the interexchange carrier (IXC) that handles the call pays *access charges* to both the terminating LEC and the originating LEC.[21]

The Order adopts a rate transition to bill-and-keep for most switched access termination rates[22] (and certain transport rates), and seeks comments on the transition

[19] Offering incumbents the right-of-first refusal was criticized by some competitors, but helped secure the necessary consensus for reform and expedite the process. The FCC adopted some but not all proposals that were made by a coalition of the major price-cap carriers (Quinn et al. 2011). One that did not have wide support was for incumbents to accept or reject support at the level of individual wire centers. Critics and the FCC feared that incumbents would accept where their costs were lower than estimated by the model and reject elsewhere. To minimize such adverse selection, the FCC required the state-level offer.

[20] The scoring criteria could reflect the values that consumers place on various broadband attributes. For estimates see e.g., Rosston et al. (2010).

[21] New terminology adopted in November 2011 renames these charges "non-access reciprocal compensation charges" and "access reciprocal compensation charges", respectively. For the purpose of discussing earlier examples, this article will use the traditional names ("reciprocal compensation charges" and "access charges").

[22] "Switched access" refers to traffic that is routed over shared public switched telephone network (PSTN) lines via switching equipment that connects individual customer premises to trunk lines (end office switching) or that connects different trunk lines (tandem switching) as necessary to create a path for a call. Conversely, "special access" refers to private, dedicated (i.e., non-switched) circuits that are leased from telecommunications carriers.

to bill-and-keep also for originating access and remaining transport rate elements. It also takes immediate steps to reduce rate arbitrage. Termination rates are the principal source of arbitrage schemes, some of which are described below.[23] Arbitrage opportunities arise for two reasons: termination rates vary widely; and they generally are well above marginal cost.

*Termination rates vary widely* based on various regulatory distinctions, reflecting different jurisdictions and decisions that were made at different stages in the industry evolution (Nuechterlein and Weiser 2007). One distinction involves the call's origin—interstate (i.e., from outside the state), intrastate long-distance, or local. Access charges are typically higher for intrastate than for interstate calls.[24] And access charges (interstate and intrastate) generally exceed local reciprocal compensation rates.[25]

A second distinction involves the terminating wireline carrier's regulatory classification: Rates, especially intrastate access, are typically highest for small rural incumbent LECs (ILECs under rate-of-return regulation) and lowest for large ILECs under price-cap regulation (with competitive LECs' [CLECs'] rates generally closer to those for large ILECs). The carrier's technology also matters: E.g., termination rates often were significantly lower or absent for calls involving wireless carriers, and ICC obligations related to VoIP calls were frequently subject to disputes.

The first and the last distinctions—the call's origin and technology—have spawned costly arbitrage schemes and battles over regulatory classification, as carriers jockey to obtain their preferred rate. The difference in rates can be large. For small rural carriers, in one state the 2009 average access charge was $0.12 for intrastate calls and $0.02 for interstate.[26] Reciprocal compensation rates, for terminating local wireline calls, vary widely but are typically well under $0.01 for large price-cap regulated carriers. And the geographic region in which calls were eligible for reciprocal compensation rates could differ depending on whether the call was originated by a wireless provider or

[23] Given the vertical integration between the largest local and long-distance carriers since the 1996 Telecom Act and that consumers typically obtain all-distance services from the same provider, most originating access payments today are intra-company transfers (although they are still mandated for regulatory reasons). The LEC operations of large integrated carriers are generally regulated under price caps (rather than rate-of-return), so high originating access payments that are paid to the LEC by the long-distance affiliate do not automatically reduce the LEC's allowable local retail prices and, hence, are less onerous to overall company profit than is high terminating access, which is typically paid to other carriers.

[24] Historically, both intrastate and interstate access charges were set well above marginal cost as an implicit cross-subsidy to reduce the price of basic local voice service. The FCC, which historically regulated interstate access, has reduced rates more aggressively than have many states.

[25] The 1996 Act—seeking to promote local competition and low retail rates—requires reciprocal compensation rates to be based on the "additional cost" of termination. The FCC adopted a methodology for estimating "additional cost" called TELRIC (Total Element Long Run Incremental Cost), and state commissions determined the rates based on this standard. Carriers may negotiate mutually acceptable rates, which are incorporated in private contracts. Access charges—both interstate and intrastate—are typically tariffed; and once approved by the FCC or state commission, must be paid by the long-distance carrier.

[26] These figures are from a report by the National Exchange Carrier Association, which represents many rural carriers nationwide, based on responses from 1,140 of its members (NECA 2010). In over one-third of the states, the average intrastate rate was at least three times the average interstate rate.

wireline carrier. In short, rates could vary by a factor of 20 or more based on the call's origin and type, even though the cost of termination is virtually identical.[27]

*Termination rates are well above marginal cost.* Even the lower rates generally exceed marginal cost, which is estimated at much less than $0.01. As evidence, in the late 1990s CLECs found it profitable to host ISPs because of the dial-up calls to ISPs—which were made predominantly by customers of the local ILEC—even though this traffic yielded CLECs reciprocal compensation of well below $0.01.[28] (In response, the FCC adopted a temporary rate cap for ISP-bound calls of $0.000007.)

Inflated and diverse termination rates create various inefficiencies. They distort competition between carriers that use different technologies because of the asymmetry in termination rates that are paid to each other. They discourage carriers from transitioning their traditional circuit-switched networks to IP-based networks because doing so would eliminate their ability to receive per-minute access charges. And they spawn costly regulatory disputes, uncertainty, and wasteful arbitrage schemes that will be described below. The USF/ICC Order adopts two sets of reforms: a comprehensive transition towards bill-and-keep, and immediate measures to provide clarity and tackle arbitrage.

