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

In the Matter of	)	
	)	
Expanding Flexible Use of the 3.7 to 4.2 GHz Band	)	GN Docket No. 18-122
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz	)	GN Docket No. 17-183 (Inquiry Terminated as to 3.7-4.2 GHz)
	)	
Petition for Rulemaking to Amend and Modernize Parts 25 and 101 of the Commission's Rules to Authorize and Facilitate the Deployment of Licensed Point-to-Multipoint Fixed Wireless Broadband Service in the 3.7-4.2 GHz Band	)	RM-11791
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Fixed Wireless Communications Coalition, Inc., Request for Modified Coordination Procedures in Bands Shared Between the Fixed Service and the Fixed Satellite Service	)	RM-11778

COMMENTS OF THE C-BAND ALLIANCE

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EXECUTIVE SUMMARY

This proceeding provides the Federal Communications Commission ("Commission" or "FCC") the unprecedented opportunity to repurpose valuable mid-band spectrum, win the race to 5G, and preserve existing deployment through a voluntary, market-based framework. The 3.7-4.2 GHz band ("C-band Downlink") enables the coverage and capacity to deliver the high-throughput, low-latency performance that next-generation terrestrial networks demand. Currently, however, the band forms the backbone for the delivery of content by the broadcast television and radio industries (which reach more than 100 million U.S. households), supports government and public safety operations, provides critical links to remote and underserved areas, and ensures communications systems' availability during disasters when terrestrial services fail.

To balance these competing demands, the Fixed Satellite Service ("FSS") operators have formed a consortium representing virtually all of the C-band service providers in the continental United States—the C-Band Alliance—for the purpose of reaching a win-win solution. The C-Band Alliance has proposed to quickly and economically make up to 200 MHz of mid-band spectrum, including a 20 MHz guard band, available for terrestrial 5G while ensuring that satellite operators can protect the services that enable their customers' businesses ("Market-Based Approach"). The C-Band Alliance would negotiate secondary market agreements ("SMAs") with terrestrial mobile operators for the clearing and repacking of incumbent C-band Downlink operations. The Commission should adopt the Market-Based Approach for the following reasons:

- ***The Market-Based Approach represents the fastest way to repurpose C-band Downlink spectrum for terrestrial mobile services.*** The C-Band Alliance projects that repurposing up to 200 MHz can be completed within 18-36 months of a final Commission order. Compared to the alternatives, the Market-Based Approach will be easiest for the Commission and related parties to implement. The Commission need only adopt:

(1) modest revisions to the Table of Frequency Allocations regarding co-primary use of the band; (2) a corresponding change to the Part 25 rules once terrestrial mobile operators have begun to use the frequencies in the geographic areas covered by the SMA; and (3) Part 27 service rules for the new terrestrial mobile licenses. No other proposal before the Commission offers such a streamlined and expeditious resolution.

- ***The Market-Based Approach will minimize the need for Commission intervention and complex and lengthy oversight.*** Extensive FCC oversight of a Transition Facilitator would unnecessarily delay deployment of 5G services in the C-band Downlink. The creation of the C-Band Alliance renders Commission approval for the formation of the Transition Facilitator or a specific operator participation benchmark unnecessary.

- ***The Market-Based Approach efficiently makes C-band Downlink spectrum available for terrestrial mobile use while protecting the quality, reliability, and certainty of existing C-band Downlink services on which millions of customers currently rely.*** The Market-Based Approach accounts for FSS operators' non-exclusive spectrum rights, eliminates the holdout problem, and protects against price increases for downstream customer services. The Market-Based Approach promotes coordination and collaboration among all eligible C-band Downlink satellite operators to negotiate SMAs with prospective terrestrial mobile service providers and addresses the holdout problem by incentivizing each eligible C-band Downlink satellite operator to join the C-Band Alliance—all FSS incumbents affected by reallocation and repacking would be compensated for their reconfiguration and relocation costs. Finally, because the Market-Based Approach would not impose a minimum spectrum-clearing target on incumbent participants, it would mitigate against the possible inflationary effect of reduced spectrum capacity on downstream customer prices.

- ***The Market-Based Approach is fully consistent with the law and the Commission's statutory authority.*** The Market-Based Approach complies with Section 309(j) of the Communications Act, avoids anticompetitive outcomes, and satisfies the requirements of the MOBILE NOW Act and the ORBIT Act.

In addition to adopting the Market-Based Approach, the Commission should take the following steps to promote terrestrial 5G services while protecting incumbent uses of the band:

- ***The Commission should avoid prescriptive mandates.*** For example, the Commission's proposed definition of "protected earth stations" is unduly restrictive and would exclude entities such as small rural radio and television stations and private networks that rely on C-band programming but lack full-time technical personnel to monitor FCC rules and submit registration filings. The FCC should not adopt a minimum spectrum clearing benchmark, which would interfere with the market forces necessary to fairly negotiate the terms and conditions for clearing spectrum efficiently and effectively while protecting

incumbent FSS operations. The authority to grant terrestrial mobile licenses provides the Commission with the ability to ensure proper oversight and transparency.

- ***The Commission should reject the Broadband Access Coalition's Proposal ("BAC Proposal") to add incompatible point-to-multipoint ("P2MP") operations to the C-band Downlink.*** The BAC Proposal would disrupt critical incumbent satellite operations and effectively prevent satellite operators from clearing spectrum for terrestrial 5G services. Suggestions by some terrestrial parties that the C-band is underutilized and therefore available for P2MP operations have been conclusively disproven, as the Commission's International Bureau Filing System ("IBFS") now contains roughly 16,500 registered C-band earth stations, a number that is still growing. Moreover, the removal of full-band, full-arc earth station protections, upon which any such sharing proposal depends, would take away the critical flexibility required by the satellite operators to provide uninterrupted distribution of their product. Adding P2MP in the C-band Downlink is also unnecessary, given the ample alternative spectrum available for fixed wireless broadband services.

- ***The Commission should not impose burdensome information requirements on earth station operators.*** Mandating that operators of all approximately 16,500 C-band receive earth stations, most of which just completed the costly and time-consuming process to register for the first time, answer a laundry list of questions seeking detailed usage and technical parameters would inflict a punishing and unjustified workload on these earth station operators.

- ***The Commission should not permanently freeze applications for new C-band earth stations and space stations.*** A freeze would arbitrarily limit the ability of the FSS ecosystem to evolve in response to customer demands. By contrast, permitting FSS networks to fully utilize the downlink spectrum that will remain available to them following clearing is the best way to promote efficient use of that spectrum and accommodate the natural development of the businesses that depend on the unique benefits of C-band satellite coverage and reliability.

- ***The Commission should reject alternative transition mechanisms, including overlay auctions and variations on the incentive auction, which are slower, less efficient, and pose implementation challenges that the Market-Based Approach avoids.*** These alternatives require far more heavy-handed government intervention and would likely be tied up in litigation for years to come. Only the Market-Based Approach will free a portion of the C-band Downlink for terrestrial 5G use in 18-36 months following the adoption of a final FCC order.

Under the Market-Based Approach, voluntary forces—and not government—would ensure that spectrum is efficiently converted to 5G mobile use and that satellite operators receive appropriate compensation for their investment, future losses, and clearing costs. By adopting the voluntary, market-based process proposed by the C-Band Alliance, the Commission can help ensure that America continues to lead and win the race to 5G.

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COMMENTS OF THE C-BAND ALLIANCE

The Federal Communications Commission ("Commission" or "FCC") identifies four goals in this proceeding: (1) open up mid-band spectrum for terrestrial mobile use, (2) win the race to 5G, (3) protect incumbent satellite operations and the critical services they provide, and (4) do so in an economically optimal way.[1] Satellite operators Intelsat License LLC ("Intelsat"), SES Americom, Inc. ("SES"), Eutelsat S.A. ("Eutelsat"), and Telesat Canada ("Telesat") have formed a consortium, the C-Band Alliance, for the purpose of assisting the Commission in achieving these goals.

The addition of both Eutelsat and Telesat to the C-Band Alliance represents an important development with respect to the market-based approach initially proposed by Intelsat, SES, and

[1] *Expanding Flexible Use of the 3.7-4.2 GHz Band et al.*, Order and Notice of Proposed Rulemaking, GN Docket No. 18-122 *et al.*, FCC 18-91 ¶ 2 (2018) ("*NPRM*").

Intel Corporation ("Market-Based Approach"), because these four satellite operators represent virtually all of the C-band service providers in the continental United States ("CONUS"). Moreover, the C-Band Alliance recently has taken a number of steps designed to ensure the success of the Market-Based Approach, including forming the C-Band Alliance consortium; agreeing on governance and member obligations; retaining a third party (5G Everywhere in America) to staff and manage the C-Band Alliance; and retaining advisors Auctionomics, NERA Economic Consulting, and the Boston Consulting Group to develop the framework and executable plan to streamline secondary market transactions.

The C-Band Alliance believes that only the Market-Based Approach accomplishes all of the Commission's goals, promising to free up a significant portion of the 3.7-4.2 GHz band (the "C-band Downlink") for terrestrial mobile use voluntarily, expeditiously, and efficiently, while fully protecting incumbent satellite services. The C-Band Alliance projects that this can be completed within 18-36 months of a final Commission order. Accordingly, to best balance the need to ensure protection of incumbent services with the desire to accelerate the United States' 5G revolution—across the entire country, including rural America—the Commission should adopt the Market-Based Approach as soon as possible.

I. INTRODUCTION

The C-Band Alliance submits these comments in response to the *NPRM*'s request for comment on proposals to expand terrestrial use in the C-band Downlink. As noted above, one of the Commission's broad public policy objectives is to have the U.S. win the race to 5G deployment by making additional spectrum—including mid-band spectrum—available as quickly as possible. Chairman Pai stated that "we aspire to lead the world in 5G. Make no mistake about it: I want the United States to be the best country for innovating and investing in

5G networks."[2] The *NPRM* cites estimates that the bandwidth requirements of 5G mobile broadband will increase exponentially, driving demand for more spectrum to accommodate this growth, and identifies mid-band spectrum as particularly well-suited for wireless broadband given its propagation characteristics.[3] Yet the C-band Downlink supports highly valuable Fixed Satellite Service ("FSS") operations, which provide critical public services, global data connectivity, and delivery of video and audio content to more than 100 million U.S. households. The Commission properly recognizes the need to protect these incumbent users and the infeasibility of co-frequency sharing between FSS and terrestrial mobile operations.[4]

To win the race to 5G, speed is of the essence. The Market-Based Approach—what Commissioner O'Rielly called a "win-win scenario"[5]—is the only proposal that carefully balances the competing C-band Downlink interests and meets the FCC's policy objectives, making mid-band spectrum available for terrestrial 5G quickly and economically while ensuring satellite operators can protect the services that enable their customers' businesses.

Under the Market-Based Approach, market forces will ensure that spectrum is converted to 5G mobile use efficiently while satellite operators receive appropriate compensation for their investment, future losses, and clearing costs, and that satellite operators' earth station customers

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[2] Ajit Pai, Chairman, FCC, Remarks at the Mobile World Congress, at 1 (Feb. 26, 2018), *available at* https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0226/DOC-349432A1.pdf ("Pai MWC Remarks"). Chairman Pai subsequently has called U.S. leadership in 5G technology a "national imperative for economic growth and competitiveness." Ajit Pai, Chairman, FCC, Remarks at the White House 5G Summit, at 1 (Sept. 28, 2018), *available at* https://docs.fcc.gov/public/attachments/DOC-354323A1.pdf ("5G Summit Remarks of Chairman Pai").

[3] *See NPRM* ¶ 5.

[4] *See id.* ¶¶ 2, 50.

[5] *Id.*, Statement of Commissioner Michael O'Rielly.

remain fully protected. No other proposal under consideration by the Commission will enable the U.S. to close the mid-band spectrum gap as quickly.

As proposed, the C-Band Alliance will negotiate secondary market agreements ("SMAs") with terrestrial mobile operators for the clearing and repacking of incumbent C-band Downlink operations. Upon execution of the SMAs, the prospective mobile licensees would file FCC license applications. The coordinated mobile licenses granted by the FCC would include conditions agreed upon in the SMA. The compensation distributed to the eligible members of the C-Band Alliance would be used to cover repacking costs and ensure uninterrupted service for both C-band Downlink satellite operators and their customers.

Implementation of the Market-Based Approach requires three modest rule changes by the Commission:

1. Adding a co-primary mobile allocation to the Table of Frequency Allocations for terrestrial mobile service in the C-band Downlink and a new U.S. footnote stating that terrestrial mobile use may be authorized provided it has been coordinated by a secondary market agreement with the consortium of fixed-satellite service operators;
2. Adopting a Part 25 rule that removes primary status protection for all C-band fixed satellite service operators upon initiation of service by a terrestrial mobile operator in the frequencies and geographic areas covered by the secondary market agreement; and
3. Adopting Part 27 service rules for the new terrestrial mobile licenses.

Since the release of the *NPRM*, the C-band FSS operators have taken concrete steps to make the Market-Based Approach a reality. First, the four companies representing virtually all of the operational CONUS C-band services—Intelsat, SES, Eutelsat, and Telesat—have united behind the Market-Based Approach, forming the C-Band Alliance consortium and agreeing on governance and member obligations. Second, the C-Band Alliance hired industry veterans Bill Tolpegin and Preston Padden to serve as CEO and head of advocacy and government relations,

respectively. Third, the C-Band Alliance and its satellite members have agreed to make available up to 200 MHz (3.7 GHz to 3.9 GHz), including a 20 MHz guard band, for terrestrial mobile use, based on the commitment to clear the spectrum in 18-36 months.[6] Whether the full 200 MHz is ultimately repurposed will depend on demand from terrestrial mobile broadband providers. Finally, the C-Band Alliance retained Auctionomics to develop the framework and executable plan to streamline secondary market transactions.[7] Together, these actions demonstrate the industry alignment and preparation necessary to make mid-band spectrum available quickly pursuant to a market-based process.

Unlike the Market-Based Approach, the Broadband Access Coalition's ("BAC") proposal to introduce point-to-multipoint ("P2MP") fixed use in the C-band Downlink ("BAC Proposal") expressly conflicts with the Commission's goals in this proceeding.[8] The BAC Proposal, and the elimination of the long-standing Commission policy of protecting earth stations across the full-band and full-arc on which the BAC Proposal relies, would deprive FSS operators of the flexibility needed to clear a portion of the C-band Downlink for terrestrial mobile use and preserve critical existing FSS operations. Moreover, the required protection zones around FSS

[6] The C-Band Alliance announced on October 22, 2018 that up to 200 MHz of the C-band Downlink could be cleared within 18 to 36 months of a final FCC Order for terrestrial mobile use, up from its original proposal to clear 100 MHz (and a 50 MHz guard band). The C-Band Alliance's decision to increase the amount of spectrum that could be cleared followed detailed technical assessments, including technical assessments of new filter specifications and of launching additional satellites in the relevant timeframe. *See Ex Parte* Letter of the C-Band Alliance, GN Docket Nos. 17-183 and 18-122 (filed Oct. 23, 2018).

[7] The C-Band Alliance has not decided on a final plan but has undertaken the process of identifying all parties with an interest in the spectrum and begun preliminary discussions with prospective purchasers to explore desired band plans and technical parameters.

[8] *See* Petition of Broadband Access Coalition for a Rulemaking to Amend and Modernize Parts 25 and 101 of the Commission's Rules to Authorize and Facilitate the Deployment of Licensed Point-to-Multipoint Fixed Wireless Broadband Service in the 3700-4200 MHz Band, RM-11791 (filed June 21, 2017).

earth stations would preclude any meaningful deployment of P2MP networks.[9] Rather than trying to shoehorn P2MP operations into the C-band Downlink and injecting unnecessary uncertainty and delay, the Commission should consider the availability of other spectrum bands for P2MP services.

Other proposals in the *NPRM* reflect a misunderstanding of the complex FSS ecosystem, ignore market forces, require significant and time-consuming government involvement, and would be opposed vigorously by satellite operators and their customers. FCC-led auction-based mechanisms fail to overcome fundamental challenges identified by the Commission, such as time-consuming delays[10] and price increases for downstream services.[11] These proposals also ignore the difficulties of conducting an auction where FSS licensees have non-exclusive rights.[12] Moreover, the alternative auction-based mechanisms proposed raise substantial legal and implementation issues that would significantly delay the reallocation of spectrum for terrestrial 5G use. A market-based, industry-led clearing process overcomes these difficulties and best ensures the protection of incumbent operations because the satellite operators understand the specific complexities that make the goal of clearing this particular frequency band both unique and challenging.

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[9] *See* Comments of the Satellite Industry Association, GN Docket No. 18-122, at 9 n.30 (filed May 31, 2018) ("separation distances necessary to prevent unacceptable interference to receive earth stations from P2MP facilities . . . would significantly increase the area within which co-frequency P2MP operations would need to be excluded").

[10] *NPRM* ¶ 54.

[11] *Id.* ¶ 59.

[12] *Id*.

Finally, the T-Mobile proposal to relocate incumbent earth stations to alternative facilities away from urban areas falls short on several fronts.[13] First, it would be cost prohibitive to move services delivered to all earth stations to alternative facilities outside urban areas, with traffic then backhauled to the current earth station location via fiber within the timeframe needed for the U.S. to gain global leadership in 5G.[14] Second, even if this proposal could work in a few select urban markets with readily available fiber infrastructure,[15] it would not work for large swaths of suburban and rural America. Also, a significant amount of additional infrastructure (*e.g.*, equipment) would need to be designed and installed to utilize the fiber infrastructure. Furthermore, not every service is readily available for ingest into a fiber infrastructure (*e.g.*, localized content, regional sports networks, event-driven content, programming from smaller networks, and international programming). Unlike the millimeter wave bands targeted for 5G use in densely populated areas, mid-band spectrum, such as the C-band Downlink, is a "Goldilocks" band[16] that will facilitate 5G coverage throughout suburban and rural America. Any proposal—including the T-Mobile proposal—that fails to ensure that the C-band Downlink is put to its highest-value use in much of suburban and rural America will only exacerbate the

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[13] *Ex Parte* Letter of T-Mobile USA, Inc., GN Docket Nos. 17-183 and 18-122, at 2-4 (filed June 15, 2018) ("T-Mobile *Ex Parte*").

[14] *See Ex Parte* Letter of National Public Radio, Inc., GN Docket No. 18-122, at 1 (filed May 25, 2018) (stating that terrestrial/fiber-based alternatives to the C-band are cost prohibitive and do not reach some parts of the country) ("NPR *Ex Parte*").

[15] The T-Mobile *Ex Parte* includes analysis only for the Phoenix and Chicago urban markets. *See* T-Mobile *Ex Parte* at 3-4 (citing T-Mobile *Ex Parte*, Attachments 1 and 2).

[16] Mid-band spectrum has been called the "Goldilocks" band because of its ideal mix of propagation and throughput properties. *See, e.g.*, Roslyn Layton, *The FCC's mid-band spectrum strategy falls into place not a moment too soon*, AEI Blog (July 30, 2018, 6:00 AM), *available at* https://www.aei.org/publication/the-fccs-mid-band-spectrum-strategy-falls-into-place-not-a-moment-too-soon/.

digital divide, in direct contravention of this Commission's goals.[17] The C-Band Alliance recognizes just how important mid-band spectrum is for serving rural America, and it intends to ensure that smaller regional carriers will have an opportunity to acquire this spectrum.

The United States' public policy objectives require adoption of the Market-Based Approach. It is the key to opening a portion of the C-band Downlink for terrestrial mobile use efficiently and expeditiously, while protecting incumbent satellite operations. The C-Band Alliance urges the Commission to adopt the Market-Based Approach promptly.

II. ONLY THE MARKET-BASED APPROACH WILL RAPIDLY FACILITATE NEW C-BAND TERRESTRIAL DEPLOYMENT WHILE PROTECTING INCUMBENT FSS OPERATIONS.

FSS satellite operators are uniquely positioned to ensure that the Commission can both promote U.S. leadership in 5G by making significant mid-band spectrum available quickly and preserve the robust and indispensable C-band FSS backbone that provides services benefitting all U.S. residents. Under the Market-Based Approach, these operators will execute the resource-intensive process of repacking FSS customers to clear a portion of the C-band Downlink for new terrestrial networks and equip all C-band antenna users, including cable operators, with technical solutions to safeguard their ongoing services. Indeed, the C-Band Alliance has made a public commitment to protect C-band users throughout the transition to ensure that C-band FSS services continue to provide the quality, reliability, and certainty that C-band users need to operate and grow their business.[18]

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[17] Remarks of FCC Chairman Ajit Pai, at 1 (Jan. 24, 2017) (declaring that bridging the digital divide is Chairman Pai's highest priority), *available at* https://docs.fcc.gov/public/attachments/DOC-343184A1.pdf.

[18] *See Ex Parte* Letter of the C-Band Alliance, GN Docket Nos. 17-183 and 18-122 (filed Oct. 17, 2018); *see also* Exhibit 1 – Our Commitment to C-band Users.

Satellite operators have invested billions of dollars in satellite and ground infrastructure to provide video and audio programming services, support public safety and government operations, and offer essential connectivity in the C-band Downlink. The Market-Based Approach accounts for this investment and compensates satellite operators for opportunity costs, as well as for the costs associated with clearing spectrum (such as providing 5G signal-blocking filters to thousands of earth stations and launching new satellites), using revenue derived from the secondary market transactions.

A. Speed Is Critical for the U.S. to Win the Global Race to 5G.

Bringing mid-band spectrum to market is critical for the U.S. to achieve and maintain 5G leadership. Indeed, "mid-band spectrum is increasingly viewed as a key component to unlocking the benefits of 5G connectivity."[19] As Chairman Pai recently stated,

> Time is of the essence. We are not alone in our pursuit of 5G. The U.S. is in the lead, thanks to our private sector as well as the work of the FCC, this Administration, and Congress. But China, South Korea, and many other countries are eager to claim this mantle.[20]

China has already cleared 500 MHz of mid-band spectrum at 3.3-3.6 GHz and 4.8-5.0 GHz for 5G services.[21] In June 2018, South Korea auctioned 280 MHz between 3420-3700 MHz.[22]

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[19] Comments of CTIA, GN Docket No. 18-122, at 3 (filed May 31, 2018); *see also Ex Parte* Letter of Ericsson, GN Docket No. 17-183, at 3 (filed Mar. 29, 2018) ("C-band spectrum must be brought to market quickly and with a robust band plan . . . . [M]id-band spectrum is critical to enable a robust 5G ecosystem."); *Ex Parte* Letter of Nokia, GN Docket Nos. 18-122 *et al.*, at 2 (filed Aug. 30, 2018) ("Nokia has consistently advocated that the Commission authorize a private sale of the 3.7 GHz band, rather than a public auction process, due to the critical need to convert this spectrum to 5G use quickly.").

[20] 5G Summit Remarks of Chairman Pai at 1.

[21] David Abecassis *et al.*, *Mid-band spectrum geographical licensing approaches*, Analysys Mason at 2 (July 2018), *available at* https://api.ctia.org/wp-content/uploads/2018/07/Analysys-Mason-mid-band-5G-spectrum-paper-7-03-18.pdf.

[22] *Id.* at 3.

Germany plans to award a total of 400 MHz between 3.4-3.8 GHz in early 2019.[23]

The C-Band Alliance supports the Commission's recently released Facilitate America's Superiority in 5G Technology Plan ("5G FAST Plan") to ensure that the U.S. remains competitive with other global wireless leaders.[24] The value of 5G leadership will provide sustained advantages for the United States. According to a report by Deloitte, "countries that adopt 5G first are expected to experience disproportionate gains in macroeconomic impact compared to those that lag,"[25] an expectation similarly forecasted by Chairman Pai.[26] The market will move towards the greatest opportunities, and "financial analysts predict that investment in 5G infrastructure will peak around 2021."[27]

The Commission should facilitate this innovation with sensible policies that prioritize rapid private investment and deployment. The big reason U.S. wireless companies drove 4G deployment was that the Federal government instituted market-friendly policies that allowed private sector ingenuity to thrive.

The C-Band Alliance intends to move quickly to develop secondary market transactions. The C-Band Alliance is committed to making as much as 200 MHz, including a 20 MHz guard

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[23] *Id.*

[24] *See The FCC's 5G FAST Plan*, FCC (rel. Sept. 28, 2018), *available at* https://docs.fcc.gov/public/attachments/DOC-354326A1.pdf ("*FCC's 5G FAST Plan*").

[25] Dan Littmann *et al.*, *5G: The chance to lead for a decade*, Deloitte at 2 (2018), *available at* https://www2.deloitte.com/content/dam/Deloitte/us/Documents/technology-media-telecommunications/us-tmt-5g-deployment-imperative.pdf.

[26] *See* Ajit Pai, Chairman, FCC, Remarks at the 7th Annual Americas Spectrum Management Conference, at 1 (Oct. 3, 2018), *available at* https://docs.fcc.gov/public/attachments/DOC-354392A1.pdf ("Seizing the opportunities of 5G is not incidental, but central to our ability to grow our economy, create new jobs, and unleash new services and applications that will raise our standard of living.").

[27] *NPRM*, Statement of Commissioner Carr.

band, of the C-band Downlink available for licensed terrestrial service within a period of only 18 months to 3 years—years before any proposed alternative mechanism could do so. Moreover, the design of these secondary market transactions will ensure that the market process is open to all interested parties, including smaller carriers that serve rural America, to acquire spectrum. No interested party will be shut out. Adopting the Market-Based Approach will speed U.S. leadership in 5G deployment and innovation by efficiently clearing and repurposing a portion of the C-band Downlink.

B. Accommodating New Terrestrial 5G in Intensively Used C-band Spectrum Requires an Extremely Complex Balance of Competing Interests.

Introducing 5G mobile operations into a portion of the C-band Downlink requires the Commission to strike a careful balance between competing interests. On the one hand, the C-band Downlink is viewed as uniquely valuable for terrestrial 5G, possessing a "combination of favorable propagation characteristics" that make it optimal for 5G mobile buildout.[28] The C-band Downlink also affords wireless operators the opportunity to deploy base stations using smaller cells to achieve higher spectrum reuse than lower frequency bands while still providing indoor coverage.[29]

On the other hand, over the nearly 50-year period in which the Commission has permitted satellite services in the C-band,[30] FSS operations have grown significantly and now represent an indispensable element of the nation's communications infrastructure. C-band transmissions form

[28] *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373 ¶ 6 (2017) ("*NOI*").

[29] *NPRM* ¶ 5.

[30] *See* Comments of the Satellite Industry Association ("SIA"), the Satellite Broadcasting and Communications Association, the World Teleport Association, and the Aerospace Industries Association of America in IB Docket No. 00-203 *et al.*, at 18-19 n.21 (filed Jan. 8, 2001).

the backbone of the delivery of content for the linear television industry, which generated $70-$80 billion in the United States in 2017.[31]

Importantly, the C-band Downlink is already extensively used to deliver satellite signals to licensed, registered, and unregistered earth stations throughout the country.[32] As of October 26, 2018, approximately 16,500 C-band Downlink antennas have been filed with, registered, or licensed by the Commission.[33] The C-Band Alliance is also aware of an additional 1,408 operational C-band earth stations that have not yet registered during the Commission's limited registration window,[34] including many earth stations operated by federal government users.

Although content distribution models have evolved since the 1970s, the need for the C-band as an essential link in the distribution chain remains constant. The record demonstrates that video and audio programmers rely on the unparalleled quality and dependability of C-band FSS to provide video programming to tens of millions of U.S. households and includes numerous

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[31] *IAB internet advertising revenue report*, PwC at 19 (May 2018), *available at* https://www.iab.com/wp-content/uploads/2018/05/IAB-2017-Full-Year-Internet-Advertising-Revenue-Report.REV_.pdf.

[32] *See NOI* ¶¶ 12-15.

[33] *See* FCC International Bureau Filing System, *available at* http://licensing.fcc.gov/myibfs/ (last visited Oct. 26, 2018). This number was derived by regularly monitoring new applications filed in the IBFS database following the announcement of the freeze on new earth stations and adding those totals to the more than 4,000 earth stations that had been registered or licensed before the freeze was put in place. This 16,500 figure includes registrations that have not yet been accepted by the Commission.

[34] *See* Earth Station Annex (attached), which provides a list of radio affiliate earth stations SES compiled from its customers and compared against the IBFS database of filed registrations. The locations identified in the attachment reflect the stations that do not appear to have been registered during the filing window.

examples of the significant role that the C-band plays in the content distribution ecosystem.[35] Comcast, for example, receives approximately 80% of its programming by C-band Downlink satellites, comprising 6,600 distinct video services, 148 transponders, and 20 satellites.[36] NBCUniversal and Telemundo depend on C-band satellite links to serve at least 114 million households.[37] The C-band Downlink also supports government and public safety operations, provides critical links to remote and underserved areas, and ensures communications systems' availability during natural disasters when terrestrial services fail.[38]

C-band satellite distribution technology today offers 99.999% reliability, a.k.a. "five nines" reliability. Because industry standards are based on this reliability, content providers and their customers rightly have voiced concern about service degradation from future co-frequency terrestrial applications. The Content Companies (which include Time Warner Inc., The Walt

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[35] For example, 21st Century Fox, Time Warner, Univision, Viacom, CBS, The Walt Disney Co., and Scripps Networks explained that they rely on the C-band Downlink to ensure that their content reaches multichannel video programming distributors' head-ends and broadcast station affiliates. *See Ex Parte* Letter of The Walt Disney Co., CBS Corp., Scripps Network Interactive, Inc., 21st Century Fox, Inc., Univision Communications Inc., and Viacom Inc., GN Docket No. 17-183, at 1 (filed July 24, 2017). Similarly, National Public Radio has explained that it relies on C-band FSS to provide programming to 42 million listeners each week and to ensure Americans receive "timely, critical information before, during, and in the wake of emergencies." NPR *Ex Parte*, Attachment at 3. C-band FSS is also used by a variety of smaller entities that depend on its cost-effective service to reliably deliver content. For example, Enlace Christian Television, Inc. attributes the success of its ministry to content delivered to thousands of households via C-band satellite. *Ex Parte* Letter of Enlace Christian Television, Inc., GN Docket No. 17-183, at 1 (filed Nov. 13, 2017).

[36] *See Ex Parte* Letter of Comcast Corp., GN Docket No. 18-122, Attachment at 2 (filed May 10, 2018) ("Comcast May 2018 *Ex Parte*").

[37] *Id.* at 3.

[38] Comments of the Satellite Industry Association, GN Docket No. 17-183, at 6-13 (filed Oct. 2, 2017) ("SIA NOI Comments"); Comments of Gary E. Timm, GN Docket 18-122, at 2 (filed Oct. 23, 2018) (some states may be using C-band satellite networks to distribute National and State Emergency Alert System messages throughout their state) ("Timm Comments").

Disney Co., CBS Corp., 21st Century Fox, Inc., Univision Communications Inc., and Viacom Inc.) explained that if C-band satellite transmissions "were to fail or otherwise be impeded due to harmful interference from other services, the viewing public would lose access to the most important news, the most popular entertainment, and the most exciting live sports programs—no matter what technology the consumer uses to access video."[39] In any cost-benefit analysis, the Commission must account for the fact that C-band satellite distribution ensures that outages to these must-see events do not occur.

For video content and other customers that require highly reliable nationwide distribution networks, alternate spectrum bands and technologies are not adequate substitutes for the C-band. Unlike other bands such as the Ku- and Ka-bands, C-band Downlink spectrum is resistant to rain fade and allows for broad coverage areas.[40] In addition, the cost of replacing an entire ecosystem of ground antennas to enable use of a different frequency band would be prohibitive. Moreover, Ka-band satellites generally utilize spot beam technology that is ill-suited for cost-effective nationwide content distribution.[41] Although Ku-band satellites tend to have wider beam coverage, they are unlikely to have enough available capacity to accommodate existing C-band services. To assume that Ku-band transponder capacity is an equivalent substitute for C-band capacity ignores the substantial number of filings in the record stating the contrary, as well as the

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[39] Comments of the Content Companies, GN Docket No. 18-122, at 3 (filed May 31, 2018). *See also Ex Parte* Letter of Globecast America, Inc., GN Docket Nos. 17-183 and 18-122, at 1 (filed June 5, 2018) (explaining that no alternative transmission mechanism "matches the reliability and reach of C-band satellites").

[40] *See, e.g.*, SIA NOI Comments at 2.

[41] *See* Reply Comments of the Satellite Industry Association, GN Docket No. 17-183, at 21-22 (filed Nov. 15, 2017); Reply Comments of SES Americom, Inc., GN Docket No. 17-183, at 13-14 (filed Nov. 15, 2017).

fact that C-band customers do not have the ground infrastructure to be able to utilize the Ku-band.[42]

Further, other technologies do not match the C-band Downlink's reliability, coverage, and cost-effectiveness.[43] Fiber, for example, is not available everywhere, is prone to network outages that can take time to pinpoint and resolve, and is very costly for distributing common services such as cable programming to a large number of locations. As just one example of how impractical and expensive fiber would be as an alternative, the Church of Jesus Christ of Latter-day Saints recently registered more than 3,400 antenna sites in the FCC's International Bureau Filing System ("IBFS") database.[44] It would take decades and billions of dollars to run fiber to all those locations, many of which are in quite rural locations. Fiber may also be prohibitively expensive for some users due to the high costs associated with content handoff among multiple network vendors.

With certain live events—such as the Super Bowl, which generated more than $400 million in ad revenue—any loss of broadcast coverage due to the unavailability of the C-band or the use of inferior alternatives would be catastrophic for broadcasters.[45] Extrapolating this value

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[42] *See, e.g.*, *Ex Parte* Letter of NCTA, GN Docket Nos. 17-183 and 18-122, at 2 (filed June 6, 2018); *Ex Parte* Letter of PSSI Global Services, LLC *et al.*, GN Docket Nos. 17-183 and 18-122, at 1-2 (filed June 25, 2018); Comments of Robert Nemitz, Chairman Society of Broadcast Engineers Chapter 32, GN Docket Nos. 17-183 and 18-122, at 1-2 (filed May 29, 2018); *Ex Parte* Letter of LinkUp Communications Corp. *et al.*, GN Docket Nos. 17-183 and 18-122, at 1 (filed May 24, 2018); Timm Comments at 5.

[43] Comcast May 2018 *Ex Parte*, Attachment at 8.

[44] *See, e.g.*, Corporation of the Presiding Bishop of The Church of Jesus Christ of Latter-day Saints, Attachment 1, IBFS File No. SES-REG-20180917-02757 (filed Sept. 17, 2018) ("Church of Jesus Christ of Latter-day Saints Attachment").

[45] *See* Jon Lafayette, *Super Bowl Generated $414M in Ad Revenue*, Broadcasting and Cable (Feb. 5, 2018), https://www.broadcastingcable.com/news/super-bowl-generated-414m-ad-revenue-171555.

over thousands of events each year makes clear the significant financial impact that these services have on the U.S. economy. The increasing availability of 4K- and eventually 8K-offerings[46] from television broadcasters provides additional revenue opportunities that will only be possible if sufficient transponder capacity remains that can provide the five nines of reliability that broadcasters expect.

As shown in Section I of the attached Technical Annex, co-frequency sharing between FSS and terrestrial mobile service in the C-band Downlink is also infeasible. The record supports the FCC's conclusion that "co-channel sharing of spectrum between the FSS and more intensive terrestrial wireless use in the same geographic area may be difficult."[47] To receive communications from geostationary satellites 22,000 miles away, C-band Downlink earth station antennas are highly sensitive by design and, consequently, extremely vulnerable to interference.

Specifically, protecting reception of satellite signals from co-frequency terrestrial interference would require large exclusion zones around the satellite earth stations. Establishing exclusion zones around FSS earth stations would also constrain terrestrial operations significantly.

Possibilities to mitigate interference on a global basis are extremely limited, and dynamic spectrum sharing solutions, which remain unproven, are inherently and fundamentally incompatible with the nature of FSS receive earth stations. Any viable approach to expanding

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[46] 4K and Ultra HD ("UHD") refer to 3840 x 2160 pixel screen resolution. 8K refers to 7680 x 4320 pixel screen resolution. *See, e.g.*, Geoffrey Morrison, *TV Resolution Confusion: 1080p, 2K, UHD, 4K, 8K, and What They All Mean*, CNet (Jan. 25, 2016), https://www.cnet.com/news/tv-resolution-confusion-1080p-2k-uhd-4k-and-what-they-all-mean/.

[47] *NPRM* ¶ 50.

mobile broadband operations in the C-band Downlink must therefore forbid co-frequency sharing.

C. The Market-Based Approach Will Preserve Critical Satellite Services.

Importantly, only the Market-Based Approach can convert spectrum to terrestrial wireless use expeditiously while adequately protecting incumbent satellite services, including those in rural communities where alternatives to the coverage, reliability, and convenience of C-band satellite services are least likely to be available. Under the Market-Based Approach, satellite operators with detailed knowledge of their customers' exacting reliability requirements will ensure the availability of high-quality satellite service in the portion of the C-band Downlink identified for continued use by those satellite customers. Satellite operators—through the Transition Facilitator envisioned by the FCC—will undertake the arduous, complex, and costly task of clearing spectrum for terrestrial 5G while ensuring they can provide uninterrupted media and data services during the transition period and beyond by protecting ongoing FSS operations from adjacent-band interference due to new terrestrial networks. Satellite operators are uniquely positioned to protect FSS customer downlink operations, which utilize dozens of space stations and approximately 16,500 earth stations, because they have direct knowledge of those operations and business requirements—including non-public, contractual terms and conditions. In addition, the C-Band Alliance, acting in its role as the Transition Facilitator, will be best positioned to determine protection requirements for telemetry, tracking, and control ("TT&C") operations necessary to ensure safe flight of in-orbit C-band spacecraft. More so than any other stakeholder, FSS satellite operators appreciate the importance of protecting such C-band Downlink earth station operations and will be motivated to develop well-defined protections for TT&C monitoring and control.

Clearing spectrum in the lower portion of the C-band Downlink while protecting customer operations will require three components, all of which must be carefully coordinated. First, satellite capacity must be added—including by launching new satellites—to ensure sufficient supply available in the reduced FSS frequency range to absorb the incumbent services that must be moved and to meet contractual obligations for contingency capacity in the event a transponder or a satellite suffers a failure. Second, a highly detailed frequency migration plan must be mapped out and clearly communicated to all customers and their end users. This plan will result in migration, not only for services currently operating in the frequencies to be cleared for terrestrial 5G operations, but also services in the remaining FSS spectrum that may need to be consolidated to find sufficient bandwidth for larger content customers. Third, there must be a plan to define and implement the necessary technical mitigation methods that will protect all incumbent services from adjacent band-interference once terrestrial 5G services are implemented. Although baseline mitigation techniques may be adequate for the majority of incumbent operations, there will be cases that require additional action to ensure service continuity. The implementation of the technical mitigation plan must also be coordinated with the frequency migration plan, as the relevant frequencies must be cleared in order to install certain equipment that will be needed to minimize interference from terrestrial operations.

The satellite operators have done extensive analysis to determine how to repack the existing services operating in the lower 200 MHz of the C-band Downlink and have concluded that the only way to ensure continuity to existing services is to launch certain additional C-band satellites. The satellite operators are confident that they will be able to design, provision, and launch these satellites quickly enough to meet the FCC's timeline for clearing spectrum.

Satellite operators have extensive experience in migrating services between frequencies as well as between satellites. For example, over the past few years, SES has migrated a significant number of services from satellites located at 131° W.L. and 135° W.L. to satellites located at 101° W.L., 103° W.L., and 105° W.L. This transition required careful coordination with satellite programmers and broadcasters as well as earth station operators. In some cases, SES provided necessary equipment (*e.g.*, satellite receive antennas) to earth station operators, managing the procurement and delivery of the equipment in addition to covering the equipment costs. These migrations involved thousands of earth stations serving nearly 100 million U.S. households. Throughout the migrations, continuity of service necessitated the implementation of "dual illumination," whereby the affected services were transmitted simultaneously on both the destination satellite transponder and the original satellite transponder. The process and experience from prior migrations will be applied to the upcoming migrations needed to clear the lower portion of the C-band satellite band. Having this process led by the C-Band Alliance, as contemplated by the Market-Based Approach, will remove spectrum inefficiencies and implementation delays that would arise if clearing were to be performed by each satellite operator independently. The C-Band Alliance is committed to protecting all CONUS TT&C sites of C-band satellite operators if such operators provide notice prior to the execution of any SMAs.

The C-Band Alliance will also use several tools to protect FSS operations while clearing C-band Downlink spectrum. These tools include: (i) fitting C-band earth stations with band-pass filters to prevent terrestrial 5G signals in adjacent cleared spectrum from saturating low-noise block converters ("LNBs"); (ii) taking advantage of discrimination of earth station antenna patterns to suppress 5G signals near earth stations; (iii) defining maximum allowable 5G in-band

emission levels to prevent earth station LNB saturation; (iv) specifying 5G out-of-band emission levels to prevent disruption of highly sensitive satellite signals due to direct interference from both 5G base stations and 5G user equipment; (v) installing upgraded LNBs when saturation may still occur; and (vi) relying on a defined guard band between 5G signals and adjacent satellite signals.

C-Band Alliance members have already commissioned the development of band-pass filters, received prototypes, and tested the filters' ability to reject high-powered terrestrial 5G transmissions adjacent to the remaining satellite band, in order not to saturate sensitive satellite earth station LNBs, as discussed in Section III of the attached Technical Annex. Under the Market-Based Approach, the responsibility for specifying and deploying such filters, together with upgrading LNBs as needed, would lie with the C-Band Alliance. Such filters will be specifically designed to protect satellite operations in the upper portion of the C-band Downlink.

The C-Band Alliance has also developed a program for deploying the hardware needed to protect incumbent operations at no cost to antenna operators. A summary of the program is provided in Exhibit 2 and has been discussed extensively with the community of incumbent earth station operators as well as other C-band FSS users, including programmers, broadcasters, and radio networks.

In order to maximize the amount of spectrum that could be cleared while protecting incumbent satellite operations, the C-Band Alliance proposes that the Commission adopt in its Part 27 rules the out-of-band specifications for base stations and user equipment transmissions provided in Section III of the attached Technical Annex, together with a guard band of

20 MHz.[48] These specifications were developed based on extensive analysis, including modeling, simulation, and testing performed by the C-Band Alliance across a large number of potential terrestrial 5G deployment scenarios.

Additionally, because close proximity of 5G base stations and user equipment to satellite earth stations could exacerbate the interference to satellite earth stations, each SMA will include a mechanism to ensure that mutually beneficial mitigation steps are put in place to maximize flexibility for terrestrial operations while simultaneously minimizing interference to satellite services. Such mechanisms would include defining acceptable earth station receiver protection criteria, in general and as needed, on a case-by-case basis. Radiofrequency shielding could be used in rare situations but is not expected to be sufficient to protect most earth stations. The technical mechanisms defined in the SMA to protect earth stations would then be incorporated in the terrestrial operator's license, which will be issued and enforced by the FCC.

Finally, additional protection for a limited number of TT&C earth stations and teleports can also be addressed through the SMA. The list of TT&C earth stations currently used by SES, Intelsat, and Telesat in CONUS is provided in Section II of the attached Technical Annex.

III. TERRESTRIAL 5G DEPLOYMENT WILL THRIVE UNDER A VOLUNTARY MARKET-BASED PROCESS WITH MAXIMUM FLEXIBILITY AND MINIMAL COMMISSION OVERSIGHT.

A marketplace thrives when left unfettered by government mandates and bureaucracy. As Chairman Pai noted when explaining the U.S. strategy for 5G: "Our overall philosophy is founded on a simple but profound premise: The market, not government, is best positioned to

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[48] This guard band could not be used for any other services. Introducing new sources of interference in the guard band would increase the risk of saturating earth station LNBs and would disrupt the delicately balanced sharing framework relied on by the C-Band Alliance and future users of the cleared spectrum.

drive innovation and investment in the wireless sector. Government's role is not to command and control, but to enable and encourage."[49] The Market-Based Approach can put this philosophy into action, speeding U.S. leadership in 5G deployment and innovation.

A. The Commission Should Facilitate, Not Dictate, Formation of and Actions by the Transition Facilitator.

Given the voluntary and market-based nature of the Transition Facilitator role envisioned by the *NPRM*, extensive FCC oversight of the Transition Facilitator is unnecessary and likely to delay deployment of 5G services in the C-band Downlink. Specifically, Commission approval for the formation of the Transition Facilitator or a specific participation benchmark is unnecessary. Intelsat, SES, Eutelsat, and Telesat have already formed the C-Band Alliance. These four satellite operators collectively account for virtually all operational C-band satellite service in CONUS.[50] As proposed in the *NPRM*, participation in the C-Band Alliance is open to C-band satellite operators providing CONUS service pursuant to FCC-issued licenses or market access grants.[51] Given the market share of the satellite operators already participating, additional satellite operator members are not essential to the success of the Market-Based Approach.

Moreover, any other eligible C-band Downlink satellite operators have every reason to join the C-Band Alliance and participate actively in the process of clearing spectrum for mobile use and protecting their existing FSS operations. As an additional incentive, members of the C-Band Alliance might also be eligible for reimbursement of their prior investment and opportunity costs, based on an established formula. Others who choose not to join will nevertheless be

[49] Pai MWC Remarks.

[50] Under the Market-Based Approach proposed by the C-Band Alliance, Alaska, Hawaii, and the U.S. territories would explicitly be carved out from the plan to repurpose a portion of the C-band Downlink. Earth station operators in these areas would not be impacted.

[51] *NPRM* ¶ 74.

reimbursed for reconfiguration and relocation costs. As such, rather than regulate the C-Band Alliance and its membership, the Commission simply should encourage all eligible C-band satellite operators to join.

Similarly, submission of a "Transition Facilitation Plan"[52] would divert resources to a needless administrative exercise and delay implementation. To the extent the Commission deems it appropriate, the C-Band Alliance could submit periodic reports on the status of negotiations and efforts underway to clear spectrum for terrestrial 5G use. Even this may be unnecessary. The C-Band Alliance has already made significant progress in determining how to structure and implement the Market-Based Approach, including hiring Auctionomics, NERA Economic Consulting, and the Boston Consulting Group to develop the framework and an executable plan that will streamline secondary market transactions.[53] In sum, satellite operators are ready, willing, and able to work collaboratively with one another to implement the Market-Based Approach, with minimal guidance or oversight from the FCC required.

B. The Commission Should Broaden Its Proposed Definition of "Protected Earth Stations."

The C-Band Alliance urges the Commission to revise its proposed definition of incumbent "earth stations eligible to receive interference protection from terrestrial stations" to include all C-band Downlink earth stations that are in compliance with terms and conditions set by the C-Band Alliance and announced through FCC Public Notice. The Commission proposes that protections established either by FCC rule or through negotiations between the Transition

[52] *See id.* ¶ 80.