### *2.2.2 Comprehensive Transition to Bill-and-Keep*

Under bill-and-keep, each carrier collects revenue only from its customers, not from other carriers for terminating their calls. The Order adopts bill-and-keep as the ultimate methodology for all telecommunications traffic that is exchanged with a LEC, both interstate and intrastate.[29] Under the specified transition, carriers must reduce many intrastate termination rates to interstate levels by July 2013. Thereafter, termination rates (and for some carriers also transport rates) must be reduced to bill-and-keep within six years for price-cap carriers and nine years for rate-of-return carriers. These are default rules, and carriers are free to negotiate mutually preferred alternatives.[30]

[27] Call termination involves delivering the call to the destination party from the LEC's end office that serves that party; hence the cost is independent of where the call originated. (And typically, for small rural LECs all incoming calls regardless of their origin are delivered to the same location: the single end office serving all of that LEC's customers.) With regard to technology, the terminating carrier can require via contract or tariff that calls be handed to it in its preferred termination format: E.g., most rural ILECs employ traditional circuit-switched networks and can insist that a call that originates in "voice over Internet protocol" (VoIP) be converted by the sender into "time division multiplex" (TDM) before the handoff to the terminating ILEC.

[28] Malueg and Schwartz (2001, section VI) discuss another example illustrating that reciprocal compensation exceeds marginal cost. An ILEC's customer leased a line at a fixed monthly fee and made computer generated calls to a CLEC, which profited from the reciprocal compensation that was paid by the ILEC and shared the profit with the customer. In that case, the North Carolina PUC disallowed $150 million in reciprocal compensation to the CLEC.

[29] A similar approach was proposed six years earlier by a coalition of carriers but floundered due to opposition by some carriers (Intercarrier Compensation Forum 2005). Early proponents of bill-and-keep for traditional switched-voice service in the U.S. include Atkinson and Barnekov (2000) and DeGraba (2000).

[30] Recall that the Order adopts bill-and-keep as the endpoint also for originating access but seeks comments on the transition rather than adopting particular steps at this time.

Bill-and-keep has been widely used among U.S. wireless carriers. Among wireline carriers, the traditional regime is calling-party's-network-pays, based partly on a view that the calling party is the main beneficiary and should bear the cost of termination that it caused by initiating the call. It is now widely recognized that call recipients also benefit, especially since they can fairly easily avoid calls that they do not desire, through options such as caller ID and unlisted numbers.

Bill-and-keep is not universally uncontroversial, especially if termination costs are high or are very asymmetric between carriers, but it has important advantages. One advantage of bill-and-keep is simplicity and avoidance of disputes. Even a low rate can spawn arbitrage schemes if it is above marginal cost (such as the previously noted schemes to generate incoming reciprocal compensation traffic), and obtaining precise estimates of marginal cost can be difficult and contentious. Another important advantage is that bill-and-keep forces carriers to obtain their revenue from the retail rates that are charged to their customers—rates that can attract competition if they are excessive. By contrast, high termination rates are less vulnerable to competition because they are borne by parties who often cannot influence the choice of carrier that serves the called party—the "terminating-access monopoly" problem.[31] The advantage of bill-and-keep in overcoming this problem is a major consideration in its favor.[32]

### *2.2.3 Addressing Arbitrage Schemes*

Besides setting a transition to bill-and-keep, the FCC took immediate steps to combat arbitrage schemes and related disputes that are driven by call termination. We first discuss gaming practices by the paying carriers, and then by terminating carriers.

*Depressing Termination Payments: Phantom Traffic.* Paying carriers sometimes disguise the origin of calls to avoid paying higher termination rates. For example, a carrier that sends an intrastate toll call to an ILEC customer may route the call to another carrier that will remove or alter call-identifying signaling information, making the call appear to be a local call that is subject to reciprocal compensation instead of the higher intrastate access rate. Calls that lack the necessary information are known as phantom traffic. The Order requires telecommunications carriers and VoIP providers that are interconnected with the public switched telephone network (PSTN) to include the

[31] Exceptions could arise if most calling were between parties that had close family or business links, and who bore the high-termination cost through the retail rates that are charged to them by their originating carrier(s) (something that is limited by geographic averaging rules).

[32] Littlechild (2006) compares two common retail pricing regimes used by mobile carriers worldwide: Calling Party Pays (CPP) where only the caller is charged for the call, and Receiving Party Pays (RPP) where the called party is also charged by its carrier (e.g., for any minutes or airtime) so that both parties share the cost of the call. He finds that RPP typically is adopted when termination rates between carriers are low or zero (bill-and-keep) whereas CPP is associated with high termination rates, supporting the prediction that lower termination rates induce carriers to recover a greater share of their costs from their own customers. He advocates bill-and-keep on these grounds—that it is more conducive to fostering retail competition among carriers—and cites evidence that lower termination rates are associated with lower average retail prices and higher utilization. Harbord and Pagnozzi (2010) also support bill-and-keep. Vogelsang (2003) and Armstrong and Wright (2009) offer further analysis of the merits of various termination regimes and their interaction with retail pricing.

calling party's phone number in all call signaling, and requires intermediate carriers to forward this signaling information unaltered.