[53] Auctionomics is a consulting and software firm offering straightforward, innovative, and economically sound solutions to complicated problems. Auctionomics provides an unprecedented and unparalleled ability to design simple and efficient markets and create win-win solutions. *See* http://www.auctionomics.com/ (last visited Oct. 10, 2018).

Facilitator and coordinated mobile licensees would extend only to earth stations that "(1) were operational as of April 19, 2018; (2) are licensed or registered (or had a pending application for license or registration) in the IBFS database as of October [31], 2018; and (3) have timely certified the accuracy of information on file with the Commission to the extent required by the *Order*."[54] This definition is unduly restrictive and unnecessary, especially in light of the substantial number of small rural radio and television stations and private networks that rely on C-band programming but lack full-time technical personnel or outside legal counsel to monitor FCC rules and submit registration filings. The Market-Based Approach would ensure protection for *all* C-band Downlink earth stations known to the C-Band Alliance at the time of an SMA, regardless of when they become operational or whether they were timely registered and certified with the Commission. By amending its proposed definition to encompass all earth stations identified by the C-Band Alliance, the Commission can facilitate expanded terrestrial 5G use in the C-band Downlink without needlessly restricting existing FSS earth station operations.

C. The FCC Should Not Adopt a Minimum Spectrum Benchmark.

The Commission should not adopt an "Initial Minimum Spectrum Benchmark" as proposed in the *NPRM*.[55] Such a benchmark would interfere with the market forces necessary to fairly negotiate the terms and conditions for clearing spectrum efficiently and effectively while protecting incumbent FSS operations. Satellite operators, not the government, are best

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[54] *NPRM* ¶ 27. *See also id.*, Appendix A (proposing to add a definition of incumbent earth stations to Section 25.203 of the FCC's Rules). While the *NPRM* established a registration deadline of October 17, 2018, the Commission later extended the earth station registration window through October 31, 2018. *See International Bureau Announces Two-Week Extension of Filing Window For Earth Stations Currently Operating in 3.7-4.2 GHz Band*, Public Notice, GN Docket No. 18-122 (rel. Oct. 17, 2018).

[55] *NPRM* ¶ 81.

positioned to determine how much spectrum to make available for 5G terrestrial use given incumbents' current and future needs and the state of technology that fulfills those needs in a more limited frequency range.

The C-Band Alliance will make available up to 200 MHz (3.7 GHz to 3.9 GHz), which includes a 20 MHz guard band, for terrestrial mobile use. This 200 MHz commitment strikes the appropriate balance between making available as much spectrum as possible that could be cleared for terrestrial mobile service in 18-36 months and ensuring that sufficient spectrum remains to support and protect incumbent users of C-band satellite services. Whether the full 200 MHz is ultimately repurposed will depend on demand from terrestrial mobile service providers, which will be determined pursuant to a market-based process to be run by the C-Band Alliance.

Because it is impossible to know *a priori* what this demand will be, it is important that the Commission provide the C-Band Alliance with maximum flexibility in secondary market transactions with the terrestrial mobile service providers. The government should avoid putting its thumb on the scale by setting an artificial, minimum amount of spectrum to be made available for terrestrial 5G. Just as the Commission's initial target for spectrum rebanding had to be revised downward in the broadcast incentive auction, adjustments may be necessary in this market-based process. The Commission should therefore acknowledge that only the free market can efficiently determine the amount and timing of clearing that optimizes both terrestrial mobile use and continued satellite operations.

D. FCC Grant of Terrestrial Mobile Licenses Provides Oversight and Transparency.

Consistent with existing licensing requirements implementing Section 310 of the Act, the Commission already has ample authority to oversee the ultimate introduction of terrestrial

flexible use in the C-band Downlink. Under the Market-Based Approach, the Commission will review license applications from entities entering into SMAs with the C-Band Alliance and will issue terrestrial mobile licenses. As part of its public interest review, the agency evaluates whether a license applicant possesses the requisite "citizenship, character, financial, technical, and other qualifications."[56]

The Commission will also put in place service rules applicable to C-band Downlink spectrum cleared for terrestrial operations. In adopting such rules, the Commission should implement a band plan, licensing framework, and technical parameters that will provide the flexibility for deployment of terrestrial 5G operations and promote investment in the C-band.[57] Service specifications matching those discussed in Section III of the Technical Annex should be incorporated into the Commission's rules, but beyond those specifications, the rules should provide maximum flexibility for the Transition Facilitator to negotiate with mobile operators. Doing so will create the best foundation for terrestrial 5G to thrive, especially given the fact that the precise nature of 5G service and the consumer applications that it will support are yet to be determined.

The C-Band Alliance is committed to working with the Commission, C-band Downlink users, and mobile operators to ensure that technical requirements included in the SMAs provide a level of certainty and clarity to the satisfaction of all stakeholders.

In sum, the FCC's existing licensing process and ultimately adopted service rules will provide transparency, accountability, and certainty. This framework also will obviate the need

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[56] 47 U.S.C. §§ 308, 310; *see also, e.g.*, *Applications of AT&T Inc. et al.*, Memorandum Opinion and Order, 30 FCC Rcd 5107 ¶ 10 (2015).

[57] *See NPRM* ¶ 134.

for additional regulation of the C-Band Alliance, its membership, or its spectrum clearing targets and process.

IV. THE MARKET-BASED APPROACH BEST ADDRESSES ECONOMIC ISSUES.

The Market-Based Approach best addresses the three "economic problems" identified in the *NPRM*.[58] Specifically, it accounts for FSS non-exclusive spectrum rights, eliminates the holdout problem, and protects against price increases for downstream services.

First, the Market-Based Approach mitigates the impact of satellite operators' non-exclusive rights to C-band Downlink frequencies by promoting coordination and collaboration. This approach encourages all C-band Downlink satellite operators providing CONUS service to participate in the C-Band Alliance and in the C-Band Alliance's negotiations of SMAs with prospective terrestrial mobile service providers.[59] These SMAs would contractually establish the timeframe for satellite incumbents to relinquish primary protection in the frequencies covered by the SMA in exchange for compensation. The C-Band Alliance obviates the need for a terrestrial mobile service provider to enter into multiple contracts with satellite operators for access to the spectrum, which would be time-consuming and inefficient.

Second, the Market-Based Approach addresses the holdout problem by incentivizing each eligible C-band Downlink satellite operator to join the C-Band Alliance. Under the Market-Based Approach, all FSS incumbents affected by reallocation of the C-band Downlink and the resultant repacking into a smaller portion of the band will be compensated for their

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[58] *See id.* ¶ 59.

[59] As discussed in more detail in Section V.B, the Federal Trade Commission ("FTC") and U.S. Department of Justice ("DOJ") recognize the benefits of such collaborations. FTC and DOJ, Antitrust Guidelines for Collaborations Among Competitors at 6 (Apr. 2000), *available at* https://www.ftc.gov/sites/default/files/attachments/dealings-competitors/ftcdojguidelines.pdf ("Collaboration Guidelines").

reconfiguration and relocation costs. However, as an enticement to collaborate and participate in the process, eligible satellite operators that join the C-Band Alliance will receive compensation for their prior investment and opportunity costs (in addition to compensation for their reconfiguration and relocation costs) based on objective and verifiable measures, such as their 2017 CONUS C-band satellite service revenues. The formation of the C-Band Alliance reflects the effectiveness of this incentive. Importantly, the Market-Based Approach calls for the FCC to, by rule, remove primary status protection from any satellite services in the cleared frequencies (including guard band frequencies). Thus, neither satellite operators that are eligible to join the C-Band Alliance but elect not to nor those ineligible to join because they do not operate satellites capable of serving CONUS can act as holdouts. To the extent these satellite operators wish to operate in the spectrum cleared by the C-Band Alliance, they would do so at their own risk, and their services would not be protected from interference due to terrestrial mobile operations in that spectrum.

Finally, the Market-Based Approach mitigates against the inflationary effect of reduced spectrum capacity on downstream service prices by declining to impose a minimum spectrum-clearing target on incumbent participants. Instead, the C-Band Alliance will designate the amount of spectrum to be voluntarily cleared based upon whether the compensation available from mobile service providers is sufficient to repack the remaining C-band satellite spectrum in a manner that ensures continued service and availability for existing and anticipated users of C-band satellite services. More importantly, the C-Band Alliance members will build and launch new satellites to maintain the same level of supply as currently planned absent clearing. Additionally, to address this customer concern, C-Band Alliance members have already engaged

with all of their major customers to propose long term contracts reflecting the current competitive commercial environment.

V. THE COMMISSION HAS THE AUTHORITY TO ADOPT THE MARKET-BASED APPROACH.

The Market-Based Approach complies with applicable laws and, as such, the Commission faces no legal impediments to its adoption. Specifically, the Market-Based Approach conforms to the Commission's statutory authority pursuant to Section 309(j) of the Communications Act,[60] raises no antitrust concerns, and satisfies the requirements of the MOBILE NOW Act[61] and the ORBIT Act,[62] as described below.

A. The Market-Based Approach Is Consistent with Section 309(j).

Adopting the Market-Based Approach is consistent with the Commission's authority pursuant to Section 309(j) of the Act. First, the Market-Based Approach will not result in mutually exclusive applications and therefore will not trigger any obligation to employ an auction under Section 309(j)(1), which requires the Commission to use a competitive bidding system to allocate mutually exclusive licenses.[63] Indeed, it is fully consistent with Section 309(j)(1) for the Commission to require parties wishing to apply for a license in this

[60] 47 U.S.C. § 309(j).

[61] Consolidated Appropriations Act, 2018, Pub. L. No. 115-141, Division P, Title VI of the Repack Airwaves Yielding Better Access for Users of Modern Services Act ("RAY BAUM'S Act"). Title VI of the RAY BAUM'S Act is the Making Opportunities for Broadband Investment and Limiting Excessive and Needless Obstacles to Wireless Act or MOBILE NOW Act ("MOBILE NOW Act").

[62] Open-Market Reorganization for the Betterment of International Telecommunications Act, Pub. L. No. 106-180 (2000) ("ORBIT Act").

[63] *See* 47 U.S.C. § 309(j)(1). Applications are "mutually exclusive" if the grant of one application would effectively preclude the grant of one or more of the other applications. *See, e.g., Implementation of Sections 309(j) and 337 of the Communications Act of 1934 as Amended*, Memorandum Opinion and Order, 17 FCC Rcd 7553 ¶ 4 (2002).

band to have entered into negotiated SMAs with the C-Band Alliance as a prerequisite to accepting their license application.[64]

Under the Market-Based Approach, the C-Band Alliance will negotiate SMAs with prospective terrestrial mobile service providers and, for obvious reasons, it will not enter into an SMA with more than one terrestrial operator for a specific spectrum block in a given market area. Upon reaching an agreement, a terrestrial operator will apply to the Commission for a license in the agreed-upon market area and spectrum block. The Commission is correct that, because this agreement will be a prerequisite to applying for a license for the provision of terrestrial mobile service, the Market-Based Approach will not result in mutually exclusive applications.[65] Accordingly, the Market-Based Approach comports with Section 309(j)(1).

Second, the Market-Based Approach will satisfy the Commission's obligation in the public interest to use negotiation and threshold qualifications to avoid mutual exclusivity pursuant to Section 309(j)(6)(E).[66] Section 309(j)(6)(E) confirms Congress's intent that the Commission continue to employ a variety of tools at its disposal "in order to avoid mutual exclusivity in application and licensing proceedings" if it is in the public interest to do so.[67]

[64] *See* 47 U.S.C. § 309(j)(1) ("If, consistent with the obligations described in paragraph (6)(E), mutually exclusive applications are *accepted* for any initial license or construction permit, then, except as provided in paragraph (2), the Commission shall grant the license or permit to a qualified applicant through a system of competitive bidding that meets the requirements of this subsection.") (emphasis added); *Improving Public Safety Communications in the 800 MHz Band,* Report and Order, 19 FCC Rcd 14969 ¶ 72 n.236 (2004) ("*Nextel Swap Order*"); *id.* ¶ 74.

[65] *NPRM* ¶ 84.

[66] *See* 47 U.S.C. § 309(j)(6)(E) (the competitive bidding authority granted the Commission should not be construed to relieve the Commission of the obligation in the public interest to continue to use means such as threshold qualifications or negotiations to avoid mutual exclusivity in application and licensing proceedings); *see also NPRM* ¶ 84.

[67] *See* 47 U.S.C. § 309(j)(6)(E).

Providing terrestrial wireless operators rapid access to mid-band spectrum and protecting important incumbent operations serves the public interest.

Further, in implementing Section 309(j)(6)(E), the Commission has confirmed that it has broad discretion to "determine the licensing approach that is most appropriate for the services being offered, taking into account the dominant use of the spectrum, administrative efficiency and other related licensing issues."[68] As detailed herein, the Market-Based Approach best accomplishes these public interest benefits, including the rapid deployment of 5G technologies and services, and will maximize the public utility of the C-band Downlink.

Commission precedent supports the agency's authority to use various means to avoid mutual exclusivity. For instance, in the Nextel Swap proceeding, the Commission concluded that the provisions of Section 309(j) allowed the Commission to further the public interest "by adopting a band restructuring approach that avoids mutual exclusivity."[69] Likewise, because the

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[68] *See Amendment of the Commission's Rules Regarding Multiple Address Systems*, Report and Order, 15 FCC Rcd 11956 ¶ 12 (2000) (*citing DirecTV, Inc. v. FCC*, 110 F.3d 816, 828 (D.C. Cir. 1997)).

[69] *Nextel Swap Order* ¶ 73. Although that proceeding involved license modifications instead of initial license grants, the Commission noted that "as an alternative licensing approach toward the same end," it could have granted rights to the ten megahertz of spectrum to Nextel as an initial license without the need for competitive bidding procedures. *Id.* ¶ 74. As the Commission explained, the competitive auction requirement of Section 309(j)(1) would not have been triggered regardless because eligibility for the 1.9 GHz spectrum would have to be limited to Nextel in order for the restructuring plan to satisfactorily address the public interest imperatives that the Commission identified. *Id.* The Commission similarly concluded that integrating ancillary terrestrial component ("ATC") authority into existing mobile satellite service ("MSS") systems served the public interest and, therefore, did not require it to use a competitive bidding system to allocate mutually exclusive licenses. *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands*, Report and Order and Notice of Proposed Rulemaking, 18 FCC Rcd 1962 ¶¶ 220-21 (2003). The Commission recently reaffirmed its decision to modify the 2 GHz band MSS licenses, noting its "broad authority under the Communications Act to 'consider the public interest in deciding whether to forgo an auction.'" *Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands,* Order on Reconsideration, WT Docket Nos.

Market-Based Approach serves the public interest, the Commission should use negotiation and threshold qualifications (and other means as needed) to facilitate the Market-Based Approach and avoid mutual exclusivity in application and licensing proceedings, consistent with the Commission's statutory obligations.[70]

B. The Market-Based Approach Fully Complies with Antitrust Law.

The *NPRM* asks "whether a market-based approach that allows FSS licensees to coordinate their capacity would raise any antitrust concerns."[71] It would not. The Market-Based Approach has been carefully crafted to comply with antitrust law, including the Collaboration Guidelines issued by the FTC and the DOJ.[72] Indeed, the Market-Based Approach produces procompetitive consumer benefits while avoiding any potential anticompetitive effects.

Competitor collaborations often coalesce into an integrated economic venture, such as a consortium or joint venture.[73] Agencies and courts have long recognized that such agreements often are not only benign but procompetitive.[74] Specifically, the FTC and DOJ recognize that:

> [C]ompetitor collaboration may enable participants to offer goods or services that are cheaper, more valuable to consumers, or brought to market faster than would be possible absent the collaboration. A collaboration may allow its participants to better use existing assets, or may provide incentives for them to make output-enhancing investments that would not occur absent the collaboration. The potential efficiencies from competitor collaborations may be achieved through a variety of contractual arrangements including joint

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12-70 and 04-356, ET Docket No. 10-142, FCC 18-121 ¶ 18 (rel. Aug. 16, 2018) (quoting *M2Z Networks, Inc. v. FCC*, 558 F.3d 554, 563 (D.C. Cir. 2009)).

[70] 47 U.S.C. § 309(j)(6)(E).

[71] *NPRM* ¶ 67.

[72] *See supra* note 59.

[73] *See, e.g.,* Collaboration Guidelines at 6.

[74] *Id*.

> ventures, trade or professional associations, licensing arrangements, or strategic alliances.[75]

Collaboration has other benefits as well, as "[p]articipants in an efficiency-enhancing integration typically combine, by contract or otherwise, significant capital, technology, or other complementary assets to achieve procompetitive benefits that the participants could not achieve separately."[76] Indeed, even as competitor collaborations have become more commonplace in the last two decades, the federal antitrust agencies have brought relatively few civil cases challenging such collaborations.[77]

The essence of the antitrust inquiry into competitor collaborations is the likely effect on competition and consumer welfare.[78] Certain agreements, such as agreements to fix prices or rig bids, are considered *per se* illegal because they are viewed as almost always raising prices or reducing output without offsetting procompetitive justification.[79] The Market-Based Approach does not involve any such prohibited activity and, as a result, is not *per se* illegal.

Agreements that are not *per se* illegal are analyzed under the "rule of reason."[80] This is a fact-intensive inquiry that balances anticompetitive effects against procompetitive benefits, and the burden is on the party challenging the restraint to show anticompetitive effects.[81] If any such effects are found, then the agencies consider whether the agreement is reasonably necessary to

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[75] *Id.*

[76] *Id.* at 8.

[77] *Id*.

[78] *See id*. at 4.

[79] *Id*. at 3.

[80] *Id*. at 4.

[81] *See id*. at 4; Herbert J. Hovenkamp, *The Rule of Reason*, 70 Fla. L. Rev. 81, 103-04 (2018).

achieve offsetting procompetitive benefits.[82] Because the Market-Based Approach was designed to maximize the procompetitive effects of collaboration while eliminating any potential anticompetitive harms, it easily withstands scrutiny under this standard.

1. *The Market-Based Approach Will Yield Procompetitive Benefits that Could Not Otherwise Be Attained.*

The Market-Based Approach allows participating incumbents to combine assets "to achieve procompetitive benefits that the participants could not achieve separately."[83] Indeed, as these comments demonstrate, the Market-Based Approach is the only mechanism to quickly and efficiently bring spectrum in the C-band Downlink to market to address gaps in broadband connectivity[84] and cement American leadership on 5G technology and services.[85]

The Market-Based Approach's framework makes it unnecessary for mobile operators to enter into separate SMAs with each FSS operator. This alternative would produce substantially higher transaction costs and could result in holdouts, to the detriment of the public.[86] The Market-Based Approach also avoids a top-down, forced reallocation that is likely to lead to costly, protracted disputes and other delays, as well as the many serious drawbacks of the other methods of clearing the C-band proposed in this proceeding.[87]

2. *The Market-Based Approach Is Designed to Avoid Potential Antitrust Concerns.*

In addition to achieving the procompetitive benefits of integration, the Market-Based

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[82] *See* Collaboration Guidelines at 4.

[83] *Id.* at 8.

[84] *NPRM* ¶ 3.

[85] *Id.* ¶ 68.

[86] *See, e.g., id.* ¶ 61.

[87] *See infra* Section VII.

Approach is designed to eliminate potential anticompetitive harms. The C-Band Alliance is open to all C-band satellite operators that provide service to all or a portion of CONUS.[88] A member's interest in the C-Band Alliance is based on an equitable predetermined metric that reflects the U.S. C-band operations of each member.[89] In addition, numerous contractual safeguards will prevent the exchange of competitively sensitive information. For example, such information will be managed by an independent auditor and not allowed to be shared between or among members.

The Market-Based Approach will also avoid anticompetitive harm by preserving competition in the FSS industry. The Commission has repeatedly recognized that competition is vibrant in this industry.[90] The Market-Based Approach would not change this dynamic. FSS operators would retain their existing spectrum rights and remain vigorous competitors for customers in the remaining portion of the band.

3. *The Availability of Other Spectrum Suitable for Terrestrial 5G Will Ensure Competitive Pricing.*

The availability of other spectrum suitable for terrestrial use, in particular for terrestrial 5G service, will exert downward pricing pressure and prevent the C-Band Alliance from exercising monopoly pricing power. The C-band Downlink is only one of several substitutable mid-band spectrum segments being considered for terrestrial mobile operations. Therefore, the formation of the C-Band Alliance will not affect the price of this spectrum.

Through its 5G FAST Plan and other initiatives, the FCC and the National Telecommunications and Information Administration ("NTIA") have identified several hundred

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[88] *See Ex Parte* Letter of SES Americom, Inc., GN Docket No. 17-183, at 3 (filed Feb. 21, 2018).

[89] *See id*.

[90] *See, e.g., NPRM* ¶ 63 (explaining that FSS operators currently compete to provide communications services and highlighting evidence that "earth stations can and do switch providers").

megahertz of additional mid-band spectrum—other than the C-band Downlink—for terrestrial mobile operations in the U.S.[91]

- 3550-3700 MHz: The Commission has also already approved service rules for the adjacent CBRS spectrum in the 3550-3700 MHz band.[92]

- 2.5 GHz: The Commission recently initiated a proceeding to intensify use of the 2.5 GHz band, stating that it "constitutes the single largest band of contiguous spectrum below 3 gigahertz and has been identified as prime spectrum for next generation mobile operations, including 5G uses."[93] Sprint is the largest holder of Broadband Radio Service licenses and the largest spectrum lessee of Educational Broadband Service in the United States, which "now serves as the backbone of Sprint's tri-band 3G/4GLTE network."[94]

- 3100-3550 MHz: Under Section 605(a) of the MOBILE NOW Act, Congress required the NTIA to provide a report to the Commission on the feasibility of allowing commercial wireless services between 3100 and 3550 MHz.[95] NTIA has already identified the 3450-3550 MHz band for potential repurposing for terrestrial mobile operations[96] and previously recognized the potential for

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[91] *See FCC's 5G FAST Plan.* The international telecommunications standards association 3GPP has identified 1899 megahertz of downlink spectrum for 5G use. *See* Hu Wang, Remarks at the 4th Annual Asia Pacific Spectrum Management Conference, Bangkok, Thailand: Spectrum for 5G Development – Manufacturers' View (July 2018) ("Spectrum for 5G Development – Manufacturers' View").

[92] *See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959 ¶ 387 (2015) (explaining that incorporating 3650-3700 MHz into the newly created CBRS Band would create a 150 MHz block of contiguous spectrum from 3550 MHz to 3700 MHz) ("*CBRS R&O*").

[93] *Amendments of Parts 1, 21, 73, 74, and 101 of the Commission's Rules to Facilitate the Provision of Fixed and Mobile Broadband Access, Educational and Other Advanced Services in the 2150-2162 and 2500-2690 MHz Bands; Transforming the 2.5 GHz Band*, Notice of Proposed Rulemaking, WT Docket Nos. 03-66 and 18-120, FCC 18-59 ¶ 1 (rel. May 10, 2018) ("*2.5 GHz NPRM*"). The Commission also observed that "[s]ignificant portions of this band . . . currently lie fallow across approximately one-half of the United States." *Id*.

[94] Comments of Sprint Corp., WT Docket No. 18-120, at 2 (filed Aug. 8, 2018).

[95] MOBILE NOW Act § 605.