The Order also addresses the rates that are applicable to certain calls that had triggered disputes: (a) Calls that originate in VoIP, which is offered by cable companies and other providers, comprise a large and growing share of all voice calls.[33] The Order adopts rules that subject such VoIP–PSTN traffic to intercarrier compensation, and sets the default rates.[34] (b) Another controversy involved calls between mobile wireless carriers and wireline carriers. Such calls are subject to lower reciprocal compensation rates if they originate and terminate in the same Metropolitan Trading Area (intra-MTA).[35] Citing a dispute where a wireless carrier "re-originated" substantial traffic from other sources and terminated it with local exchange carriers at reciprocal compensation rates, the FCC clarified that these rates apply only to calls that originate with a mobile wireless provider, and not merely transit through it.[36]

Besides attempting to circumvent high termination rates, long-distance call providers have incentives simply to reduce calls to such locations—mainly served by small rural carriers—because they cannot charge selectively higher retail prices for calls that incur higher termination rates.[37] Consistent with such incentives, a study by a rural carriers association found that incompletion rates were 13 times higher to rural than to non-rural areas (Sellers 2012). Rural carriers state that many of the problems could stem from deceptive call setup and related practices of least-cost routers—third parties that are used by retail long-distance providers to route calls so as to minimize costs—that mislead callers into abandoning call attempts.[38] As a general matter, FCC rules

[33] Traffic data are hard to obtain, but the total number of business and residential interconnected VoIP service connections rose from 21.7 million in December 2008 to 31.7 million in December 2010.

[34] For "toll" VoIP–PSTN traffic (interstate or intrastate), default rates will be the interstate rates that govern non-VoIP traffic; for other VoIP–PSTN traffic ("local"), default rates will be the reciprocal compensation rates (FCC 2011c, ¶933).

[35] See footnote 3 for a discussion of MTAs and other geographic designations used by the FCC.

[36] FCC (2011c, ¶¶s 1003–1006). The dispute featured Halo Wireless that partnered with a least-cost routing provider (Transcom), whereby Halo re-originated external traffic as intraMTA mobile wireless and terminated it at reciprocal compensation rates. An association of rural carriers reported that Halo's share of traffic to some of its members rose from 0 to 25 % over a short period, and that a sample study showed that this traffic was originated by customers of 176 different domestic and Canadian wireline carriers and 63 different wireless companies. Halo argues that this traffic qualified as mobile wireless because those customers (or their least cost router) connect to Halo's base stations using wireless equipment that is capable of operation while in motion.

[37] Long-distance telecommunications carriers are required under the Telecom Act to charge geographically-averaged rates for interstate calls, which precludes them from charging higher rates for calls of the same distance to reflect differences in termination rates. Beyond this legal requirement, the ability to reflect differential termination rates in retail prices is limited by marketing considerations and transaction costs—such as the desire for flat-rate plans. Reflecting such factors, certain VoIP providers, such as magicJack, that are not subject to geographic averaging rules nevertheless limit calls to high-termination rate locations.

[38] See FCC (2012c), which further documents problems with call completion to rural areas. Callers often hear multiple false rings whereas the destination phone does not ring, because the terminating carrier has not been signaled, leading callers to think nobody is present and hang up (one observer estimates this accounts for about two thirds of abandoned attempts). Alternatively, they experience a long silence ("dead air") before the signaling information is relayed to the destination carrier, leading them to think that the call did not go through; or they hear a frustratingly familiar message saying "the number you have called cannot be reached as dialed; please hang up and try your call later".

prohibit carriers from blocking or otherwise restricting calls. In its ongoing review of call completion problems in rural areas, the agency recently clarified that the prohibition covers practices of third-parties that work with the originating carriers, and that a carrier is liable for not resolving such problems if it knows of them or should know (FCC 2012c).

*Inflating Termination Payments: Access Stimulation.* The ability to shift large volumes of telecommunications traffic creates gaming incentives even when termination rates are only a fraction of a cent, as was demonstrated by the dial-up ISP controversy. Incentives are especially pronounced for those rural LECs that, having a very small customer base (as few as several hundred lines) on which to spread their fixed costs, are authorized to charge especially high terminating access rates. Some such carriers have participated in schemes that artificially increase their incoming minutes in order to collect termination payments from IXCs, practices known as "access stimulation" or "traffic pumping".

Those schemes work as follows: A LEC with high termination rates has an arrangement with one or more entities that generate large volumes of inbound calling to the LEC by offering free or very low-priced call services such as adult chat lines, conference calling, and voice mail. Inbound callers are drawn to these "free" services and typically pay no per-minute long-distance charges because their calling plans offer large numbers of free minutes—as the call-service providers stress in their advertising. Callers reach those providers by dialing a number that is provided by the LEC and the callers' IXCs make termination payments to the LEC, which typically has a revenue sharing agreement with the access stimulator.[39]

Access stimulation payments are estimated at several hundred million dollars per year.[40] Those inflated payments raise IXCs' costs and ultimately the price of long-distance calls generally, since long-distance retail prices are based on overall costs and not on termination costs to individual locations. Though there are potential benefits to users of these call-services, fraudulent call forwarding schemes also create affirmative harms. Even for services such as conference calls that benefit their users, funding the services through access stimulation is inefficient for several reasons. Users do not pay the cost and, hence, are likely to over-consume these services. Competitors

[39] Richer details about these schemes appear in a filing by AT&T (2007). Routing the incoming calls to the call-service provider entails very low cost because the latter's equipment is collocated at the LEC's end office or connects through a high-capacity private line. On AT&T's network alone, in November 2007 adult chat lines generated 47.4 million minutes (to only 2,610 lines), and free conference bridge services generated 226 million minutes (to 99 lines). Free voicemail services generate termination revenue when a caller leaves a message *and* whenever the subscriber calls to retrieve messages; these schemes have used millions of telephone numbers in Iowa, prompting concerns that telephone numbers would be exhausted. Missed call/remote call forwarding schemes are especially brazen: a service provider auto-dials thousands of calls throughout the U.S., leaving a message advertising a service such as banking. The reply calls are forwarded to a *toll-free* number of a third-party that is unaware of the scheme (e.g., the FTC's Do-Not-Call-Registry phone number …), and the LEC collects both terminating access from the IXC that delivered the inbound reply call *and* originating access from the IXC that forwarded this call to the toll-free number.

[40] A report filed in 2010 estimates the cumulative payments at more than $2.3 billion for the previous five years, which is broadly consistent with Verizon's estimate of the overall annual payments by IXCs at between $330 and $440 million (FCC 2011c, ¶664).

that seek to provide such services by charging users directly are artificially disadvantaged, which is likely to generate production inefficiencies (e.g., voicemail services are located in areas where termination rates are high rather than based on efficient network considerations).

The Order requires a LEC to reduce its interstate switched-access tariffs if (1) it has a revenue-sharing agreement with an access stimulator and (2) its traffic meet conditions suggesting access stimulation.[41] Ultimately, however, these arbitrage schemes and other gaming issues will only be entirely resolved once the incentives are removed by the comprehensive move to reduce termination rates.

Finally, recall that the Order mainly addresses termination rates for circuit-switched minutes. Looking forward, there are important open issues that include reforming origination rates and certain transport rates, and a host of questions that relate to interconnection for IP-to-IP traffic, which is an area that the FCC has not regulated.[42]

## 3 Merger Review: AT&T/T-Mobile and Level 3/Global Crossing

### 3.1 AT&T/T-Mobile Merger

*Overview.* In early 2011, AT&T, Inc. filed an application with the Commission to acquire full ownership of T-Mobile USA in a stock and cash transaction valued at $39 billion. The proposed transaction was a horizontal merger that would have combined the second and fourth largest mobile wireless providers to make AT&T the largest wireless provider, with two-and-a-half times the subscribers of the third largest provider Sprint. AT&T's proposed purchase required approval from both the Department of Justice (DOJ) and the FCC.[43]

On August 31, 2011, the DOJ filed in court to block the merger.[44] After an extensive review of the FCC's public record, internal company documents and analysis of industry data, the FCC staff released a report that found potential for substantial harm to mobile wireless competition (FCC 2011d). The staff recommended that the

[41] Specifically, if in any month, the LEC's ratio of terminating to originating traffic is at least 3/1 or its originating or terminating traffic grew by more than 100 % over the same month in the prior year. The tariff reduction rule applies to the main generators of access stimulation: primarily competitive LECs, and rate-of-return incumbent LECs. Recall that price-cap ILECs generally are the larger LECs and have lower access rates. Rural CLECs historically were allowed to benchmark their access rates to the highest-cost ILEC in their state, on the expectation that CLECs have a small customer base and, hence, high average costs. However, data for Iowa, Minnesota, and South Dakota show that CLECs averaged 750 million minutes compared to 2 million for the rate-of-return ILECs against which those CLEC rates are benchmarked. Under the new rules, a CLEC that meets the two access stimulation criteria must refile its interstate access rates so that they are no higher than the lowest rate of a price-cap LEC in that state. A rate-of-return ILEC that meets the two criteria will have to base its rate on its current costs and volume instead of historical costs and demand projections.

[42] See the Further Notice of Proposed Rulemaking that was issued with the USF/ICC Order (FCC 2011c).

[43] While the DOJ reviews proposed mergers under an antitrust standard, the FCC has a broader public interest standard that includes competitive effects analysis as well as other aspects of communications policy.

[44] Seven states also filed with DOJ to block the merger. The states joining the lawsuit were Pennsylvania, Ohio, Washington, Massachusetts, New York, Illinois, and California (DOJ 2011).

Commission designate the matter to a hearing before an administrative law judge, but AT&T immediately withdrew the application without prejudice, and formally ended its bid for T-Mobile on December 19, 2011 (FCC 2011e).[45] This section focuses on the main competition issues and discusses the evidence underlying the staff's recommendations.

The FCC's competitive analysis focused on whether the loss of T-Mobile as a direct competitor would enhance AT&T's market power and result in harm to consumers who purchase mobile wireless services. These competitive harms could take the form of increased prices (or a reduction in the rate of price declines), a reduction in output or service quality, or decreased product development or other innovations.[46] Two overarching points served as the backdrop for the analysis. First, the transaction would have caused an unprecedented increase in both subscriber and spectrum concentration. Second, it would have eliminated a nationwide rival that played the role of a disruptive competitive force in pricing, technological innovations, and product offerings. While this evidence alone was insufficient to make an affirmative determination of harm to competition, it was indicative of the scope and scale of competitive risk.

*Market Definitions and Concentration Measures.* FCC staff began the competitive analysis by identifying the relevant product and geographic markets that would be affected by the transaction. The bulk of the staff's analysis focused on a "retail mobile wireless services" product market, which was composed of mobile wireless services (including voice, text, and data) that are accessible using a handset or other mobile device and sold to consumers.[47] Consistent with past wireless transactions where geographic markets were defined as local, staff again recognized that most retail customers purchase wireless service at a local level and that service far from a consumer's home or work would be a poor substitute.[48] However, since prices and service plan offerings of the nationwide providers do not vary significantly across local geographies, the effect of the transaction on these decisions can be assessed by analyzing aggregated national data on variables such as margins, buyer substitution, and market shares.