[96] David J. Redl, *NTIA Identifies 3450-3550 MHz for Study as Potential Band for Wireless Broadband Use*, NTIA Blog (Feb. 26, 2018) *available at* https://www.ntia.doc.gov/blog/2018/ntia-identifies-3450-3550-mhz-study-potential-band-wireless-broadband-use.

spectrum sharing in the 3100-3550 MHz band for mobile broadband use.[97]

- 4.9 GHz: The 4.9 GHz band has also been identified as a potential option for commercial wireless deployment.[98]

Moreover, mid-band spectrum is only one portion of a typical carrier's spectrum portfolio. The Commission's latest *Mobile Wireless Competition Report* makes clear that there is no one-size-fits-all spectrum strategy for 5G deployment, "with more carrier aggregations across different types of spectrum."[99] Soon, the Commission will bring several millimeter wave bands to auction.[100] Additional low-band spectrum can be acquired through secondary market transactions. The availability of these alternatives will assist in further disciplining spectrum prices for mid-band spectrum, including the C-band Downlink.[101]

C. The Market-Based Approach Satisfies the Requirements of the MOBILE NOW Act and Is Consistent with the ORBIT Act.

The Commission seeks comment on whether the Market-Based Approach will satisfy the

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[97] U.S. Dep't of Commerce, *Quantitative Assessments of Spectrum Usage* at 9, Table 7.6 (Nov. 2016) *available at* https://www.ntia.doc.gov/files/ntia/publications/ntia_quant_assessment_report-no_appendices.pdf.

[98] *Amendment of Part 90 of the Commission's Rules*, Sixth Further Notice of Proposed Rulemaking, WT Docket No. 07-100, FCC 18-33 ¶ 80 (rel. Mar. 23, 2018) ("*4.9 GHz Sixth FNPRM*").

[99] *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services*, Twentieth Report, 32 FCC Rcd 8968 ¶ 86 (2017).

[100] *See Auctions of Upper Microwave Flexible Use Licenses for Next-Generation Wireless Services; Notice and Filing Requirements, Minimum Opening Bids, Upfront Payments, and Other Procedures for Auctions 101 (28 GHz) and 102 (24 GHz)*, Public Notice, AU Docket No. 18-85, FCC 18-109 (rel. Aug. 3, 2018); *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, Fourth Further Notice of Proposed Rulemaking, GN Docket No. 14-177, FCC 18-110 (rel. Aug. 3, 2018).

[101] 3GPP has identified several gigahertz of additional low- and high-band spectrum for 5G use. *See* Spectrum for 5G Development – Manufacturers' View.

MOBILE NOW Act's mandate that the Commission work with NTIA to identify 255 megahertz of spectrum for mobile and fixed wireless broadband use,[102] including at least 100 MHz of spectrum "for use on an exclusive, licensed basis for commercial mobile use, pursuant to the Commission's authority to implement such licensing in a flexible manner."[103] The Market-Based Approach will accomplish exactly that. Although the MOBILE NOW Act sets forth a number of exceptions, none are applicable here.[104]

Finally, the Commission seeks comment on the potential applicability of Section 647 of the ORBIT Act, which prohibits assigning by "competitive bidding orbital locations or spectrum used for the provision of international or global satellite communications services."[105] As a threshold matter, the ORBIT Act's prohibition only applies where the Commission offers up spectrum by competitive bidding. Under the Market-Based Approach, the C-Band Alliance, not the Commission, would negotiate with interested parties for the rights to clear spectrum for terrestrial 5G. The *NPRM*'s alternative mechanisms based on FCC competitive bidding, however, could be subject to potential legal challenges under Section 647. Indeed, one benefit of the Market-Based Approach is that it avoids any potential legal challenges under the ORBIT Act.

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[102] *NPRM* ¶ 53.

[103] *See id.* ¶ 7; MOBILE NOW Act § 603(a)(2)(B).

[104] Aside from the exception for spectrum with more than *de minimis* mobile or fixed broadband operations, Section 603(a)(3) of the MOBILE NOW Act explicitly excludes the 1695-1710 MHz, 1755-1780 MHz, 2155-2180 MHz, and 3550-3700 MHz bands from spectrum eligible to be included among the 255 megahertz identified for mobile and fixed broadband use.

[105] *NPRM* ¶ 109; *see also* 47 U.S.C. § 765f ("[T]he Commission shall not have the authority to assign by competitive bidding orbital locations or spectrum used for the provision of international or global satellite communications services[.]").

VI. THE BAC'S PROPOSAL TO ADD INCOMPATIBLE P2MP OPERATIONS AND RESTRICT FSS FLEXIBILITY WOULD FORECLOSE 5G USE OF THE C-BAND DOWNLINK AND DISRUPT CRITICAL SATELLITE SERVICES.

The BAC Proposal to permit P2MP operations in the C-band Downlink and the burdens that would be imposed on FSS networks to accommodate such new systems are directly at odds with the Commission's explicit policy goals and will harm consumers. FSS operators need maximum leeway to implement the massive clearing effort necessary to make spectrum available for terrestrial 5G networks. Freezing their operations and requiring them to work around new P2MP links in C-band Downlink frequencies would stymie these efforts and contravene the public interest. Moreover, depriving incumbent FSS users of essential full-band, full-arc flexibility in order to benefit P2MP systems would fundamentally undermine the quality and reliability of FSS content delivery that supplies video and audio programming enjoyed by more than 100 million households in every corner of the United States. Meanwhile, the need for significant separation distances around ubiquitously-deployed receive earth stations would prevent any material use of the C-band Downlink for new fixed broadband networks. Any legitimate requirement for additional spectrum for P2MP services, which are less dependent on specific bands with particular propagation features, can be met by focusing on alternate bands rather than the heavily used C-band Downlink.

By preserving its existing FSS licensing policies, including full-band, full-arc authorization of earth stations, the Commission can continue to support vibrant competition for FSS services and avoid imposing unnecessary application filing and information reporting requirements that would bury earth station operators and Commission staff alike in a deluge of costly paperwork. A wide range of businesses and government agencies rely on the broad coverage and unmatched performance of C-band FSS today and will continue to do so into the

foreseeable future, and Commission regulation must provide the tools necessary for efficient management of FSS networks in order to allow this vibrant business sector to continue to evolve.

With the Market-Based Approach that carefully balances the requirements of new terrestrial 5G systems and critical incumbent FSS operations, the Commission can achieve a true win-win outcome for U.S. consumers. Attempting to introduce a new P2MP service, which is inherently incompatible with both of these uses and can more readily be accommodated in other spectrum, would impede mid-band 5G deployment and harm consumers.

A. The Costs of Introducing P2MP Operations Greatly Outweigh Any Prospective Benefits in the C-band Downlink.

The BAC Proposal seeking access to the C-band Downlink for P2MP services fails the most basic cost-benefit analysis. Achieving the goals of this proceeding requires scrupulous management of the valuable C-band Downlink spectrum. Now is the worst possible time to complicate matters by opening that spectrum up to a new, conflicting P2MP service, especially given the absence of evidence of P2MP demand or that P2MP services would be feasible on any meaningful scale.

1. *Introducing P2MP Services and Eliminating Full-Band, Full-Arc Flexibility Would Block FSS Operators' Ability to Clear Spectrum for 5G.*

Most significantly, the proposals in the *NPRM* to revise earth station coordination rules to limit FSS use of available C-band spectrum[106] and authorize P2MP services[107] would frustrate the Commission's 5G policy objectives. The Commission has recognized that co-channel sharing between terrestrial mobile service and existing FSS use of the C-band Downlink is not

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[106] *NPRM* ¶¶ 37-40.

[107] *Id.* ¶¶ 116-132.

feasible.[108] Thus, to make spectrum available for terrestrial 5G in the lower portion of the C-band Downlink frequencies, FSS operators must shift their customers to a more limited amount of spectrum at the upper end of the band. To do so, FSS operators must have free rein to reallocate transponders and frequency channels among satellite users.

Restricting full-band, full-arc protection of FSS earth stations and allowing P2MP deployments would effectively render this process impossible. The *NPRM* observes that the full-band, full-arc policy provides important flexibility for FSS operations,[109] but it fails to recognize that the ability to reassign FSS customers to other satellites and frequencies is a necessary tool to clear part of the band to make spectrum available for terrestrial 5G. Nor does the *NPRM* acknowledge that permitting new P2MP deployments—even on a secondary basis vis-à-vis FSS[110]—would unacceptably handcuff FSS operators' efforts to accommodate existing customers in a more limited range of spectrum. Transitioning a nationwide programming package received by hundreds or thousands of users to different frequencies, potentially on a different satellite, is already an immense task that should not be complicated further.

The Commission must keep its eyes on the prize, focusing its efforts on establishing a framework that will propel U.S. 5G deployment while preserving the existing satellite services that support critical industries. Proposals to remove full-band, full-arc protection and introduce P2MP systems are contrary to these goals, as they would thwart the FSS community's ability to efficiently and expeditiously clear spectrum for flexible use terrestrial operations and harm consumers of incumbent satellite services.

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[108] *Id.* ¶ 52. *See supra* Section II.B.

[109] *Id.* ¶ 40.

[110] The *NPRM* suggests that for some undefined transition period, P2MP use of the C-band would be secondary to FSS but thereafter would be co-primary. *See id.* ¶ 116.

2. *Continued FSS Flexibility is Required to Preserve Critical Satellite Services that Provide Substantial Economic Benefits.*

Limiting FSS operations to pave the way for P2MP services would needlessly stifle the flexibility to switch satellites or transponders that is a critical element of the value proposition for nationwide C-band content delivery. The Commission's current policy of full-band, full-arc protection of C-band receive earth stations allows programming providers to safeguard the lifeblood of their businesses—the ability to offer uninterrupted distribution of their product. The record already before the Commission offers myriad examples of the public interest benefits of the policy, and just a few are highlighted here.

To ensure service continuity, users must be able to change satellites or transponders immediately in the event of an outage affecting their primary source of space segment.[111] To guarantee the seamless restoration of capacity in such circumstances, many content providers have purchased protected service, meaning that the satellite operator is contractually obligated to assign replacement transponders following an outage. Under the current framework, a programming provider can safely assume that its customers can simply reorient their antennas and/or tune to a different channel as needed to continue receiving the programming over the replacement satellite capacity. But terminating full-band, full-arc protection and permitting new P2MP services would leave earth stations vulnerable to harmful interference if they change

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[111] *See, e.g.*, Comments of General Communication, Inc., RM-11791, at 10 (filed Aug. 7, 2017) ("GCI BAC Petition Comments") (To provide critical services to the state of Alaska, GCI "relies on the flexibility afforded by the FCC's rules to efficiently shift frequencies and satellites in the event of a transponder or satellite failure."); *Ex Parte* Letter of the Public Broadcasting Service, RM-11778, at 1 (filed Jan. 24, 2017) (PBS relies on the flexible nature of the existing regulatory framework "to execute its redundancy and disaster recovery plans in the event that its current satellite and transponder become inoperable."); Comments of EchoStar Satellite Operating Corporation and Hughes Network Systems, LLC, RM-11778, at 2 (filed Jan. 9, 2017) (Regulatory flexibility "enables satellite operators to respond quickly to changes in space segment configurations and transponder or other equipment failures.").

frequencies or antenna pointing. That result would deprive customers who have purchased protected service of the economic benefits of their contracts.

Switching transponders or satellites is also frequently necessary to address interference issues that may arise from the specific operational characteristics of individual satellite carriers.[112] When an interference problem is identified, resolving it may require a thorough review of the traffic on corresponding transponders of the adjacent satellites to determine how that traffic might be rearranged to ensure compatibility with adjacent satellite operations. A satellite operator's ability to provide high-quality service to its customers depends on the flexibility to reassign capacity as needed to manage interference in these instances.

In addition, the flexibility to change satellites is needed to allow FSS customers to benefit from competition among satellite operators.[113] Unless its customers can reorient their antennas to a different satellite, a content provider is effectively locked into its current space segment. Commission rules allow any of the dozens of C-band satellites included on the "Approved Space Station List"[114] to communicate with any U.S. earth station, ensuring that customers have access to the broadest possible range of service options. Removing full-band, full-arc protection to accommodate new P2MP operations would harm competition by significantly impeding users' ability to change satellite providers to obtain more favorable terms and conditions.

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[112] *See, e.g.*, Reply Comments of Speedcast Communications, Inc., RM-11791, at 6 (filed Aug. 22, 2017) ("[S]atellite operators rely on the ability to shift customer traffic among transponders and satellites to optimize network loading and resolve interference[.]").

[113] *See, e.g.*, GCI BAC Petition Comments at 10 (The flexibility to change satellites and frequencies allows GCI to take advantage of market competition, "resulting in capacity cost reductions."); Comments of the National Association of Broadcasters, RM-11778, at 1-2 (filed Jan. 24, 2017) (the ability to shift to different satellites promotes competition among satellite operators).

[114] *See Approved Space Station List*, FCC, *available at* https://www.fcc.gov/approved-space-station-list (last visited Oct. 10, 2018).

Flexibility to access the full C-band Downlink is also essential for live coverage of breaking news, sporting events, and entertainment programming. For example, PSSI Global Services has explained that it uses a fleet of C-band transportable trucks to carry a broad range of live programming, such as National Football League games (including the Super Bowl), NASCAR races, golf tournaments, NCAA football and basketball games, and the Academy Awards.[115] In most cases, PSSI does not know the venue where its services will be required until a few days before the event.[116] Accordingly, PSSI and other providers of short-term video transmission and reception services rely on the unfettered ability to access the full C-band Downlink spectrum and point to satellites across the arc, without the need to work around new P2MP deployments.

In each of the above scenarios, the flexibility conferred by current policies will be even more critical once FSS operations have been concentrated into a more limited segment of the C-band Downlink. Denser use of the available C-band Downlink spectrum will magnify the effects of any satellite or transponder outage, increase the likelihood that interference issues will arise, and constrain the capacity available to meet growing customer requirements and cover live events. In short, the Commission's commitment to protect incumbent FSS operations while making new spectrum available for terrestrial 5G requires retaining FSS full-band, full-arc flexibility without the constraints that would be imposed by new P2MP systems.

3. *Ample Alternative Spectrum Is Available to Expand Fixed Wireless Broadband Services to Rural and Unserved Areas.*

Compromising the primary objectives of this proceeding to allow for new fixed P2MP

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[115] *See* Reply of PSSI Global Services, LLC, RM-11778, at 2 (filed Jan. 12, 2017).

[116] *Id.*

operations is completely unnecessary given myriad other bands in which P2MP could be provided to meet any demonstrated need for more spectrum. Wireless internet service providers ("WISPs") "employ a variety of licensed and unlicensed spectrum to deliver their services" today,[117] including the 500-700 MHz, 900 MHz, 2.4 GHz, 2.5 GHz, 3.65 GHz, 5 GHz, 28 GHz, 39 GHz, and above 40 GHz bands.[118] WISPs have not shown that additional spectrum is needed to expand fixed broadband to currently unserved areas—instead, spectrum is likely to be plentiful in communities which lack wireless broadband operations.[119] Regardless, any legitimate requirement for more spectrum for P2MP networks can be met using bands that are either currently available for fixed wireless broadband services or are being considered for such operations.

One example is the 3.55-3.7 GHz band. WISPs already are heavy incumbent users of the 3.65 GHz frequencies.[120] Once the CBRS regulatory framework adopted by the Commission in

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[117] *See* The Carmel Group, *Ready for Takeoff: Broadband Wireless Access Providers Prepare to Soar with Fixed Wireless*, The BWA Industry Report: 2017, at 7 (2017), *available at* http://www.wispa.org/Portals/37/Docs/Press%20Releases/2017/TCG's_2017_BWA_FINAL_REPORT.pdf.

[118] *Id.* at 13.

[119] *See, e.g.*, Opposition of the Satellite Industry Association, RM-11791, at 15 (filed Aug. 7, 2017) (noting that spectrum congestion "cannot possibly present an obstacle to terrestrial network expansion in areas where terrestrial wireless broadband service is not being provided. Instead, other factors, such as high build-out costs, must play a significant role in deterring new deployment of terrestrial wireless broadband facilities in those areas. Accordingly, there is no reason to expect that designating additional spectrum for terrestrial fixed P2MP services will have any impact on bridging the digital divide.").

[120] *See Realizing the Benefits of Rural Broadband: Challenges and Solutions*, Hearing Before the Subcommittee on Communications and Technology, of the House Committee on Energy and Commerce, 115th Cong. (2018) (written testimony of Claude Aiken, President/CEO, Wireless Internet Service Providers Association), *available at* https://democrats-energycommerce.house.gov/sites/democrats.energycommerce.house.gov/files/documents/Testimony-Aiken-Hrg-on-Realizing-the-Benefits-of-Rural-Broadband-2018-07-17.pdf ("Aiken Testimony").

2015 is fully implemented, WISPs will have access to the remainder of the 3.55-3.7 GHz frequencies by bidding for Priority Access Licenses and/or operating opportunistically under the licensed-by-rule General Authorized Access category.[121]

WISPs are also actively seeking rule changes that would allow them to use the 4.9 GHz band currently reserved solely for public safety uses.[122] Moreover, a number of WISPs currently lease spectrum in the 2.5 GHz Educational Broadband Service ("EBS") band, and WISPs are pursuing expansion of their ability to use EBS frequencies.[123]

Each of these bands would provide a more favorable sharing environment for P2MP than the C-band Downlink. The *NPRM* expressly highlights the fact that the small number of active FSS earth stations in the 3.6-3.7 GHz frequency range makes shared use of that band by commercial wireless operations much more feasible than in the conventional C-band, which is home to tens of thousands of earth stations.[124] The Commission has observed that no more than 3.5% of eligible public service entities are making use of the 4.9 GHz band[125] and that significant portions of the available EBS spectrum "currently lie fallow across approximately one-half of the United States, primarily in rural areas."[126]

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[121] *See generally CBRS R&O*.

[122] Comments of the Wireless Internet Service Providers Association, WP Docket No. 07-100 (filed July 6, 2018).

[123] Comments of the Wireless Internet Service Providers Association, WT Docket No. 18-120 (filed Aug. 8, 2018).

[124] *NPRM* ¶ 52 (establishing CBRS in the 3.55-3.7 GHz band "despite the presence of FSS receivers because there are only FSS earth stations in 35 cities and two MSS gateways in the 3600-3700 MHz band").

[125] *4.9 GHz Sixth FNPRM* ¶ 1.

[126] *2.5 GHz NPRM* ¶ 1.

Thus, other spectrum bands would allow WISPs or other proponents of P2MP operations to add to the existing spectrum available for those services without the requirement to work around tens of thousands of incumbent FSS earth stations and without imperiling the Commission's ability to clear spectrum for terrestrial 5G. The Commission should focus its attention on these more promising alternatives and abandon the idea of attempting to introduce P2MP in the C-band Downlink.

4. *Technical Barriers Will Prevent Material Deployment of P2MP Systems.*

The C-Band Alliance's technical analysis confirms that, in contrast to these other potential spectrum bands, the usage characteristics of the C-band Downlink make the band poorly suited for P2MP networks. Specifically, as discussed in Section V of the attached Technical Annex, the need for significant exclusion zones to protect ubiquitous FSS earth stations with highly sensitive receivers will preclude introduction of P2MP operations on any significant scale in the C-band Downlink.

While conceding the need for substantial exclusion zones, the BAC's strategy has been to assert that the number of active C-band receive earth stations requiring protection is relatively small, ignoring all evidence to the contrary. The BAC's predicted deployment areas consider only earth stations that had been licensed or registered in IBFS under longstanding Commission policies that did not require registration of receive earth stations.[127] The thousands of new registrations for C-band receive earth stations that have been submitted in the past several months and that continue to be submitted have conclusively discredited the BAC's assumptions regarding paltry FSS use. As of October 26, 2018, approximately 16,500 C-band Downlink

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[127] *See Ex Parte* Letter of the Broadband Access Coalition and Google LLC, GN Docket No. 17-183 and RM-11791, Attachment 1 at 8-10, Attachment 2 at 14, 25 (filed Mar. 29, 2018) ("BAC/Google *Ex Parte*").

antennas have been filed with, registered, or licensed by the Commission.[128] Thus, the BAC's claims that the need to protect active FSS earth stations would not substantially constrain possible P2MP deployment have always been based on fantasy, not reality.

Critically, this existing antenna base includes thousands of cable head-ends that require access to the full range of C-band Downlink spectrum. The American Cable Association has advised the Commission that its members operate roughly 3,000 C-band receive earth stations,[129] and thousands more C-band antennas are used by NCTA members.[130] These cable head-ends use all or virtually all of the 500 MHz of C-band Downlink spectrum available today.[131] Comcast, for example, receives the large majority of its programming by C-band Downlink satellites, comprising 6,600 distinct video services, 148 transponders, and 20 satellites.[132] P2MP networks will be wholly precluded from operating within the 50-plus kilometer exclusion zones surrounding these sites—there will be no unused channels suitable for P2MP use within these areas.

Even outside exclusion zones surrounding cable head-ends, realistic options for deploying P2MP networks will be extremely limited. In addition to one or more cable systems, most communities are served by multiple television and radio stations affiliated with various broadcast networks, and these services similarly rely on C-band content distribution. To protect

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[128] *See supra* note 33.

[129] Comments of the American Cable Association, GN Docket No. 17-183, at 4 n.6 (filed Oct. 2, 2017) ("ACA Comments").

[130] Comments of NCTA – The Internet & Television Association, GN Docket No. 17-183, at 3 (filed Oct. 2, 2017).

[131] *See Ex Parte* Letter of SES Americom, Inc. and Intelsat Corp., GN Docket No. 17-183, at 2 (filed Feb. 9, 2018) (discussing a small cable system with 15,000 customers that currently receives signals from 23 of 24 C-band transponders).

[132] *See* Comcast May 2018 *Ex Parte,* Attachment at 2.

all of these FSS earth stations, a prospective P2MP provider would need to identify a C-band channel that does not overlap with the frequencies used by any FSS customer within a radius of 50 kilometers or more and find a base station site sufficiently removed from any earth station to ensure that the out-of-band emissions from the P2MP system would not create harmful interference to FSS reception. The likelihood that a site selected after this process of elimination would happen to be in an area with sufficient demand for fixed wireless capacity to support a viable business case for P2MP deployment is very small.

In short, coupling the significant separation distances that the BAC has conceded will be necessary with updated information regarding the ubiquity of FSS receive earth stations produces the inescapable conclusion that P2MP systems cannot feasibly be deployed in the portion of the C-band Downlink band that will remain available to FSS following clearing of the lower part of the band. The facts flatly contradict the *NPRM*'s preliminary view that this intensely used spectrum can provide a meaningful opportunity for fixed wireless broadband given the Commission's primary objectives of clearing a portion of the C-band for flexible use and protecting incumbent FSS earth stations from harmful interference.[133]

5. *Eliminating Full-Band, Full-Arc Flexibility Would Create a Bureaucratic Nightmare.*

The *NPRM* also fails to grapple with the mountain of administrative red tape that would stem from the proposed elimination of the full-band, full-arc policy. Commission staff and FSS users alike would experience an exponential increase in the workload associated with managing earth station operations and the need to keep the IBFS database current.

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[133] *NPRM* ¶ 116.