The first step in analyzing whether the transaction would lessen competition in a sufficient number of local markets to induce national price changes was to calculate pre- and post-merger Herfindahl-Hirschman Index (HHI) levels in each Cellular Market Area (CMA).[49] The proposed transaction would have resulted in two firms (AT&T and Verizon Wireless) serving nearly three-fourths of all wireless subscribers in the

[45] Since AT&T withdrew its license Application before the Chairman and three Commissioners could vote on the staff's recommendation to designate the matter for hearing, all of the views and findings in the staff report reflect those of the FCC staff and do not necessarily reflect the views of the Commission.

[46] Harms were measured relative to the way that the market would likely evolve if AT&T and T-Mobile remained separate. In the wireless industry, improvements in quality and reductions in price would be expected to flow from ongoing technological change.

[47] FCC staff also analyzed potential harms for an enterprise and government services product market.

[48] See FCC (2011d), at ¶¶33–34.

[49] CMAs are 734 geographic areas that are used by the Commission for spectrum licensing purposes (FCC 2011a). The Commission examines the potential anticompetitive effects of any wireless transaction when the HHI in any market after the transaction would be greater than 2,800 with a change in HHI of at least 100, or when the change would exceed 250 regardless of the level.

U.S. As a consequence, HHI levels almost everywhere exceeded the threshold for a "highly concentrated" market and often supported a presumption that the transaction would result in competitive harms.[50] In the 100 most populous CMAs, the population-weighted HHI based on retail mobile wireless subscriber market shares would have increased to 3,448 after the transaction.[51]

*Unilateral Effects Analysis.* After analyzing market concentration, Commission staff performed a unilateral effects analysis to gauge the scope for consumer price increases. According to the standard differentiated products unilateral effects model, AT&T would have an increased incentive after the transaction to raise prices because some of the sales that would previously have been lost after a price increase would now be recaptured by T-Mobile products with which it formerly competed but now owns. The profitability of such a price increase depends in general upon the degree of substitution between the products that are sold by the two firms and the relative profit margins of the products (Moresi 2010).

An interesting modeling issue that arose is that standard unilateral effects models and "upward pricing pressure" (UPP) measures did not directly apply to the proposed transaction.[52] These models typically assume that the acquiring firm will maintain both sets of products after a merger, whereas AT&T intended to close T-Mobile service plans to new subscribers after the transaction. As a result, all wireless providers (not just AT&T) could have had an increased incentive to impose unilateral price increases as follows.[53] For AT&T, the incentive arises because many of its customers view T-Mobile as their second choice at current prices. If AT&T tried to raise prices pre-merger, enough customers would instead select a product that was offered by T-Mobile or some other firm as to make the price increase unprofitable. After the transaction, T-Mobile's plans would no longer be available as an alternative for AT&T's customers. Closing the T-Mobile brand would make AT&T's demand more inelastic and increase the profit maximizing prices for its products. Similar reasoning for other firms implies that all non-merging providers (e.g. Verizon Wireless and Sprint) would also have unilateral incentives to raise prices, even if AT&T did not raise its prices. The magnitude of these likely price increases would depend in part on the relative attractiveness of the third choice for the group of subscribers at each firm for whom T-Mobile was their second choice. All else equal, the less attractive the third alternative is relative to T-Mobile, the greater is the incentive for post-transaction price increases among all wireless providers.

[50] According to the DOJ/FTC (2010), an HHI above 2,500 indicates a market with a high degree of concentration. Mergers resulting in concentration above this level and that increase the HHI by more than 200 points are presumed likely to enhance market power.

[51] The post-transaction HHI would have exceeded 2,800, with an increase in HHI of more than 100, in 95 of the 100 most populous CMAs, and the increase in HHI would exceed 250 in 93 of the 100 most populous CMAs. Nationwide, 419 CMAs satisfied these criteria.

[52] UPP is a measure of the incentive to raise prices for both firms' products following a merger. See, e.g., Farrell and Shapiro (2010) and Moresi (2010).

[53] In the standard model, other firms may have an incentive to raise prices due to "feedback effects," but the incentive to raise price discussed here is a direct effect on pricing incentives.

This modeling subtlety was not raised by any outside parties in the public record; consequently, the data that were provided were insufficient to model fully the change in pricing incentives. The FCC staff took the approach of using the data that were available to estimate how the transaction would affect pricing incentives by reasoning as follows: The change in each firm's elasticity and the incentive to raise price depends on two factors: (1) the percentage of that firm's customers that view T-Mobile as their second choice; and (2) the percentage of those customers that would stay with the firm (after a specified price increase) instead of switching to their third choice now that T-Mobile products are no longer available. The diversion rate parameter that is used in the UPP analysis provides an estimate of the first component of the incentive to raise price. Lacking information on how close a substitute the third choice was for the group of consumers at each firm for whom T-Mobile was their second choice prior to the transaction, the staff were unable to estimate the importance of the second component. Accordingly, UPP measures were used as the best available evidence to gauge the potential for post-transaction price increases due to demand becoming more inelastic, and we report the results of this analysis here.