The process sketched out in the *NPRM* would impose costly and time-consuming burdens on FSS users. First, in response to a "future information request," each of the approximately 16,500 C-band receive earth stations now in IBFS would be required to report the "frequencies, azimuths, and elevation angles and other parameters" that are in "regular use," a term defined as meaning "at least daily."[134] The earth station would thereafter be protected from interference only for services consistent with those specific operating details. Thus, for example, an earth station that pointed toward a specific satellite to receive routine, but not daily, content (*e.g.*, professional football or baseball games, which air frequently but not every day) would not be entitled to protection with respect to that programming.

To seek interference protection for services using a new or revised frequency segment or carried over a different satellite, the earth station operator would have to obtain a coordination report and prepare and file an application requesting modification of its earth station registration. The coordination report, which currently costs roughly $700, would be mandated even though the receive earth station is incapable of causing interference and regardless of whether there are any non-FSS operations in the vicinity. Each modification application would require payment of a $210 filing fee to the Commission. When the internal preparation costs are accounted for, this means that the financial outlay for an earth station operator would be about $1,000 every time any change was made to the frequencies or orientation of the station's antennas.

Such frequency changes are a regular occurrence for many C-band earth station operators, including cable head-ends. Affidavits filed in support of the American Cable Association's comments confirm that ACA members routinely are instructed to repoint their

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[134] *Id.* ¶ 39.

antennas in order to continue receiving content and that these notifications are sent with little advance warning, typically just a few weeks or even a few days.[135]

Currently, no regulatory action is needed to accommodate these shifts of programming from one satellite to another. If the Commission eliminates full-band, full-arc flexibility and protects only specific frequencies and pointing angles, however, it will face a landslide of new modification applications. Specifically, each time the satellite or frequency assignment for a given programming package changes, every one of the thousands of earth stations that receive that package nationwide would need to prepare and submit a modification application accompanied by a coordination report or lose its ability to rely on continuous, protected service. Moreover, because a few weeks' advance notice is insufficient to obtain a coordination report for an earth station change, under the procedures outlined in the *NPRM*, earth station operators would not even be able to confirm their ability to successfully operate with the new satellite prior to the change in programming delivery taking effect. To mitigate such issues, earth station operators would likely regularly request special temporary authority pending submission of and action on the modification application, increasing the administrative burden on operators and on Commission staff still further.

The adverse consequences of these massive new regulatory requirements would be far-reaching. The burdens would fall most heavily on small cable systems and broadcasters with a handful of personnel unfamiliar with the intricacies of azimuth angle calculations and gain

[135] *See* ACA Comments, Exhibit 1 at 2 (operator of a cable system that serves largely rural areas in the Nebraska panhandle and eastern Wyoming receives notifications from programmers regarding a need to repoint earth stations to new satellites "all the time, indicating that programming migrates often from one satellite to the other"); *id.*, Exhibit 2 at 2 (cable operator serving 14,000 customers in Jackson, Tennessee is "often asked by programmers to repoint [its] antennas to different satellites," and these notifications are typically received "a few weeks prior to the change").

patterns and which do not have funds available to expend on compliance with unprecedented FCC obligations. In many cases, operators may choose to forego the complexities of revising their authorizations to reflect changes in the satellites and frequencies on which they receive programming, placing them at risk of interference that would undermine their ability to provide continuous, high-quality service to their end users. Ultimately, U.S. consumers of video and audio programming in the smallest communities and rural areas will be most vulnerable to potential losses of reliable service because of these new administrative obligations.

B. Imposing Burdensome Information Requirements on Earth Station Operators Is Unnecessary.

The extensive information collection requirements discussed in the *NPRM*[136] are also unduly onerous and would serve no valid purpose. Mandating that operators of all approximately 16,500 C-band receive earth stations, most of which just completed or are completing the costly and time-consuming process to register for the first time, answer a laundry list of questions seeking detailed usage and technical parameters would inflict a punishing workload on earth station operators. Some of the proposed questions would require the earth station operator to provide registration information again, duplicating data already in IBFS. Other questions, however, seek highly specific information that many earth station operators simply cannot obtain.

For example, in seeking a waiver of the requirement to supply some elements of the data specified on the Form 312, Schedule B, the Corporation of the Presiding Bishop of the Church of Jesus Christ of Latter-day Saints explained that it was unable to supply the details of the antenna sizes, models, and gain characteristics or to provide site-specific elevation data for the 3,476

[136] *NPRM* ¶¶ 41-43.

individual churches that have C-band receive antennas deployed.[137] The *NPRM*'s proposal would add several more equally unanswerable questions to this list.

Not only is the information set forth in the *NPRM* difficult or impossible to assemble and submit, it is also quite transitory. In particular, clearing a portion of the C-band Downlink for terrestrial 5G will necessarily involve widespread changes in the satellites, transponders, and frequencies used by any given receive earth station, as traffic loading is rearranged to compress existing services into a narrower range of frequencies.

Nevertheless, the *NPRM* seems to contemplate that the information collection would occur prior to spectrum clearing on the grounds that the data would assist the Commission in its consideration of transition options.[138] If the Commission takes that approach, all the usage information it collects prior to spectrum clearing would immediately be rendered obsolete once the clearing process begins. Presumably, the Commission would then require earth station operators to provide the required information yet again to reflect the changes resulting from spectrum clearing, multiplying the oppressive administrative burdens associated with the *NPRM*'s proposals.

The C-Band Alliance's approach wholly avoids this type of aggressive and burdensome regulatory oversight of FSS operations by preserving full-band/full-arc protection (outside of cleared frequencies) and allowing market forces to drive spectrum reallocation and efficient use of available frequencies.

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[137] *See, e.g.*, Church of Jesus Christ of Latter-day Saints Attachment.

[138] *See, e.g.*, *NPRM* ¶ 42.

C. There Is No Justification for a Long-Term Freeze on FSS Facilities.

As discussed above, C-band FSS networks play a central role in the nation's telecommunications backbone, supporting a broad range of services enjoyed and relied on by U.S. consumers every day, both now and in the foreseeable future. The Commission should not arbitrarily limit the ability of the FSS ecosystem to grow and evolve in response to customer demands by making the current freezes on applications for new C-band earth stations and space stations permanent.[139]

To the contrary, permitting FSS networks to fully utilize the downlink spectrum that will remain available to them following clearing is the best way to promote efficient use of that spectrum and accommodate the natural development of the businesses that depend on the unique benefits of C-band satellite coverage and reliability. Indeed, the C-Band Alliance anticipates that new satellite capacity will be required to implement its plans to make spectrum available for terrestrial 5G services. This new satellite capacity will be essential to ensure that C-Band Alliance members can meet the ongoing requirements for C-band connectivity in a more limited amount of spectrum.

Adding ground facilities will often be necessary, as well. For example, shifting population distribution may lead to the addition of new cable systems or broadcast affiliates that will require access to the nationwide programming distributed over C-band satellites. Codifying the freeze on new earth stations would prevent U.S. video and audio content providers from extending their reach to new communities.

[139] *See NPRM* ¶ 30 (seeking comment on whether to codify the current temporary ban on new earth stations in the 3.7-4.2 GHz frequencies); *id.* ¶ 46 (proposing to bar the filing of new space station applications or requests for market access using C-band Downlink).

The rationale expressed in the *NPRM* does not support the need for prohibiting new space or earth stations in the upper portion of the band that will remain available for FSS once spectrum in the lower part of the band is cleared for terrestrial 5G operations. Specifically, there is no incentive for satellite operators to file "speculative applications for satellite usage of the band,"[140] as compensation to C-Band Alliance members will be based on their recent, already determinable, CONUS C-band revenues. Moreover, as discussed above, C-Band Alliance members plan to deploy new satellites in order to provide continued service to customers. Similarly, limiting new earth stations is unnecessary to "provide a stable spectral environment for more intensive terrestrial use."[141] Any new earth stations would operate only in spectrum still available for FSS and would therefore not constrain terrestrial use of the cleared spectrum.

VII. ALTERNATIVE PROPOSALS ARE INEFFICIENT, POSE LEGAL AND IMPLEMENTATION CHALLENGES, AND FAIL TO ACCOUNT FOR CURRENT FSS OPERATIONS IN THE C-BAND DOWNLINK.

The *NPRM* proposes several alternatives to the Market-Based Approach.[142] These alternative proposals lack detail but appear to require significant FCC resources and would fail to clear spectrum as quickly and efficiently as the Market-Based Approach.[143] Intelsat and SES, in their joint response with Intel, include a white paper from The Brattle Group (the "Brattle

[140] *Id.* ¶ 46.

[141] *Id.* ¶ 30.

[142] *See id.* ¶¶ 99-114.

[143] *See Ex Parte* Letter of Intelsat Corp., SES Americom, Inc., and Intel Corp., GN Docket Nos. 17-183 and 18-122, at 1 (filed Apr. 20, 2018) ("Intel-Intelsat-SES April 20 *Ex Parte*") (stating that SES and Intelsat expect to repurpose some portion of the C-band Downlink in 18-36 months following a final Commission order).

Paper"), which provides a detailed economic analysis of several of these alternative proposals.[144] The Brattle Paper confirms that the alternative proposals "do little or nothing to solve the central impediments to finding an efficient repurposing [of spectrum]" because they "do not solve the holdout problem[,] resolve the ill-defined legal rights in the band," or provide a mechanism to close the information deficit that the government faces about the costs and benefits of the many aspects of transitioning users.[145] Indeed, the Brattle Paper confirms that all of the alternatives "would take significantly longer to effectively assign or clear spectrum" than the Market-Based Approach.[146]

In this section, the C-Band Alliance highlights the key takeaways discussed in the economic analysis provided in the Brattle Paper and also addresses the significant legal and implementation challenges posed by each of these proposals. The variations of the incentive auction approach, which account for several of the proposed alternatives, share many of the same shortcomings, and any differences between them are addressed separately at the end of the section.

A. An Overlay Auction Will Fail to Clear Contiguous Spectrum for Terrestrial 5G Use Without Significant Government Intervention.

Although the FCC has conducted overlay auctions in the past,[147] concerns about coordination between incumbent licensees and overlay license winners have moved the

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[144] *See* Joint Comments of Intel Corporation, Intelsat License LLC, and SES Americom, Inc., Appendix A, GN Docket Nos. 17-183 and 18-122, RM-11791, RM-11778, at 32-40 (filed Oct. 29, 2018).

[145] *Id.*, Appendix A at 38.

[146] *Id.*

[147] *See Amendment of the Commission's Rules to Establish New Personal Communications Services*, Second Report and Order, 8 FCC Rcd 7700 (1993); *Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to*

Commission away from using overlay auctions to assign mobile rights in bands targeted for terrestrial 5G use.[148] In particular, the Commission has expressed concern that disputes between incumbents and new users would delay implementation of 5G mobile service.[149] The overlay auction proposal in the *NPRM* does not mitigate those concerns.[150] The significant risk of coordination issues means that an overlay auction likely would fail to clear the contiguous spectrum required for terrestrial mobile operations without extensive government intervention and lengthy delays. In addition, an overlay auction would face unusually high transaction costs due to the sheer number of earth station owners in the C-band Downlink. The *NPRM* proposed that registered earth station operators would be protected from any future use of the band, including from new terrestrial operations.[151] But such protection would require an overlay license winner to negotiate with both satellite operators and the owners of numerous earth stations located within a particular license area in order to make spectrum in that area available for terrestrial mobile use. These multiple negotiations would greatly increase the prospect of failure in many locations, resulting in variable clearing across the band.

Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems, Second Report and Order, 17 FCC Rcd 23193 (2002); *see also* 47 C.F.R. §§ 24.239-24.253 (rules for relocating incumbent microwave users from the PCS band), 27.1111, 27.1160-27.1190 (relocation rules and policies for the AWS-1 and AWS-3 bands).

[148] In the 28 GHz and 39 GHz bands, the FCC explicitly rejected the proposal to use an overlay auction to separately license the mobile rights. The Commission expressed concerns "that awarding fixed and mobile rights separately would lead to disputes between fixed and mobile licensees that could make it more difficult for both licensees to provide service." *See Use of Spectrum Bands Above 24 GHz for Mobile Radio Services et al.*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014 ¶¶ 37-42, 86-87 (2016).

[149] *Id.*

[150] *NPRM* ¶¶ 99-105.

[151] *Id.* ¶ 27.

The Commission appropriately recognized that the transaction costs in an overlay auction would be high and that co-channel sharing between FSS and more intensive terrestrial wireless use in the same geographic area would be "difficult."[152] That acknowledgment led the Commission to ask in the *NPRM* whether earth station operators should be required to discontinue operations in some portion of the C-band Downlink if no voluntary agreement is reached.[153] But any such mandatory action taken by the Commission effectively renders the process compulsory for incumbents and would likely provoke lengthy procedural and litigation delays.

In light of the importance of speedily clearing the spectrum to further the deployment of terrestrial 5G, the Commission rightly expressed concern that an overlay auction would fail to quickly clear as much spectrum as the Market-Based Approach.[154]

B. Proposals Based on an Incentive Auction Are Infeasible and Raise Significant Legal and Implementation Questions.

The three other proposals in the *NPRM* are variations of an incentive auction and share a common set of defects. Importantly, these government-run auction proposals would result in lengthy delays to resolve the flaws discussed below, denying mobile broadband providers the opportunity to gain access to the C-band Downlink in a timely fashion. The first proposal is a "traditional" incentive auction in which FSS operators in the C-band would volunteer to relinquish their spectrum usage rights in exchange for compensation.[155] The second proposal is a "capacity auction" in which the Commission would conduct a reverse auction for satellite

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[152] *See id*. ¶ 50.

[153] *Id.* ¶ 100.

[154] *Id.* ¶ 101.

[155] *See id.* ¶¶ 103-05.

transponder capacity that could be used to compensate the satellite incumbents for giving up C-band transponder capacity.[156] The third proposal is a hybrid approach put forth by T-Mobile, which incorporates elements of the Market-Based Approach and a traditional incentive auction.[157]

All three proposals in the *NPRM* ignore important distinctions from the recently concluded broadcast incentive auction. For example, the Commission not only possessed authority to conduct the broadcast incentive auction, but it also possessed specific authority to repack holdouts and to set aside funds to relocate those holdouts.[158] Currently, the Commission does not have similar powers for the C-band Downlink. Although the FCC does have the authority to reduce the amount of spectrum that C-band Downlink satellites are authorized to use in the U.S., the Commission has also said that it plans to protect the thousands of registered earth stations from interference due to any future use of the band, including from new terrestrial operations.[159] Many of these earth stations already use substantial portions of the band—in some cases, the whole band—and will need to be protected. Without authority to repack non-participating FSS operators and their earth station customers more efficiently in the portion of the C-band remaining for video downlink services, it will be challenging to clear sufficient contiguous and unencumbered spectrum that terrestrial mobile operators will be interested in

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[156] *Id.* ¶ 106.

[157] *See id.* ¶¶ 112-15.

[158] *See* Spectrum Act, Pub L. No. 112-96 § 6403(b)(1) (2012) ("Spectrum Act") (requiring the FCC, in order to "mak[e] available spectrum to carry out the forward auction," to "evaluate the broadcast television spectrum," and authorizing it to "make such reassignments of television channels as the Commission considers appropriate" and to "reallocate such portions of such spectrum as the Commission determines are available.").

[159] *NPRM* ¶ 27.

purchasing. Moreover, issuing new licenses for terrestrial mobile use to auction winners without clear authority to repack—or at least to fully-protect—non-participants may risk violating the Commission's statutory obligation under Section 309(j)(6)(E) to avoid mutual exclusivity.[160]

All three variations also suggest that auction proceeds would be split between the government and reverse auction participants (*e.g.*, the FSS operators), with non-participating earth station operators' relocation costs paid for out of the share going to winning participants in the reverse auction.[161] But the proposals are silent on how exactly proceeds would be divided between the government and the FSS operators and under what authority the government could actually share these revenues if the Commission ran the auction. The Commission rightly concluded in the *NPRM* that there are likely statutory barriers to sharing government auction revenues, particularly if some proceeds are shared with non-participants or non-licensees, in light of the requirements of Section 309(j)(8)(A).[162] At a minimum, there will be lengthy delays to

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[160] 47 U.S.C. § 309(j)(6)(E) (stating that the competitive bidding authority granted the Commission should not be construed to relieve the Commission of the obligation in the public interest to continue to use engineering solutions, negotiation, threshold qualifications, service regulations, and other means in order to avoid mutual exclusivity in application and licensing proceedings); *see also NPRM* ¶ 84 (stating that one advantage of the market-based approach is that it would not likely result in mutually exclusive applications for the Commission to consider because a negotiated agreement with the C-Band Alliance would be a prerequisite for applying for a license in the band).

[161] Although the *NPRM* only raises this revenue sharing issue in the context of the T-Mobile proposal, implicit in any proposal for the FCC to run a reverse auction to clear spectrum is the sharing of auction proceeds between Treasury and reverse auction winners. *See, e.g., NPRM* ¶ 112; *see also* T-Mobile *Ex Parte* at 4-6.

[162] *NPRM* ¶ 112; *see also* 47 U.S.C. § 309(j)(8)(A) (stating that except for some limited exceptions, all proceeds from the use of a competitive bidding system shall be deposited in the Treasury); *see also* Spectrum Act, § 6402, codified at 47 U.S.C. § 309(j)(8)(G) (authorizing the sharing of proceeds with a licensee who voluntarily relinquishes some or all of its licensed spectrum usage rights based on the value of the relinquished rights as determined in a reverse auction).

clarify this authority question and to reach industry consensus on the appropriate formulas to split revenues and cover relocation costs.

In addition, the three variations of the incentive auction proposals are vague in defining the target products of the auction. Defining the products to be sold is a critical step before assessing the feasibility of various auction designs. On the one hand, if the products to be sold in the reverse auction are the FSS operators' transmission rights in the C-band Downlink, these proposals do not address how such a proposal would work without eliminating their earth station customers' full-band, full-arc protections. In the absence of such a change, nothing would stop other satellite operators from using the same spectrum over the same geographic area that another satellite operator agreed to relinquish in exchange for compensation. Even if these full-band, full-arc rights are removed by the Commission—a problem in its own right, as discussed above—there is no guarantee that such a proposal will provide adequate competition to meet the requirements under Section 309(j)(8)(G)(ii).[163] On the other hand, if the products to be sold are incumbent earth stations' rights to receive interference-free transmissions, difficult questions would remain, such as what criteria would have to be met for a geographic area to be deemed cleared. For example, if 65% of the earth stations in a particular geographic area participate in the reverse auction and agree to relocate to a new band in exchange for compensation, would this area be considered cleared? For those earth stations that remain, would they have a right to be protected or, if forced to move, to have their rebanding costs paid for?

Without resolving these product definition issues and granting the Commission the authority to involuntarily repack non-participants, the same coordination problems that would

[163] 47 U.S.C. § 309(j)(8)(G)(ii)(II) (requiring that at least two competing licensees participate in the reverse auction of an incentive auction).

complicate overlay auction rights could appear in the context of incentive auctions. Indeed, if, as CTIA's proposal suggests, the reverse auction participants include not only incumbent FSS operators but also incumbent earth station owners and incumbent microwave licensees, there could be a four-way coordination problem.[164] Broadening the pool of participants eligible to participate in the reverse auction might help satisfy the competition requirements under Section 309(j)(8)(G)(ii),[165] but without addressing the questions of product definition and mandatory repack authority, the transaction costs for a winning bidder to actually clear a portion of spectrum would go up dramatically, and the process ultimately would likely be unworkable.

Resolving these complexities could take years. As a point of reference, it took more than five years from the time Congress gave the Commission the authority to run the broadcast incentive auction to resolve similarly complicated product definition and revenue sharing challenges. Moreover, it will take another 39 months from when the broadcast incentive auction closed to finish clearing the band of incumbent television broadcasters. Here, with open issues that include the protection rights of non-participants and how auction proceeds might be shared between the government, auction winners, and involuntarily repacked incumbents, a highly contested and lengthy proceeding is guaranteed. A slow, cumbersome, command-and-control process will not help the U.S. win the race to 5G.

The capacity auction, which Commissioner O'Rielly noted has left many "scratching their heads,"[166] presents several unique challenges. The capacity auction proposal suggests that

[164] Comments of CTIA, GN Docket No. 17-183, at 13 (filed Oct. 2, 2017); *see also NPRM* ¶ 104.
[165] 47 U.S.C. § 309(j)(8)(G)(ii)(II).
[166] *NPRM*, Statement of Commissioner Michael O'Rielly.

potential bidders could be any FCC licensee that could make transponder capacity available.[167] Critically, this proposal does not explain how a diverse set of potential bidders would compete against each other. For example, would Ku-band capacity be viewed as equivalent to the same amount of C-band capacity? As described above, Ku-band transponder capacity is an inadequate substitute for the C-band Downlink, as well as the fact that C-band customers do not have the ground infrastructure to be able to utilize Ku-band.[168] Also, how would the capacity being offered by earth station operators be quantified given that FSS operators have non-exclusive rights to the spectrum and that numerous earth stations may be required to give up their rights to clear a particular spectrum segment? And what level of "impairment" would be acceptable to remain in the band? Ultimately, despite the different nomenclature, a capacity auction suffers from product definition issues even more complex than the other incentive auction proposals.

The T-Mobile auction proposal suffers from additional flaws. First, nothing in the record supports the premise that satellite operators would be willing or able to clear 500 megahertz upfront, and it is unlikely to occur.[169] Thus, the T-Mobile proposal will almost certainly result in a lengthy, multi-stage incentive auction to find the actual amount of spectrum that satellite operators would be willing and able to vacate in each geographic area.

Second, despite claims of its market-based nature, the T-Mobile proposal is far more reliant on government intervention than the Market-Based Approach. The T-Mobile proposal

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[167] *Id.* ¶ 106.

[168] *See supra* Section II.B.

[169] Indeed, both FSS operators and earth station owners have consistently opposed any proposal to clear the entire C-band Downlink because of its heavy current use for video downlink operations. *See, e.g.*, Intel-Intelsat-SES April 20 *Ex Parte* at 1; *Ex Parte* Letter of the American Cable Association, National Association of Broadcasters, National Public Radio, Inc., and NCTA, GN Docket Nos. 17-183 and 18-122, at 1-2 (filed June 15, 2018); *Ex Parte* Letter of Comcast Corp., GN Docket Nos. 17-183 and 18-122, at 1 (filed June 7, 2018).

requires that the government—rather than the market—decide key issues such as how much spectrum to make available in each area during subsequent phases and the minimum amount of spectrum to clear.[170] These decisions will likely be economically inefficient and delay making this spectrum available for 5G use. In addition, T-Mobile's suggestion that satellite operators sell their spectrum rights as a consortium in the government-run auction[171] likely violates Section 309(j)(8)(G)(ii), which requires at least two auction participants.[172]

VIII. CONCLUSION

The Market-Based Approach represents the fastest way to repurpose C-band Downlink spectrum for terrestrial mobile services while also protecting valuable incumbent FSS operations. With the U.S. in a global race to 5G, time is of the essence. The C-band Alliance urges the Commission to act quickly and adopt the Market-Based Approach.

Respectfully submitted,

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170 T-Mobile *Ex Parte* 4-6; *see also NPRM* ¶ 112.

171 *Id*.

172 47 U.S.C. § 309(j)(8)(G)(ii)(II).

TECHNICAL ANNEX

I. CO-FREQUENCY SHARING IS NOT FEASIBLE

The Commission correctly recognizes that "co-channel sharing of spectrum between the FSS and more intensive terrestrial wireless use in the same geographic area may be difficult."[1] In fact, sharing between the FSS and terrestrial wireless services in the same frequency band and in the same geographical area, absent implementation of specific mitigation techniques, is impossible in most cases.