How a merger will change the merging firms' pricing incentives depends on two conflicting forces: the upward pricing pressure due to the loss of a competitor, and possible downward pricing pressure that results from efficiencies that reduce marginal costs. To gauge the importance of the first of these forces, the staff calculated "gross upward pricing pressure indices" (GUPPIs) for AT&T and T-Mobile products on the assumption of no change in pre-transaction marginal costs. Following the transaction, the value of lost sales of firm one (AT&T) on a per unit basis that are now recaptured by the newly acquired second firm (T-Mobile) are $D_{12}$* ($P_{2-}C_2$), where $D_{12}$ is the fraction of customers leaving firm one that would choose to buy instead at firm two following a price increase, known as the "diversion ratio", and ($P_2 - C_2$) is the per unit margin at firm two. To gauge the importance of the values of these recaptured sales, this per unit value is typically normalized by the unit price for product one to form the "GUPPI" that is given by $D_{12}$* ($P_{2-}C_2$)/$P_1$.[54]

*Buyer Substitution Measures and UPP Estimates.* A crucial component of UPP calculations and any unilateral effects analysis is the degree of buyer substitution between the products of the two merging firms. AT&T argued that it and T-Mobile were not close competitors and would not likely be so in the foreseeable future (AT&T 2011). The standard economic measure of the degree of substitution between the products of two firms is the cross-price elasticity of demand. The diversion ratio used in the GUPPI is a closely related measure.[55] To test AT&T's claim, staff used the FCC's Local Number Portability (LNP) database to calculate the diversion rates. The LNP data tracks the number of customers who switch their mobile wireless telephone number from one provider to another in a given month by rate center. From this data, the staff

[54] The GUPPI calculation for the products of firm two is analogous.

[55] The diversion ratio is the percentage of customers leaving firm $i$ due to a price increase that choose firm $j$ and is given by $d_{ij} = (\partial X_j/\partial P_i)/(\partial X_i/\partial P_i)$, where X denotes the quantities at each firm. The diversion ratio and cross-price elasticity ($\varepsilon_{ij}$) are related by the following formula: $\varepsilon_{ij} = -d_{ji} * X_j/X_i * \varepsilon_{jj}$, where $\varepsilon_{jj}$ is the own-price elasticity of demand.

calculated diversion rates between all providers and found that buyers view AT&T and T-Mobile as close substitutes when purchasing mobile wireless voice and data services.

One potential shortcoming of using the FCC's LNP data to calculate diversion rates is that many customers who port their numbers to a new carrier are not necessarily switching providers in response to a price or quality change. For diversion rates that are calculated using these data to be correct, we must assume that customers who switch providers in response to a price or quality change would have the same substitution patterns as customers who switch providers for any reason. To address this concern, the FCC used the number of customers who ported by rate plan from individual wireless providers in response to Information Requests issued by the Commission to analyze substitution between AT&T and T-Mobile following an actual change in a plan's price or quality change such as the introduction of a new iPhone model. The results of this deeper analysis confirmed the basic insight of the simple porting data analysis. AT&T customers responded strongly to T-Mobile pricing and quality changes, and vice-versa.

Adverse unilateral effects are sometimes considered unlikely if GUPPI measures are less than 5 % (Shapiro 2010). The proposed transaction greatly exceeded these thresholds. For T-Mobile products, GUPPIs ranged from 24 to 27 %, which suggested that T-Mobile is a significant rival for AT&T. The pricing pressure index for AT&T branded products was lower but still of concern, ranging from 6.6 to 7.3 %.[56] All upward pricing pressure metrics indicated that the transaction would generate strong incentives for AT&T to raise mobile wireless prices unilaterally if marginal costs remained unchanged.

*Incorporating Cost Efficiencies.* The previous analysis only measured the pricing pressure that was potentially generated by the transaction and did not account for any production efficiencies that could offset these increased incentives to raise price. AT&T submitted an economic merger simulation model and a theoretical network engineering cost model as the basis for its argument that the efficiencies that would result from the transaction would outweigh any price-raising incentives. The engineering model predicted AT&T's and T-Mobile's future marginal network costs, both with and without the transaction. The economic model then used the engineering model's marginal cost estimates and estimates of cross-price elasticities and margins to predict firm-specific mobile wireless prices with and without the transaction.[57]

AT&T argued that the transaction-specific cost efficiencies and quality benefits outweighed any potential anticompetitive harms; hence mobile wireless industry prices

[56] The pricing pressure on T-Mobile products was greater due to the greater fraction of T-Mobile customers that would choose AT&T as their second choice as well as AT&T's higher margin. After the transaction, AT&T would have a strong incentive to raise the price of T-Mobile plans (or to stop offering those plans as was their stated intention) in order to divert customers to AT&T's higher margin plans.

[57] The primary economic model that was employed by AT&T was a standard Bertrand competition differentiated products merger simulation exercise under a linear demand assumption. The model was calibrated using current wireless industry data, and wireless pricing predictions through 2015 were estimated both with and without the transaction. A quality adjustment module accounted for other claimed network quality improvements in addition to marginal cost reductions and translated these into consumer price changes.

would fall, and output would rise in comparison to the wireless industry without the transaction. Its models predicted that quality-adjusted prices would fall between 3.8 and 9.4 % and mobile wireless industry output would rise by 9.0–22.4 % in 2015, depending on the market studied.

While the Staff Report agreed with AT&T that the transaction would result in some network efficiencies as a result of combining AT&T's and T-Mobile's spectrum and network resources, the staff found that these efficiency claims were vastly overstated. In particular, AT&T's models were deficient in a number of respects and did not support its conclusions. The most critical input to the merger simulation model was the marginal cost estimate that was derived from the network engineering cost model. While we will only briefly discuss the engineering details, a particular modeling assumption resulted in greatly overstated efficiency benefits.

In order to relieve network congestion at a particular cell site without additional spectrum, it is necessary to build a new cell site or apply other technology so that the traffic load is now "split" between two sites instead of one. The engineering model assumed that network traffic was distributed over an area according to a specific mathematical distribution and this caused AT&T to implement the model's cell-splitting algorithm incorrectly. Rather than only targeting congested sites, as would occur in actual network management, the algorithm effectively built cell sites uniformly across an entire geographic area. As a result, the estimates of future marginal costs were inaccurate for at least two reasons: (1) cell site splits raised costs without relieving congestion; and (2) even more expensive technologies were then required by the model to relieve the traffic congestion that should have been relieved by the initial ineffective cell splits. Both of these factors disproportionately affected the firms' cost estimates under a no-merger assumption due to their smaller spectrum holdings, and this led AT&T to dramatically overstate the estimated cost savings of the transaction.

After correcting this one problem and using the resulting more reasonable marginal cost savings estimates in the merger simulation model (but not correcting for many other problems that the FCC staff had identified in both the economic and engineering models), AT&T's conclusions were reversed. The merger simulation model now predicted higher industry prices and lower output for every year after the transaction in nearly every CMA. Thus, even if AT&T were credited for all of the network efficiencies that were estimated by their engineering model, their economic model predicted competitive harms. Given the dramatic difference in estimates that arose from the correction of only this one issue, the staff concluded that these models were insufficient to support AT&T's consumer benefit claims and materially unreliable for predicting the outcome of their proposed transaction.[58]

*Coordinated Effects and other Competitive Harms.* While unilateral effects analysis formed the core of the staff's analysis of the transaction, a coordinated effects analysis (not summarized here) found potential for pricing harms above and beyond the unilateral incentives that were just discussed, due to the loss of T-Mobile as a disruptive

[58] Further corrections to AT&T's model for incorrect parameter assumptions and overstated efficiencies led to findings that the merger would raise prices and lower output even further. However, the staff concluded that the two models were too deeply flawed to have any probative value in the proceeding (FCC 2011d).

low-cost provider of mobile wireless services.[59] Substantial and material questions of fact on the potential for competitive harms were also found in the provision of mobile wireless voice and data roaming services, backhaul services, and wholesale and resale mobile wireless services, as well as handset purchasing and innovation (FCC 2011d, pp. 96–122).

*Conclusion.* On the basis of an extensive document review and the economic evidence presented here and in the Staff Report, as well as the lack of any verifiable and cognizable benefits of the transaction, FCC staff concluded that AT&T's proposed transaction with T-Mobile was not in the public interest.

### 3.2 Level 3/Global Crossing Merger

Another large merger reviewed by the FCC last year is the $3 billion purchase of Global Crossing Communications (GCL) by Level 3 Communications. While AT&T/T-Mobile raised traditional horizontal concerns with the merger's elimination of a competitor, in Level 3/GCL the main competitive concern was "vertical": that the merged firm might impede the ability of remaining rivals to compete by imposing worse interconnection terms. The FCC's stance also differed: It voiced serious concerns about the AT&T/T-Mobile, but approved the Level 3/GCL transaction with no conditions (FCC 2011b).

Level 3 and GCL were major providers of various international communications services. The competitive analysis focused on their role as providers of Internet "transit"—paid delivery of IP traffic to any Internet address—for customers such as smaller Internet service providers (ISPs), content providers, and enterprises. Both firms provided such connectivity through (a) their own high-capacity, long-distance IP transport networks and (b) interconnection agreements with other major networks to terminate traffic that was destined for each other's customers at no fee (unpaid "peering"). Major networks that deliver Internet traffic globally without paying any other network are known as "Internet backbone providers" (IBPs) or "Tier 1 ISPs". Services of IBPs were deemed a distinct product market for purposes of competitive analysis by the FCC, DOJ, and European Commission in several prominent mergers, including MCI/WorldCom (1998), WorldCom/Sprint (abandoned 2000), and SBC/AT&T and Verizon/MCI (2005).

In the Level 3/GCL transaction, a rival IBP named XO initially repeated a concern from prior mergers: The merged firm would control a large enough share of Internet traffic that it would either require rival IBPs to pay for traffic termination (de-peering) or degrade interconnection with them.[60] Competitors' increased costs or reduced service quality ultimately would harm end users of Internet backbone services. Importantly, interconnection to exchange Internet traffic—unlike traditional

[59] For example, T-Mobile was a founding member of the Open Handset Alliance, which helped bring Android devices to the market, and was the first provider to offer the Android smartphone. Documents also revealed that T-Mobile was the price leader among all nationwide wireless providers (FCC 2011d, pp. 71–84).

[60] XO later withdrew its objection to the merger.

circuit-switched telecommunications traffic—traditionally has been unregulated, and attempting to regulate it tightly would raise difficult issues. The question of whether a merger of Internet backbones will harm interconnection incentives therefore takes on added weight.

The basic argument for why incentives *might* worsen is the following: Given pervasive network effects in communications services, a provider's service quality is higher when its reach is broader. Consider two competing networks, L and S, with L's serving a larger base of users that are reachable only through it (single-homed users) and that cannot easily switch to other networks.[61] If L refuses or degrades interconnection with S, then S will suffer a greater drop in quality because its customers lose access to more connectivity than do L's customers. While L also suffers from its quality reduction, it gains a relative competitive advantage over S in attracting new customers, which on balance may create incentives for L to degrade interconnection or use this threat to extract payment.