To receive communications from geostationary satellites 22,000 miles away, C-band Downlink earth station antennas are highly sensitive by design and, consequently, extremely vulnerable to interference. Terrestrial mobile signals are several orders of magnitude more powerful than satellite signals at ground level and would cause harmful interference to FSS earth stations.

Specifically, protecting reception of satellite signals from co-frequency terrestrial interference would require large exclusion zones around the satellite earth stations. As the National Association of Broadcasters explained, large separation distances (ranging from "tens or, under extreme circumstances, even hundreds of kilometers") would be required to adequately protect earth stations, and mobile operations pose a particular challenge because there is no reliable means of "geofencing" users from operating mobile handsets in exclusion zones.[2] However, establishing exclusion zones around FSS earth stations would constrain terrestrial operations significantly. The Commission observes that even a 20-kilometer exclusion zone

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[1] *NPRM* ¶ 50.

[2] Comments of the National Association of Broadcasters, GN Docket No. 18-122, at 3 (filed May 31, 2018); Reply Comments of the National Association of Broadcasters, GN Docket No. 18-122, at 4 (filed June 15, 2018).

around earth stations would prevent carriers from offering 5G service in C-band Downlink spectrum to 83.25% of the United States population[3]—and that calculation considered only earth stations in the IBFS database as of early May 2018, not the thousands of additional earth stations registered after that date.

Moreover, studies by wireless providers confirm the difficulties of co-frequency sharing. For example, an analysis by Ericsson concludes that, depending on the assumptions used, the required separation distances between an FSS earth station and a terrestrial wireless base station would be at least 30 kilometers, and as high as 50 to 70 kilometers, making "any co-channel sharing approach of limited utility."[4] Dynamic spectrum sharing solutions, like the approach adopted for the Citizens Broadband Radio Service ("CBRS"), would prove ineffective in the C-band Downlink due to the number and disbursement of FSS earth stations and the need to ensure that satellite customers retain the flexibility to quickly shift to different frequencies in the event of interference, transponder outage, or satellite failure.[5] Indeed, such sharing schemes remain unproven. Moreover, satellite earth stations are passive devices that are not capable of reporting back their operational parameters to any centralized database, and since these earth stations do not transmit, it is impossible to identify them with any radiofrequency sensing devices. As such, the concept of "dynamic" sharing is inherently and fundamentally

[3] *See NPRM* ¶ 51, Figure 2.

[4] Comments of Ericsson, GN Docket Nos. 17-183 and 18-122, at 4-5 (filed May 31, 2018). *See generally* Ericsson, Co-Channel Sharing Assessment, GN Docket No. 17-183 (filed Oct. 2, 2017); *see also Ex Parte* Letter of Nokia, GN Docket No. 17-183, Attachment (filed Jan. 22, 2018) (addressing technical aspects of co-channel deployment).

[5] *See NPRM* ¶ 52 ("The Commission was able to establish the [CBRS] in the 3550-3700 MHz [band] despite the presence of FSS receivers because there are only FSS earth stations in 35 cities and two [Mobile Satellite Service] gateways in the 3600-3700 MHz band. This is unlike the current incumbent earth station environment in the 3.7-4.2 GHz band.") (internal citation omitted).

incompatible with the nature of FSS receive earth stations in this context. Any viable approach to expanding mobile broadband operations in the C-band Downlink must therefore avoid co-frequency sharing.

II. ENSURING THE PROTECTION OF TT&C EARTH STATION SITES

The *NPRM* seeks comment on the means of protecting telemetry, tracking, and control ("TT&C") antennas.[6] The number of TT&C earth stations licensed in the U.S. today is limited.[7] For example, for the CBA members, the current TT&C and Teleport sites in the continental United States ("CONUS")[8] are as follows:

Table 1: TT&C and Teleport Sites Utilized by C-Band Alliance Members

Site	State	Operator
Fillmore	CA	Intelsat
Napa	CA	Intelsat
Riverside	CA	Intelsat
Castlerock	CO	Intelsat
Atlanta	GA	Intelsat
Mountainside	MD	Intelsat
South Mountain	CA	SES
Woodbine	MD	SES
Hawley	PA	SES
Vernon Valley	NJ	SES
Cedar Hill	TX	SES
Manassas	VA	SES
Brewster	WA	SES
Mount Jackson	VA	Telesat

[6] *NPRM* ¶ 180.

[7] The C-Band Alliance envisions that a subset of these TT&C sites would also be required to continue to operate in the entire 3.7-4.2 GHz band.

[8] The C-Band Alliance is committed to protecting TT&C sites located in the continental United States of C-band satellite operators providing service outside the United States, if such operators provide notice prior to any secondary market agreements.

Protection of the limited number of TT&C earth stations and teleports remaining in the cleared portion of the spectrum or receiving in the adjacent spectrum will be addressed through the secondary market agreements negotiated with terrestrial wireless carriers.

III. 5G IN-BAND AND OUT-OF-BAND SPECIFICATIONS

In order to determine acceptable maximum 5G in-band and out-of-band emission levels, members of the C-Band Alliance performed extensive analysis and field testing to establish the 5G interference limits for the satellite earth stations, taking into consideration the following factors:

1. The performance characteristics of the existing population of low-noise block converters ("LNBs") already operational in the field, particularly as they relate to local oscillator stability, noise temperature, technology (Dielectric Resonator Oscillator versus Phase Locked Loop), and gain transfer curves. Some LNBs have been in the field for decades.
2. The performance characteristics of the deployed base of satellite receivers and modulation and coding schemes commonly used for the transmission of satellite signals.
3. The expected performance of band-pass filters (to be fitted on satellite earth stations) representing the latest filter technology and performance to obtain maximum roll-off while maintaining acceptable levels of insertion loss, group delay, and return loss. The design of these optimized filters yielded an improvement in the rejection of altimeter radar signals, which operate in the 4200-4400 MHz band. This improved rejection of altimeter radar signals provides additional saturation margin for 5G in-band signal interference at the input of the LNB.

In order for the analysis to yield results that are applicable and relevant to the massive number of earth stations currently deployed and in operation, it is imperative that the typical performance of commonly used LNBs is considered in the analysis. This is particularly important because the 5G in-band emissions are orders of magnitude more powerful than the satellite signals and can saturate the earth station LNBs. Preventing the LNBs from being saturated is necessary to avoid excessive levels of non-linear effects such as intermodulation products, phase noise, and non-linear AM to AM conversion that result in excessive satellite

signal degradation. Through testing and analysis, it was determined that the receive signal performance will encounter insignificant degradation if the aggregate LNB input power level across its entire operational frequency range is lower than -59 dBm[9] at the input of the LNB.

In order to prevent terrestrial 5G signals in adjacent cleared spectrum from saturating the LNBs, C-band earth stations will need to be fitted with bandpass filters. Such filters can provide acceptable suppression of the 5G signal while minimizing adverse filter effects, such as insertion loss, return loss, and group delay on satellite signals. Through careful and detailed analysis, C-Band Alliance members have determined that a filter mask, as shown in Figure 1, will provide the necessary 5G in-band emission suppression, provided that the 5G base station aggregate power spectral density does not exceed the levels discussed below. C-Band Alliance members have already commissioned development of bandpass filters that will adhere to the filter mask, received prototypes, and performed tests to verify that these filters will be capable of suppressing in-band 5G emissions. Figure 2 illustrates the performance of such a prototype filter with respect to the intended filter mask.

[9] The unit saturation level for most LNBs is -55 dBm. A lower value is required, however, to ensure that the received signal performance is not significantly degraded.

Figure 1: 5G Rejection Filter Mask

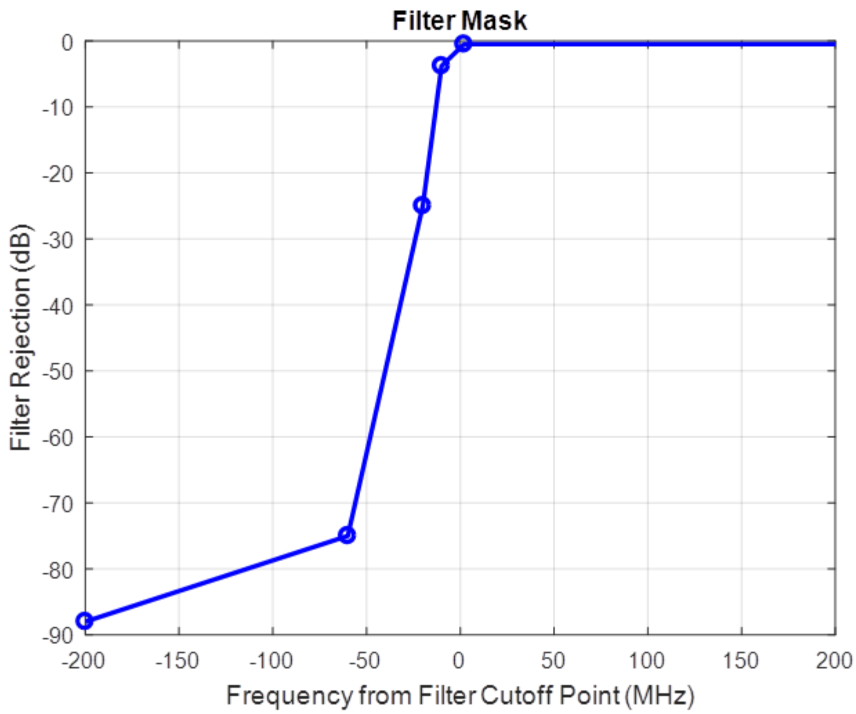
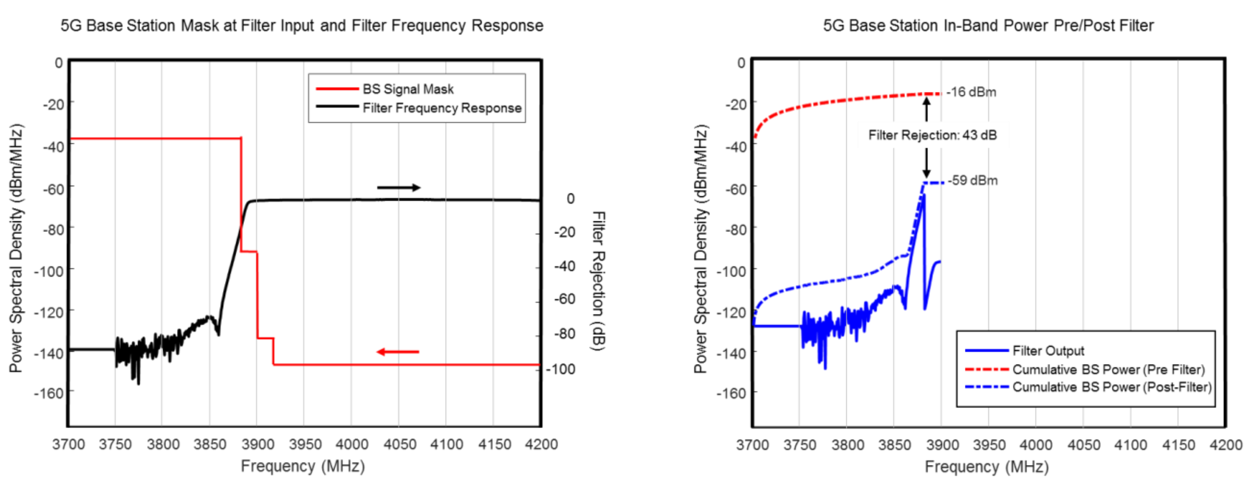


Figure 2: Prototype Filter Performance

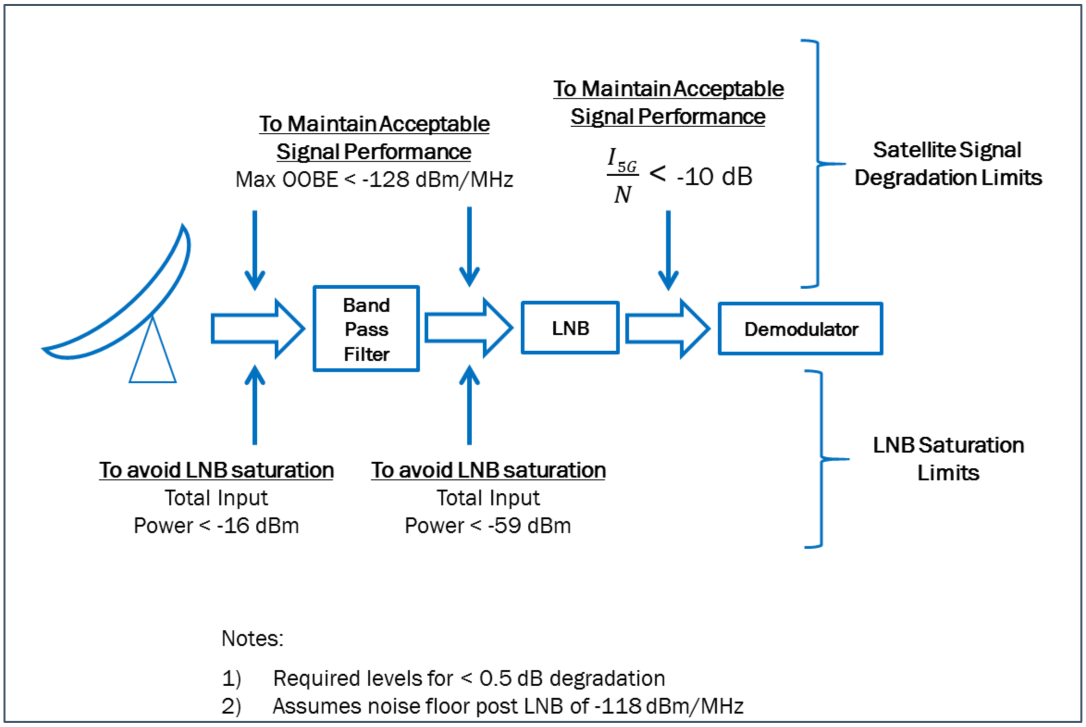


The figure on the left shows the power of 5G base station signal received at a specific FSS site and the filter frequency response. The figure on the right shows that a 43 dB reduction of the cumulative power at the input of the LNB is achieved once the filter is inserted.

It is also equally important to define out-of-band emission levels for 5G signals since the current 3GPP standard (Release 15) does not provide adequate details on the behavior of 5G transmitters in the out-of-band region at multiple C-band frequencies from the upper band edge of the 5G signal. For the out-of-band emissions power density limits, using existing satellite demodulators for field testing to corroborate the analysis, a maximum 5G interference to noise ratio (I_{5G}/N) of -10 dB was established to maintain the satellite signal degradation at acceptable levels. This results in a 5G out-of-band emission limit of -128 dBm/MHz at the output of the filter/input of the LNB. Note that the 5G out-of-band emissions are within the filter passband so they are not attenuated by the filter. Therefore, the levels are required to be well below noise floor in order not to significantly degrade the low power level satellite signals. Figure 3 illustrates the 5G in-band and out-of-band levels at various points for a satellite earth station.

The C-Band Alliance conducted a lab test using a simulated 5G signal that is modeled after the parameters defined in the 3GPP standard (Release 15). Indeed, the test indicated that the out-of-band emission levels as defined in 3GPP were inadequate for the protection of satellite signals, and that a tighter out-of-band emission mask for 5G signals was necessary to ensure the protection of satellite signals in the adjacent band.

Figure 3: 5G Emission Levels Within Satellite Earth Station



Establishing the in-band and out-of-band interference limits of the satellite earth stations is the first step before evaluating 5G deployment scenarios. Any deployment scenario must ensure that the aggregation of in-band and out-of-band 5G signal levels are below these limits since exceeding them may result in excessive satellite signal degradation or complete loss of satellite services.

Taking into consideration some potential 5G deployment scenarios and the satellite earth station interference limits established through analysis, lab testing, and field testing, the C-Band Alliance has defined a 5G waveform mask that specifies the 5G in-band and out-of-band power levels that allow for acceptable satellite service performance.

To calculate the received interference at the earth station from a 5G deployment scenario, the analysis included the following:

1. Number and location of 5G base stations and user equipment
2. 5G base station and user equipment transmit power
3. Radiation pattern of the 5G transmitters
4. Angle of incidence into the satellite earth station antenna and the antenna receive patterns
5. Propagation effects of the channel between the 5G transmitters and the satellite earth station

The resulting 5G signal mask is as follows and as shown in Figures 4 and 5.

In-Band Limits

For 5G base stations, the limit must be set at 66 dBm/100 MHz (*i.e.*, 46 dBm/MHz).

Note that higher power levels, such as 75 dBm as referenced in paragraph 165 in the *NPRM*, will not allow for continued satellite operations in the remaining satellite spectrum due to LNB input power levels exceeding the -59 dBm level as described above. Increasing the differential between the power levels of 5G base stations and the power levels received by earth stations will exacerbate the difficulty in achieving compatibility.

For user equipment, an in-band maximum level of 30 dBm is required.

Out-Of-Band Limits

For 5G base stations:

- at band edge: -13 dBm/MHz
- between 20 and 40 MHz outside the band edge: -50 dBm/MHz
- beyond 40 MHz outside of the band edge: -60 dBm/MHz

The level of -60 dBm/MHz beyond 40 MHz outside the band edge is necessary to protect earth stations against the aggregate effect of out-of-band emissions of multiple base stations.

For 5G user equipment, out-of-band emission levels must take into account the aggregate effect of multiple users, which can have higher concentration in certain areas. The following levels are required:

- at band edge: -28 dBm/MHz
- between 20 and 40 MHz outside the band edge: -55 dBm/MHz
- beyond 40 MHz outside of the band edge: -65 dBm/MHz

Figure 4: 5G Base Station Signal Mask

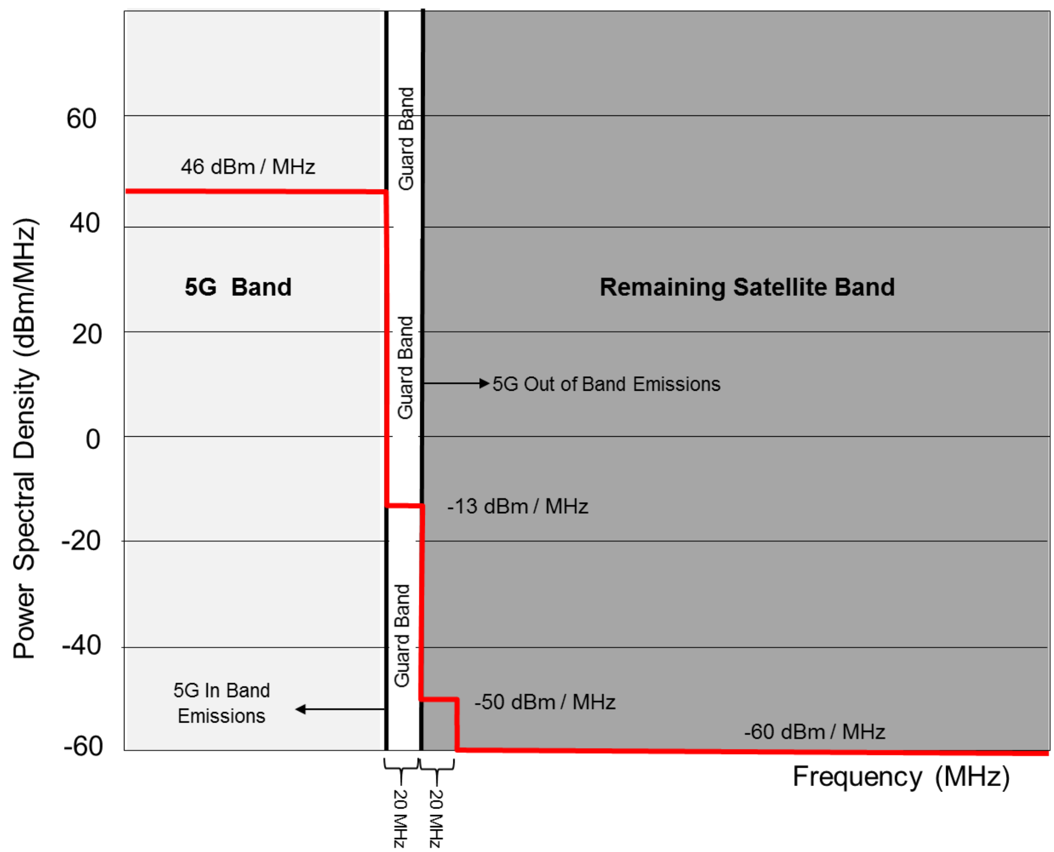
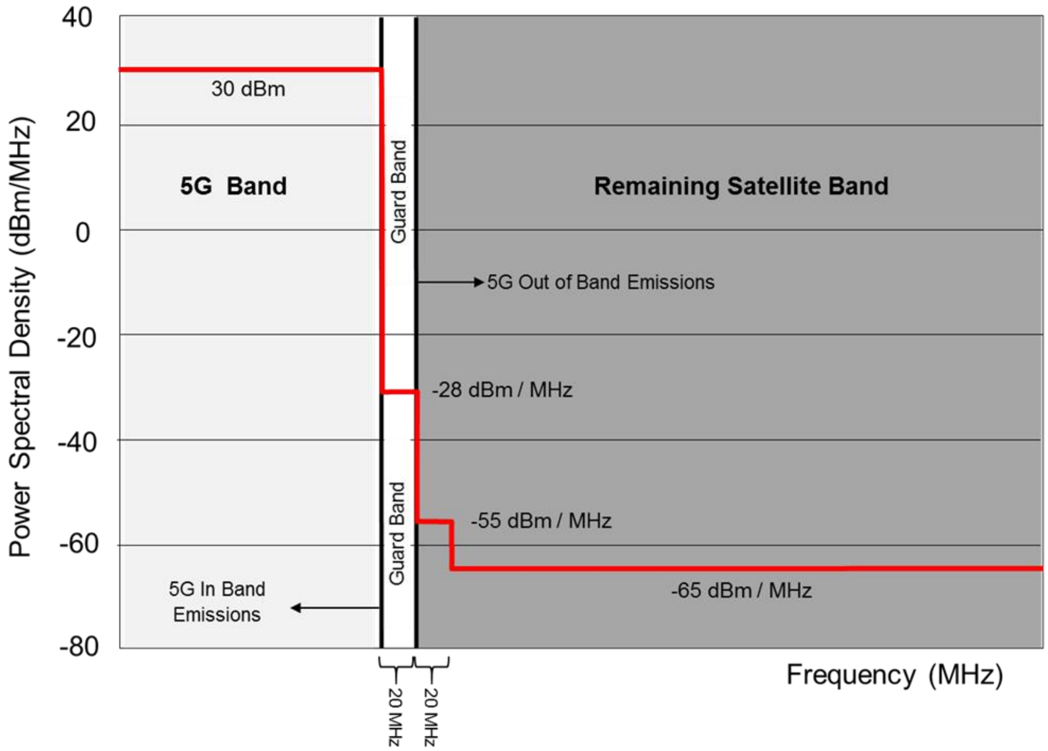


Figure 5: 5G User Equipment Signal Mask



IV. KU-BAND AS A REPLACEMENT FOR C-BAND SERVICES

The *NPRM* seeks comment on whether Ku-band is an adequate replacement for C-band. This section addresses this question only from the technical standpoint. Ku-band satellite capacity is not a reliable replacement spectrum for certain C-band services. While Ku-band spectrum is widely used in satellite communications, it is typically deployed for services that do not need high availability ("five nines" or 99.999%), as Ku-band is significantly more susceptible to signal degradation due to atmospheric attenuation ("rain fade") than the C-band. Services such as direct-to-home video broadcast and data networks are typical applications using Ku-band because as consumer services, they do not require five nines availability. In contrast, video distribution is held to a much higher quality standard because it is a service in which video content is distributed to other businesses (B2B), such as television affiliates, cable companies,

and others which in turn re-distribute this video content to consumers through their distribution network. In the limited instances where Ku-band is used for such high availability services, C-band satellite and/or terrestrial distribution (*e.g.,* fiber optic networks) are used as back-ups in the event of high rain events.

For example, in Florida, where high density rain events are frequent, as much as 20 dB of additional link margin may be required in Ku-band as compared to C-band in order to achieve a similar high quality and availability of the signal. To overcome this difference, either higher power satellites would be required (which would greatly exceed regulatory limits) or extremely large satellite earth station antennas would be needed.

Currently deployed C-band antennas at satellite earth stations could not be easily retrofitted to support Ku-band services, or could not be retrofitted at all, and therefore, a significant economic and logistical impact would occur if existing antennas were replaced with Ku-band antennas. Antenna sizes would need to increase significantly (a Ku-band antenna size of 9 meters or more would be required to replace a 3.7 meter C-band antenna), and with large Ku-band antennas, meticulous installation and antenna pointing become a driving factor in maintaining performance. Additionally, the cost of large Ku-band antennas is exponentially higher than C-band antennas, as they require a higher degree of precision in manufacturing, not to mention the added cost of building a much larger antenna. Also, many cable head-end locations may not have the physical space necessary to house several large Ku-band antennas at their existing facilities, which is yet another logistical and financial challenge to switching to Ku-band. All C-band satellite uplink facilities also would have to be replaced by Ku-band antennas.

Also, a significant amount of additional Ku-band satellite capacity would be required to support the current C-band services. The number of available Ku-band orbital locations that can

serve CONUS is insufficient to deploy the necessary Ku-band satellite capacity. Finally, bandwidth efficiency would greatly suffer as lower order modulation and coding schemes would likely be needed (*e.g.*, QPSK R1/4 in Ku-band instead of 8PSK R5/6 in C-band). Therefore, it is not technically or logistically feasible to migrate the entrenched C-band infrastructure and services to Ku-band in a timeline that would ensure U.S. leadership in 5G.

V. ANALYSIS OF INFEASIBILITY OF P2MP AND FSS CO-EXISTENCE

This section presents the results of analysis regarding the potential for co-existence between fixed point-to-multipoint ("P2MP") broadband services and FSS earth stations within the C-band by analyzing co-frequency (co-channel) scenarios for an individual earth station in Virginia Beach, VA, as well as for a cluster of earth stations in the area near Virginia Beach, VA, with elevation angles ranging from 19 degrees to 39 degrees. The analysis also addresses adjacent frequency and LNB saturation scenarios. The analysis confirms that significant separation distances between P2MP facilities and FSS receive earth stations will be required. Given the ubiquitous deployment of receive earth stations nationwide, these separation distances will significantly limit the areas within which P2MP operations of the type proposed by the Broadband Access Coalition ("BAC") and Google[10] and discussed in the *NPRM*[11] will be possible.

The BAC and other proponents of P2MP operations in the C-band contend that P2MP services could be deployed around existing receive earth stations in channels not used by the earth station. But these parties simply ignore the fact that the deployed base of C-band receive

[10] *See, e.g.,* BAC/Google *Ex Parte*.

[11] *NPRM* ¶ 178.

earth stations includes thousands of cable head-ends that rely on the ability to receive the full range of C-band spectrum.

Leaving this fundamental flaw aside, the following analysis assumes, for the sake of argument, that in certain locations specific C-band channels could be used by P2MP services. The analysis demonstrates that P2MP deployments will be limited due to the need for significant separation distances to protect the FSS earth stations.

First, the results of the co-channel scenario indicate that large separation distances will always be required to prevent P2MP operations from interfering with FSS reception. Specifically, the single-entry simulation below shows that separation distances ranging from 10 to 50 kilometers will be necessary when the P2MP base station is operating in a 20 MHz channel that overlaps with a wanted satellite transponder received by one or several closely spaced FSS receive antennas. The aggregate effect of multiple P2MP base stations and user terminals will further increase this required separation distance.

Second, applying the most constraining out-of-band ("OOBE") emission levels contained in Part 101.111(2)(i), separation distances in excess of 5-15 kilometers will be required in order to keep the P2MP OOBE levels 10 dB below the noise level in the wanted satellite channel. Again, even if the P2MP base station is operating in a 20 MHz channel that is not used by a specific earth station, large separation distances will be needed to protect the earth stations using other frequencies.

Third, in the adjacent channel scenario, even when a P2MP base station is operating in a 20 MHz channel not being used by a specific earth station, the difference in power level is such that the P2MP emission will saturate the LNB of the earth station if the separation distance is not large enough (*i.e.*, on the order of several hundred meters). In addition, having several 20 MHz

channels operated by a single P2MP base station will significantly increase the required separation distance to more than 500 meters up to 1 kilometer. The analysis also shows that a lower P2MP base station height (10 meters) requires a larger separation distance to avoid saturation of the LNB.

The above distances are based on representative parameters for P2MP and FSS systems and do not represent the worst case. Larger distances would be required to prevent interference in cases involving earth stations with lower elevation angles or different P2MP base station heights. Distances will also increase when the aggregate effect of several P2MP base stations and user terminals is taken into account.

The results of this analysis demonstrate that co-frequency, adjacent frequency, and LNB saturation issues will prevent P2MP from being deployed in a meaningful way across the United States in the C-band.

1. P2MP (BAC) Base Station Characteristics

The analyses were based on the assumptions regarding P2MP base station operations set forth in Table 2, which reflect information contained in FCC filings by the BAC as well as Report ITU-R S.2199 ("Studies on compatibility of broadband wireless access systems and fixed-satellite service networks in the 3400-4200 MHz band").

Table 2: P2MP Base Transmit Station Characteristics

Antenna Pattern	Recommendation ITU-R F.1336
Antenna Sectors	3
Antenna Gain	18 dBi[12]
Antenna downtilt	2 degrees (sub-urban)
Sectorization	3 sectors
P2MP BS Power	32 dBm
P2MP Bandwidth	20 MHz
Out of Band specs	FCC Rule Section 101.111(2)(i)
Peak EIRP	50 dBm/20 MHz
BS height above terrain	10 m and 30 m
Propagation Model	Recommendation ITU-R P.452-16
Clutter characteristics	25/9 m (sub-urban)[13]
Terrain	SRTM V3 North America[14]

Antenna sectors

In the simulations, the sector antenna pointing azimuths are kept fixed and pointed at 0 degrees, 120 degrees, and -120 degrees (*i.e.*, there is no artificial beam peak pointing towards the FSS earth station, which would produce worst case results). In the absence of detailed information on the frequency reuse approach by the P2MP base stations, the analysis assumed that each sector of the base station antenna reuses the same frequency. This approach is also

[12] Report ITU-R S.2199 specifies a 17 dBi gain, but because the International Mobile Telecommunications sub-urban antenna is used for this scenario, an antenna gain of 18 dBi is assumed. To compensate for this change, the P2MP base station power parameter is assumed to be 32 dBm in order to achieve a peak EIRP of 50 dBm, consistent with the value proposed in the *NPRM*.

[13] Recommendation ITU-R P.452-16 provides a model to estimate the losses due to shielding by clutter, based on a variety of clutter categories. For each category, the nominal distance to the clutter feature and the nominal clutter height are defined. For the sub-urban category, the distance to the clutter feature is 25 meters, and the height is 9 meters.

[14] *See* The Shuttle Radar Topography Mission (SRTM) Collection User Guide (Oct. 2015), *available at* https://lpdaac.usgs.gov/sites/default/files/public/measures/docs/NASA_SRTM_V3.pdf.

consistent with the possibility that P2MP base stations may use omnidirectional antennas as indicated in paragraph 126 of the *NPRM* and with the fact that P2MP sectorized antennas can be pointed in any direction. The contours obtained in the simulation therefore show the impact of a potential P2MP deployment over a given geographical area considering the different P2MP deployment scenarios put into the record so far.

P2MP base station height

Two heights were considered for the base station: 10 meters and 30 meters. The BAC/Google *Ex Parte* refers to an antenna height of 9.1 meters,[15] which seems to lead to a P2MP service area of 5 kilometers.[16] While such an assumption leads to a lower potential for interference from P2MP into FSS, it may not be the most commonly used height for P2MP services. In fact, as indicated in paragraph 120 of the *NPRM*, the BAC proposes a service area radius of 18 kilometers in rural areas. Such a large distance can be more realistically achieved by using an antenna height greater than 10 meters. In addition, BAC members have stated that base stations for fixed wireless services are often placed on "tall structures like grain silos or water towers."[17] The heights of these constructions can vary between 10 and 90 meters. A height of 30 meters was selected for the simulations in order to provide a more realistic case study. As shown herein, increasing the heights of P2MP base stations leads to larger required separation distances to avoid co-channel interference.

2. Satellite Earth Station Characteristics

Two sets of FSS earth stations are considered for the simulations: a single earth station located

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[15] BAC/Google *Ex Parte*, Attachment 2 at 28.

[16] *Id.* at 26.

[17] *See* Aiken Testimony.

in Virginia Beach (Table 3a) and a cluster of five earth stations near Virginia Beach (Table 3b). In each case, the locations of existing authorized earth stations in the Commission's IBFS database were used. The earth station antenna sizes were also taken from the IBFS authorizations for each earth station. The satellite orbital locations are two of the positions currently used to distribute video programming to cable head-ends across the United States.

Table 3a: Virginia Beach FSS Earth Station Characteristics

Parameters	Value
Satellite longitude	103° W.L.;131° W.L.
Earth station location	Virginia Beach, VA 36° 50' 50.9"N 76° 15' 36.4"W
Earth station antenna diameter	3.7 meters
Earth station antenna pattern	47 C.F.R. § 25.209
Earth station antenna gain	41.3 dBi

Table 3b. Cluster of FSS Earth Station Characteristics

Earth Station Description and Call Sign	Cox E872907	CBN E930230	CBN WD58	Norfolk State E050120	Cox E090089
Latitude (Degrees North)	36° 50' 35.0"	36° 48' 1.0"	36° 48' 1.5"	36° 50' 50.9"	36° 46' 23.4"
Longitude (Degrees West)	76° 9' 51.0"	76° 11' 27.5"	76° 11' 29.2"	76° 15' 36.4"	76° 14' 33.7"
Antenna Pattern	47 C.F.R. § 25.209	47 C.F.R. § 25.209	47 C.F.R. § 25.209	47 C.F.R. § 25.209	47 C.F.R. § 25.209
Antenna Size (m) /efficiency	10 / 65%	11 / 65%	9 / 65%	3.7 / 65%	3.8 / 65%
ES height above terrain (m)	6	6.5	5.5	3	3
GSO Longitude	103° & 131° West Longitude				
Elevation Angle (°) (to 103°W.L./to 131° W.L.)	38.8/19.2	38.9/19.3	38.9/19.3	38.8/19.3	38.9/19.3

3. Co-channel interference analysis

3.1. Single Entry Simulation Set-up

In order to determine the separation distance contour for an earth station located at each of the chosen geographic locations, simulations were performed using the "Area Analysis" module of the "Visualyse Professional V7" interference analysis software tool ("Visualyse"). Within a pre-defined area around the FSS receive earth station, the P2MP base station was moved in 500 meter test point intervals. At each point, the elevation and azimuth angles at the P2MP base station antenna's boresight height towards the FSS earth station were determined, from which the off-axis angle of the P2MP base station antenna relative to its maximum gain lobe was calculated. This off-axis gain data was used to derive the EIRP level of the P2MP base station towards the earth station. Taking into account the propagation loss (including terrain and clutter) between the P2MP base station and the FSS earth station, the interference-to noise (I/N) level at the FSS earth station location was computed. Contour lines were then plotted through the P2MP base station locations for which the computed I/N value at the FSS earth station met the minimum required I/N level of -10 dB.

Scenarios were created in Visualyse for:

1. the single Virginia Beach earth station (Table 3a) and P2MP base stations at 10 meter and 30 meter heights; and
2. the cluster of earth stations (Table 3b) and P2MP base stations at 10 meter and 30 meter heights.

3.1.1. Single Entry Protection Distance Results

3.1.1.1. Virginia Beach earth station

Figures 6 and 7 provide plots of the separation distance contours for the single Virginia Beach earth station. Separation distances between 10 kilometers and 30 kilometers are required

in order to guarantee an interference level 10 dB below the noise floor of the earth station. A higher P2MP base station height leads to larger separation distances.

Figure 6: Virginia Beach, VA Earth Station communicating with 103° W.L.
Red: separation distance; Blue: reference distances of 10, 20 and 30 kilometers
P2MP height: 30 meters (left) and 10 meters (right)

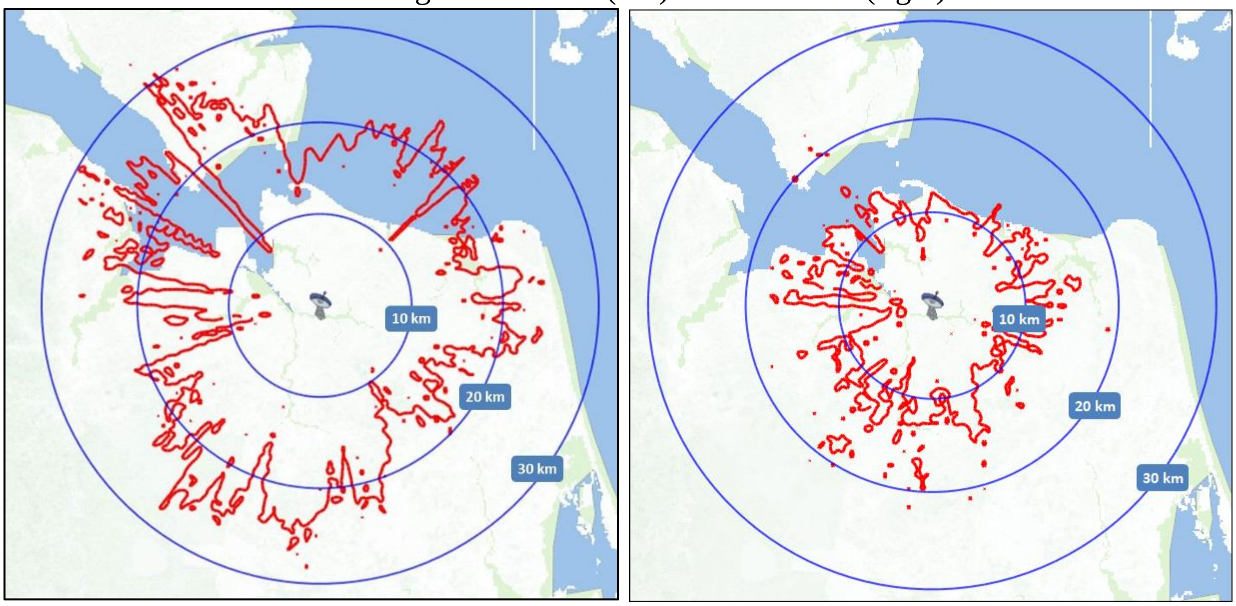
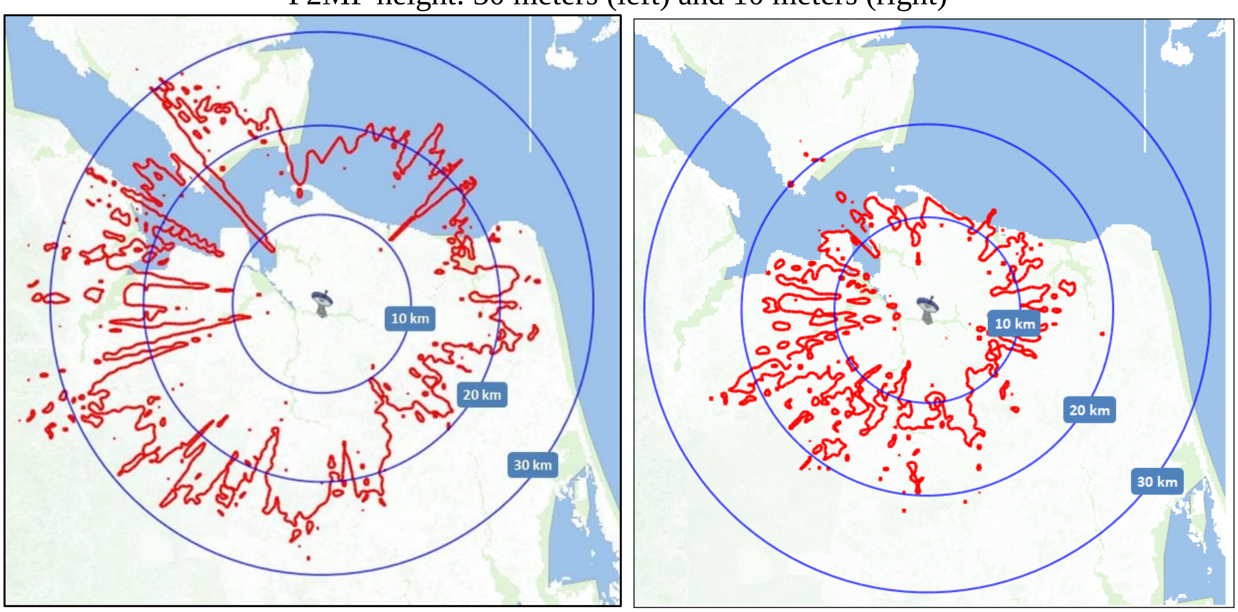


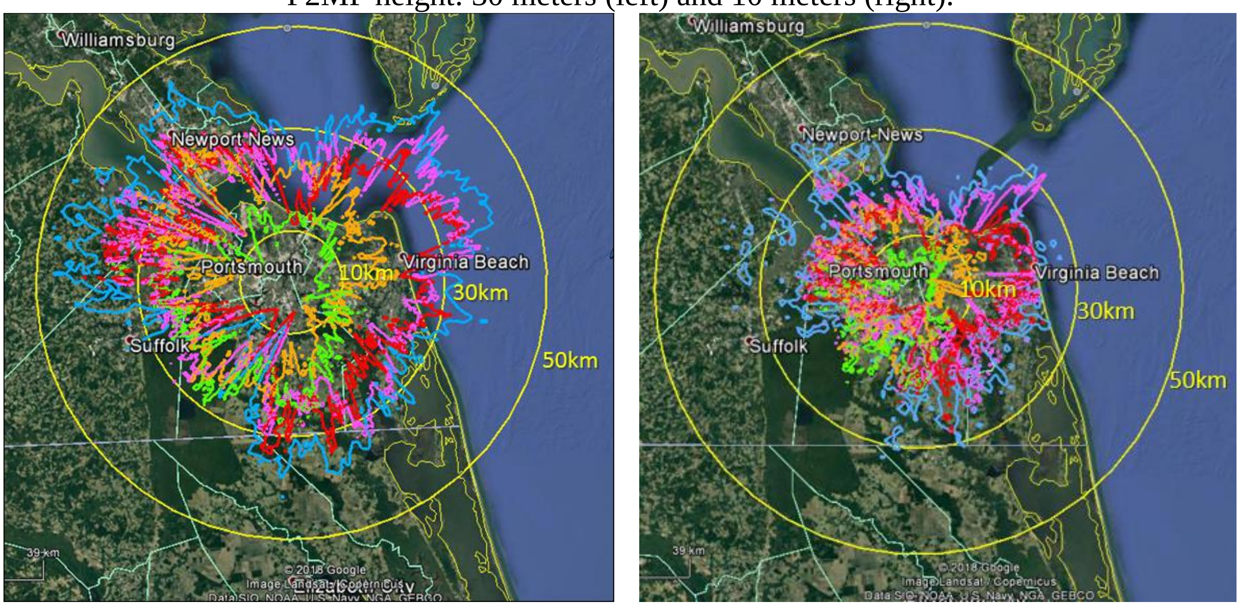
Figure 7: Virginia Beach, VA Earth Station communicating with 131° W.L.
Red: separation distance; Blue: reference distances of 10, 20, and 30 kilometers
P2MP height: 30 meters (left) and 10 meters (right)



3.1.1.2. Cluster of earth stations

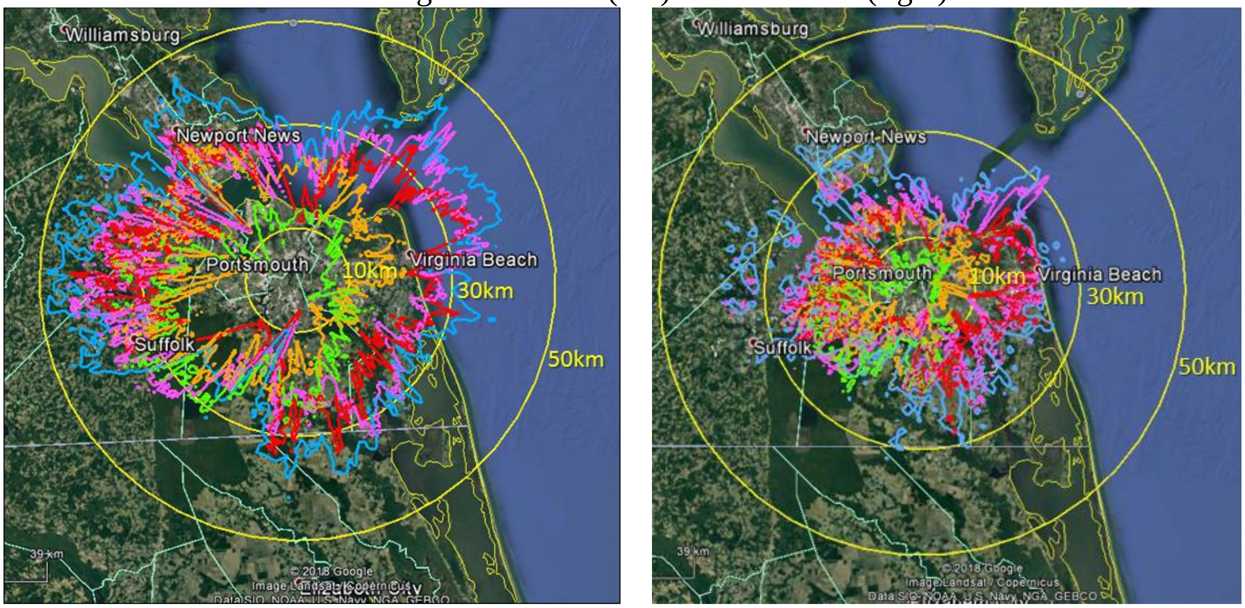
Figures 8 and 9 provide plots of the separation distance contours for a cluster of earth stations near Virginia Beach. The contours were created for each earth station in Visualyse as described above and then exported as KML files in order to be displayed in Google Earth. The yellow distance contours were created by assuming a "weighted" central location[18] between the various earth stations under study. The results show that separation distances between 10 and 50 kilometers are required in order to guarantee an interference level 10 dB below the noise floor of the earth stations. Again, higher P2MP base station heights lead to larger separation distances.

Figure 8: Cluster of Earth Stations communicating with 103° W.L.
Color references: Yellow: reference distances of 10, 30 and 50 kilometers.
Green: E090089, Orange: E05120, Red: WD58, Purple: E872907, Blue: E930230
P2MP height: 30 meters (left) and 10 meters (right).