However, there is an opposing force that is sometimes overlooked: Network L will suffer a competitive *disadvantage relative to remaining networks*, whose qualities have not fallen.[62] Consequently, even a network with a much larger share of the relevant connectivity measure (say, traffic) may not find it profitable to refuse or degrade interconnection selectively with a smaller rival. The net effect of the opposing forces on incentives cannot be resolved at the level of theory alone.

Turning to the facts, XO made two claims. First, Tier-1 ISP services remained the relevant product market as in prior mergers. Second, Level 3/GCL would have a combined market share of about 35 %. Regarding the product market, the FCC staff noted that there were increased alternatives to Tier-1 ISPs (e.g., the growth of secondary peering), but assumed conservatively that Tier-1 service remained a distinct category because the record still did not support competitive concerns. Regarding market shares, the FCC staff first noted that there is no single, generally accepted metric that perfectly calculates the relative size and importance of competing ISPs, and was skeptical that Level 3/GCL's share reached 35 % of either Tier-1 ISPs' connections or traffic. More important, in this case the FCC staff saw the asserted share as an unreliable proxy for L3/GCL's ability to dictate interconnection terms to smaller rivals.

A key fact that underpinned this view was that Level 3 and GCL each peered with numerous competitors, many of whom were much smaller by various measures. Level 3, the larger of the merging firms by Internet traffic, peered with 21 providers in North America, 11 of whom sold transit service, hence prima facie competed with

[61] If users are not equally important, the relative importance of each network's uniquely reachable user base will depend not only on the number of those users but also on the relevant asymmetries: e.g., in their traffic volumes or other attributes.

[62] Even under aggressive assessments of Level 3/GCL's position, there was no plausible risk that it could profitably degrade interconnection with all other IBPs: "global degradation". In a stylized model where all communication links are equally valuable, Cremer et al. (2000) showed that global degradation by the largest network will be unprofitable if its market share of installed-base customers is not above 50 %. Intuitively, global degradation would harm quality without yielding a competitive advantage over rival networks. Extending that analysis, Malueg and Schwartz (2006) show that if network effects are sufficiently important and the largest network were to degrade interconnection with two or more rivals that are interconnected among themselves, then under certain conditions (about the scope for demand growth), the market would tip away from the largest firm regardless of the size of its market share of the installed-base customers.

Level 3. The willingness to accept much smaller entities as peers, instead of demanding payment, casts serious doubt on the claim that an increase in market share within the plausible range caused by this merger would materially increase the merged firm's interconnection leverage.

Aside from this "revealed preference" evidence, another salient fact that eased competitive concerns was extensive *multi-homing* by customers of Level 3 and GCL. For a combined Level 3/GCL, 86–88 % of its customers were also served by other providers (the traffic-weighted percentage is likely higher); i.e., only 12–14 % were single-homed to the merged firm, hence could not be reached through other networks. As the fraction of a firm's customers who are multi-homed rises, that firm's ability to profit from degrading interconnection with smaller rivals falls for two reasons: First, the competitive harm to the targeted rivals is reduced because their customers lose connectivity to a smaller user base (they do not lose access to the merged firm's multi-homed customers, only to its single-homed customers). Second, the harm to Level 3/GCL is increased because it is more susceptible to losing traffic in response to the decline in its service quality, because multi-homed customers can shift some traffic away to other providers without having to abandon the firm entirely.[63]

In addition to the key facts above, the FCC staff noted that the number of Tier-1 ISPs had risen from eight in 2005 to twelve in 2011 (which suggested that incumbents could not prevent entry through interconnection policies), and that the public record contained few complaints about this transaction. Based on this record, the merger was approved by both the FCC and DOJ with no conditions imposed.

## 4 Conclusion

The above actions reflect attempts to embrace market-friendly policies, including preserving competition where necessary. An additional set of market-friendly FCC initiatives focuses on improving consumers' information. Improved information generally enables consumers to make choices that better match their demands with available offers, and sharpens providers' incentives to improve their offerings because improvements attract more business when consumers are more aware of them. We conclude this review with a brief discussion of one example: efforts to improve consumer information about the speed and other performance dimensions of residential broadband ISPs.

Advertised broadband speeds, such as 10 Mbps download and 2 Mbps upload, typically denote peak speeds and can significantly overstate actual average speeds, especially during times of heavy network utilization. Consumers cannot readily assess the actual speed offered by a broadband ISP. Measuring speed by using software on the consumer's device is imperfect because speed depends not only on performance within an ISP's network but on additional factors such as the consumer's device, other activities that may be occurring on the user's home network, and the specific web

[63] The high fraction of multi-homed customers of Level 3 and GCL may help explain the willingness of each firm to accept multiple smaller entities as peers.

site accessed. Dueling advertising by competitors does not resolve the information problem either, since consumers will discount claims of self-interested parties.

With input from ISPs, consumer groups, and academics, the FCC developed measures of performance between the edges of an ISP's network (from the Internet gateway up to the customer premise). The test was administered by SamKnows, which performed similar tests for UK's Ofcom and other regulatory bodies across the globe. The first report listed speed and latency by time of day, within each ISP's network, for the main residential wireline ISPs nationwide (FCC 2011f). The report drew considerable attention, including prominent mention in competitive advertising. Since then, the FCC has continued this study and issued its second report as part of its ongoing effort to assess consumer broadband performance.[64]

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