[18] Exact coordinates for the center of the yellow circles are: 36°49'0.0" North and 76°13'30.0" West.

Figure 9: Cluster of Earth Stations communicating with 131° W.L.
Color references: Yellow: reference distances of 10, 30 and 50 kilometers.
Green: E090089, Orange: E05120, Red: WD58, Purple: E872907, Blue: E930230
P2MP height: 30 meters (left) and 10 meters (right).



4. Adjacent channel interference analysis

Assuming that a P2MP base station could operate in a 20 MHz channel that is not used by a nearby earth station, two effects are analyzed:

(1) how far away must the P2MP base station be in order to avoid producing out-of-band (OOB) emission levels within the wanted satellite transponder bandwidth exceeding an I/N of -10 dB?

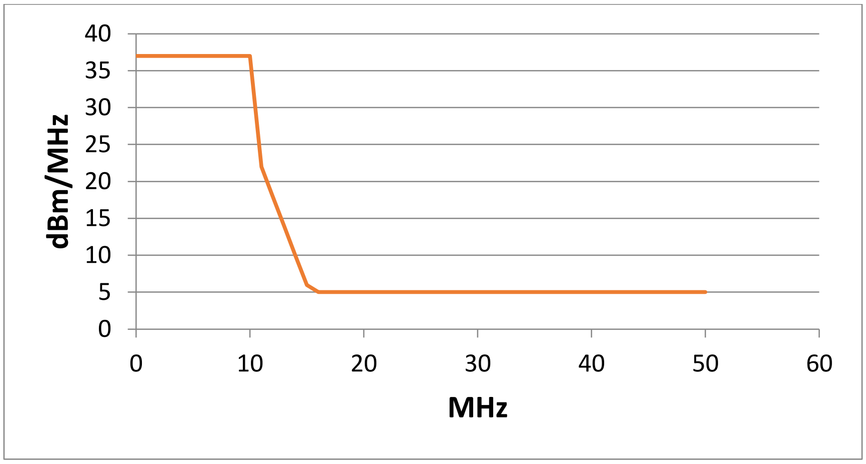
(2) how far away must the P2MP base station be in order to avoid saturation of the earth station LNB?

4.1. Out of band emissions

The *NPRM* asks whether the OOBE limits in Section 101.111 should be applied to P2MP base station emissions. Using the Section 101.111(a)(2)(i) limits, Figure 10 shows that the minimum EIRP that would fall within the adjacent satellite channel is 5 dBm/MHz (-13 dBm/MHz + 18 dBi). This would happen when the satellite channel center frequency is

separated by 32 MHz or more from the center frequency of the P2MP channel. Smaller frequency separation will increase the OOBE level.

Figure 10: Section 101.111(a)(2)(i) limits for EIRP in dBm/MHz

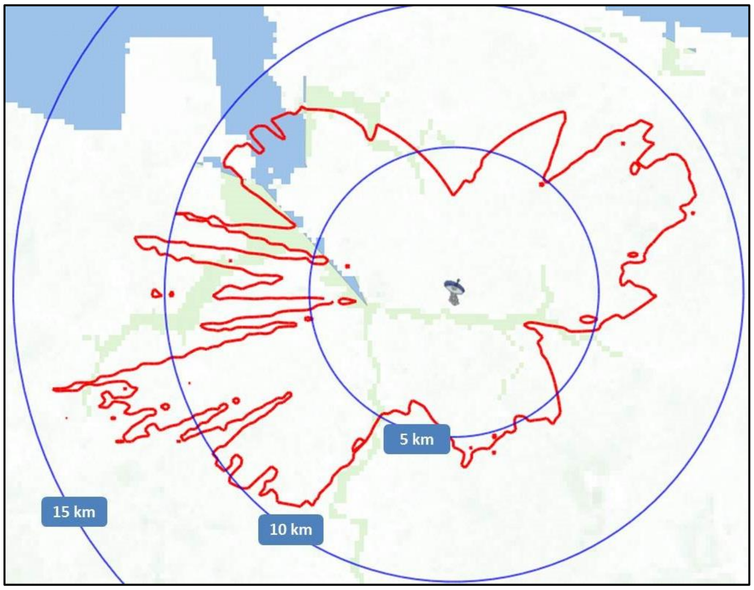


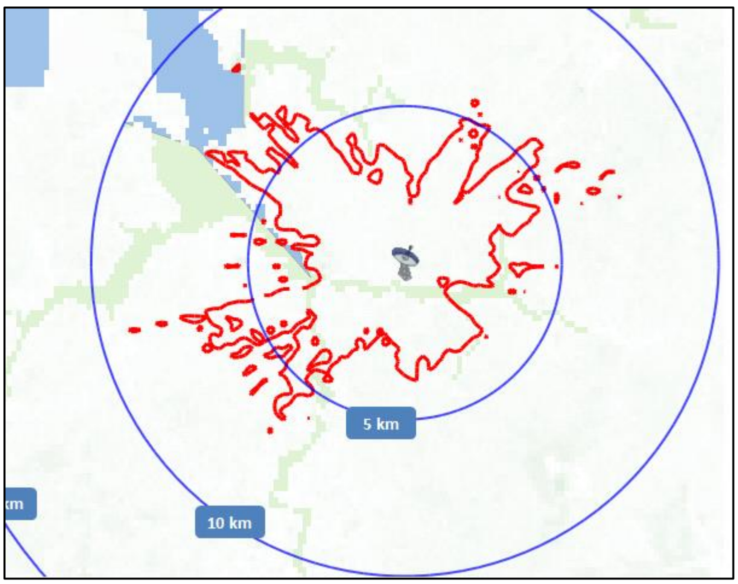
With an OOBE level of 5 dBm/MHz, Figure 11 shows that separation distances of roughly 5 to 15 kilometers would be required in order to meet an I/N criteria of -10 dB for earth stations using different frequencies than the P2MP base station.[19] A higher P2MP base station height leads to larger distances.

The above calculation does not take into account the combined effect of several P2MP base station and user terminals, which would require an even larger separation distance to prevent the aggregated power levels of multiple devices from degrading the satellite signal. Note that clutter attenuation was not included in the simulation because for short distances the clutter model is not accurate without precise terrain/building data.

[19] The Visualyse area analysis was set up in a similar way as described in Section 3, except in this case test points were created at 200 meter intervals.

Figure 11: Virginia Beach, VA Earth station communicating with 131° W.L.
P2MP height: 30 meters (top) and 10 meters (bottom)





4.2. LNB Saturation

Typical C-band LNBs have a 1 dB compression point at an input power of -55 dBm. Figures 12 and 13 show the required separation distances[20] with one, two, and three 20 MHz channels (crx) operated by the P2MP base station in order to limit the total input power at the entry of the LNB to no more than -55 dBm. The total input power is composed of the one, two, or three P2MP channels, plus the total satellite power received in one polarization of the C-band. Required separation distances are on the order of 500 to 1000 meters for earth stations using different frequencies than the P2MP base stations. The typical satellite power flux density ("PFD") on the ground for satellite transmissions in C-band is on the order of -138 dBW/m^2/MHz. The PFD of a P2MP base station at a distance of 50 meters is roughly -37 dBW/m^2/MHz. The difference between the two levels is therefore very large, around 100 dB.

The clutter effect was not taken into account in these calculations for the same reason discussed above.

The analysis also shows that a larger separation distance is required for a P2MP base station with a height of 10 meters compared to a P2MP base station with a height of 30 meters. At the short distances considered the geometry is indeed less favorable when the P2MP is at a lower height such as 10 meters, because the P2MP height is now closer to the earth station antenna height.

It is worth noting that because the P2MP proposal calls for using spectrum that is unused by satellite receivers in certain geographical locations—in a manner akin to TV White Spaces—

[20] The Visualyse area analysis was set up in a similar way as described in Section 3, except in this case test points were created at 10 meter intervals.

the P2MP proposal essentially calls for interlacing P2MP signals with satellite signals whenever possible. Therefore, it is practically and logistically impossible to fit earth stations with band-pass filters (similar to what we propose in Section III) because the frequencies used by P2MP stations could be located anywhere within the satellite spectrum and change over time.

Figure 12: Virginia Beach, VA Earth station communicating with 131° W.L.
P2MP height: 30 meters (top) and 10 meters (bottom)

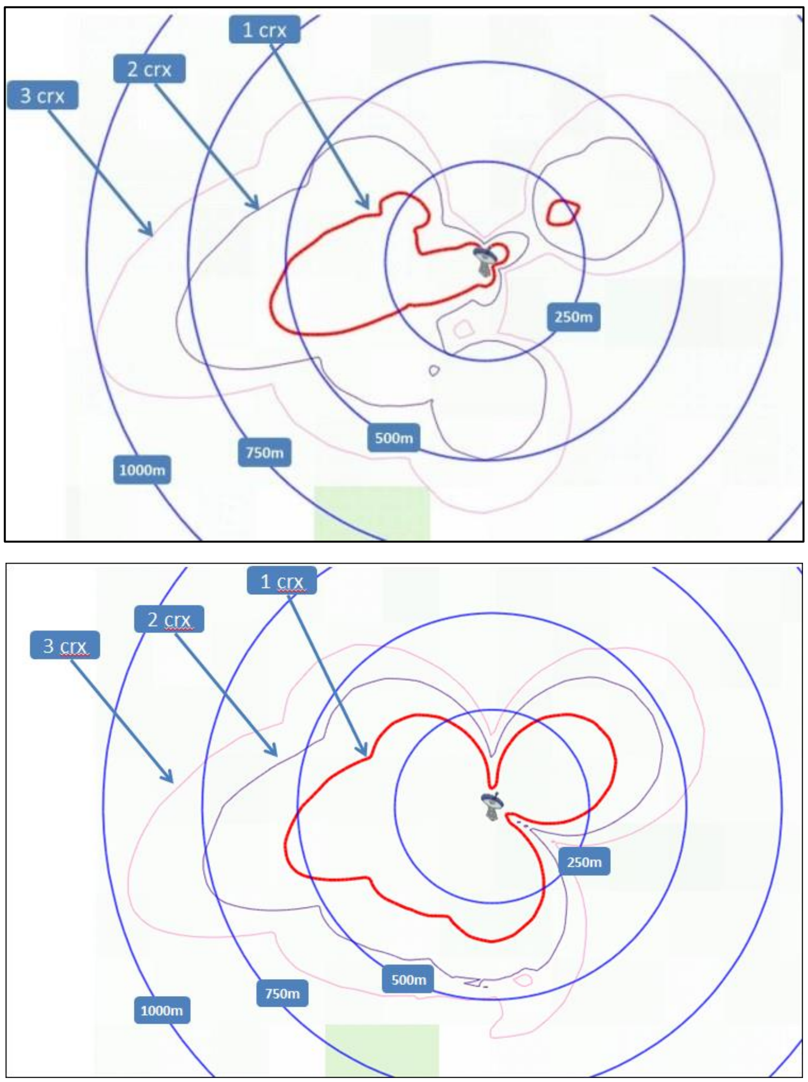
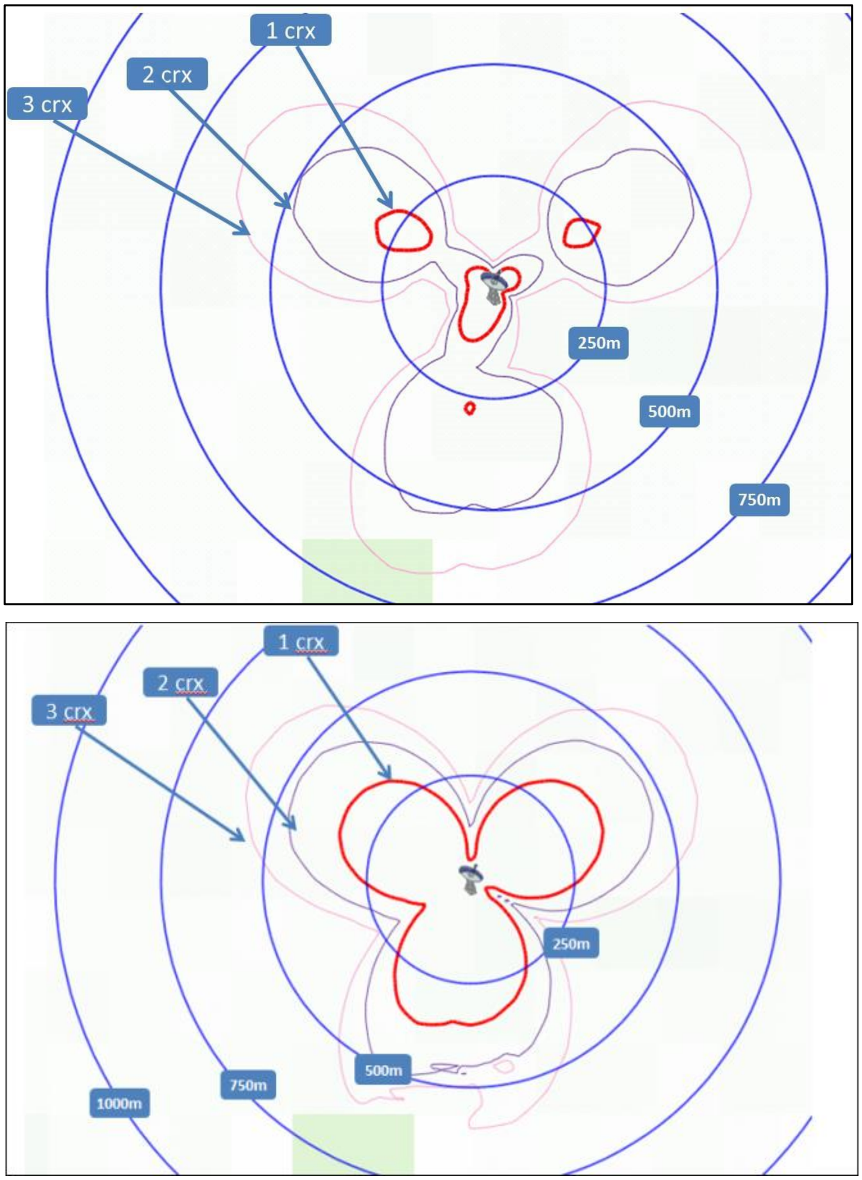


Figure 13: Virginia Beach, VA Earth station communicating with 103° W.L.
P2MP height: 30 meters (top) and 10 meters (bottom)



5. Conclusion

Thousands of satellite earth stations receive FSS transmissions across the full C-band. The analyses above demonstrate that even where that is not the case, a P2MP base station operating in so-called available channels would still impair satellite reception at nearby earth stations.

- Separation distances in excess of 10 kilometers and up to 50 kilometers would be required with respect to FSS earth stations receiving on the same frequency bands.
- In the case of adjacent channel operations, large separation distances would be required to prevent out of band interference (5 kilometers to 15 kilometers) and LNB saturation (500 meters to 1000 meters).

Moreover, these distances do not represent the worst case, as larger distances would be required depending on the specific operating parameters, including FSS earth station elevation angles and varying P2MP base station heights. These distances will also increase when the aggregate effect of multiple P2MP base stations and user terminals near a given earth station is taken into account. Furthermore, the concept of operation for the P2MP presents operational and logistical challenges because the interference environment created by P2MP signals will be different depending on time and location. Therefore, it would not be possible to design a band-pass filter that could address all the P2MP operational permutations.

In short, the facts show that P2MP operations are incompatible with protection of ongoing C-band FSS services. Given the ubiquitous deployment of FSS earth stations, the separation distances needed to avoid co-frequency interference, adjacent frequency interference, and LNB saturation issues will prevent P2MP systems from being introduced in 3.7-4.2 GHz frequencies used for FSS.

EARTH STATION ANNEX

City	State	Latitude	Longitude
Alexander City	AL	32.94705	-85.94179
Andalusia	AL	31.30828	-86.4810399
Andalusia	AL	31.305992	-86.491185
Anniston	AL	33.65495	-85.8293
Anniston	AL	33.659	-85.82458
Arab	AL	34.3324877	-86.50354
Arab	AL	34.30615	-86.49974
Athens	AL	34.83748	-86.97341
Atmore	AL	31.026969	-87.4939474
Auburn	AL	32.55483	-85.5089799
Birmingham	AL	33.46634	-86.83339
Birmingham	AL	33.4647099	-86.85139
Birmingham	AL	33.49924	-86.87971
Centre	AL	34.15027	-85.68419
Cullman	AL	34.17932	-86.86627
Decatur	AL	34.5888	-87.00035
Demopolis	AL	32.49992	-87.83225
Dothan	AL	31.22317	-85.3683099
Dothan	AL	31.25312	-85.3981699
Enterprise	AL	31.31473	-85.85383
Flomaton	AL	30.99995	-87.23326
Florence	AL	34.82289	-87.65156
Florence	AL	34.79569	-87.67676
Foley	AL	30.406832	-87.668636
Fort Payne	AL	34.440308	-85.7044948
Gadsden	AL	34.02319	-86.02007
Guntersville	AL	34.33416	-86.31541
Heflin	AL	33.6389996	-85.5653728
Huntsville	AL	34.72778	-86.595
Huntsville	AL	34.72939	-86.60083
Huntsville	AL	34.65725	-86.57005
Jackson	AL	31.5604889	-87.8773617
Lanett	AL	32.8735	-85.19187
Mobile	AL	30.68801	-88.0610899
Mobile	AL	30.67356	-88.13115
Montgomery	AL	32.37756	-86.31026
Montgomery	AL	32.35996	-86.23456
Oneonta	AL	33.933762	-86.447934
Opp	AL	31.30937	-86.25597
Opp	AL	31.284478	-86.25969

City	State	Latitude	Longitude
Oxford	AL	33.60344	-85.83932
Pell City	AL	33.5883082	-86.3175049
Rainbow City	AL	33.9644232	-86.0285862
Ramer	AL	32.050544	-86.219881
Roanoke	AL	33.1858099	-85.40294
Russellville	AL	34.50582	-87.73129
Scottsboro	AL	34.6736999	-86.0451
Selma	AL	32.47234	-87.05555
Selma	AL	32.41222	-87.02421
Sylacauga	AL	33.171194	-86.2315703
Tallahassee	AL	32.51522	-85.89537
Thomasville	AL	31.8824	-87.74408
Tuscaloosa	AL	33.16765	-87.53471
Tuscaloosa	AL	33.1907564	-87.5266592
Tuscumbia	AL	34.7372	-87.7039
Arkadelphia	AR	34.11682	-93.05514
Barling	AR	35.32337	-94.31694
Benton	AR	34.5674	-92.58513
Blytheville	AR	35.92666	-89.90439
Conway	AR	35.09319	-92.43892
Conway	AR	35.08687	-92.44061
Crossett	AR	33.13474	-91.94702
Danville	AR	35.05548	-93.39236
Dermott	AR	33.5599599	-91.38509
Fayetteville	AR	36.07983	-94.18486
Fayetteville	AR	36.12767	-94.14377
Fort Smith	AR	35.38073	-94.41721
Fort Smith	AR	35.27811	-94.37663
Hardy	AR	36.27475	-91.50575
Harrison	AR	36.24244	-93.11082
Harrison	AR	36.22401	-93.11152
Harrison	AR	36.26323	-93.13731
Helena	AR	34.5286908	-90.6298688
Little Rock	AR	34.7471	-92.2758
Marked Tree	AR	35.528843	-90.415916
Mountain Home	AR	36.34298	-92.3798599
Newport	AR	35.61243	-91.25382
Paragould	AR	36.05093	-90.46262
Paragould	AR	36.0369009	-90.5147916
Pine Bluff	AR	34.22108	-91.9727599
Pocahontas	AR	36.27676	-90.95492
Texarkana	AR	33.46013	-94.01594

City	State	Latitude	Longitude
Cottonwood	AZ	34.7207999	-111.98983
Douglas	AZ	31.35551	-109.55283
Flagstaff	AZ	35.18297	-111.66117
Flagstaff	AZ	35.2119799	-111.61362
Globe	AZ	33.40946	-110.80988
Lake Havasu City	AZ	34.47815	-114.33756
Lake Havasu City	AZ	34.47373	-114.33318
Lakeside	AZ	34.1640551	-109.9738666
Maricopa	AZ	33.071809	-112.046961
Mesa	AZ	33.4146651	-111.8656061
Payson	AZ	34.22692	-111.33029
Peridot	AZ	33.3335099	-109.97142
Phoenix	AZ	33.45809	-112.07422
Phoenix	AZ	33.4512849	-111.9838001
Prescott	AZ	34.55024	-112.46355
Safford	AZ	32.83574	-109.73098
Sedona	AZ	34.8599792	-111.8186598
Show Low	AZ	34.24744	-110.04696
Show Low	AZ	34.2674	-110.02693
Thatcher	AZ	32.8312551	-109.7557372
Tucson	AZ	32.26564	-110.97657
Tucson	AZ	32.2777219	-111.0179941
Tucson	AZ	32.22193	-110.89736
Willcox	AZ	32.249823	-109.826906
Window Rock	AZ	35.6630246	-109.0479391
Yuma	AZ	32.67587	-114.62812
Yuma	AZ	32.67695	-114.587231
Alturas	CA	41.50664	-120.50055
Avalon	CA	33.342	-118.328917
Bakersfield	CA	35.43765	-119.07133
Bakersfield	CA	35.36808	-119.05882
Big Bear City	CA	34.26193	-116.85666
Bishop	CA	37.37554	-118.39454
Bishop	CA	37.34555	-118.39565
Borrego Springs	CA	33.258098	-116.370829
Burbank	CA	34.15354	-118.33638
Cambria	CA	35.5634195	-121.0902199
Colton	CA	34.04733	-117.31284
Crescent City	CA	41.7702183	-124.199426
El Centro	CA	32.79315	-115.55303
Esparto	CA	38.692583	-122.018462
Eureka	CA	40.74208	-124.2014

City	State	Latitude	Longitude
Frazier Park	CA	34.824044	-118.947486
Fresno	CA	36.75742	-119.79669
Hesperia	CA	34.46769	-117.29319
Jackson	CA	38.34981	-120.77499
Kernville	CA	35.75579	-118.41997
Lakeport	CA	39.04266	-122.91473
Los Angeles	CA	34.15307	-118.46565
Los Angeles	CA	34.04953	-118.44775
Los Angeles	CA	34.04007	-118.37066
Mammoth Lakes	CA	37.59716	-118.91563
Newhall	CA	34.37927	-118.52795
Palm Springs	CA	33.8235	-116.52376
Paso Robles	CA	35.64763	-120.69467
Quartz Hill	CA	34.64587	-118.2181
Red Bluff	CA	40.1769	-122.24167
Redding	CA	40.58564	-122.39181
Redlands	CA	34.0472899	-117.16945
Ridgecrest	CA	35.63441	-117.67137
Riverside	CA	33.93083	-117.39637
Sacramento	CA	38.66131	-121.33944
San Bruno	CA	37.627855	-122.44736
San Diego	CA	32.879519	-117.202275
San Jose	CA	37.32881	-121.85791
San Luis Obispo	CA	35.259226	-120.6439271
Santa Cruz	CA	36.9619799	-121.98176
Santa Maria	CA	34.94025	-120.43638
Santa Maria	CA	34.91852	-120.45465
Santa Rosa	CA	38.43314	-122.68708
Santa Rosa	CA	38.4209	-122.749235
Sonora	CA	37.98051	-120.38189
Stockton	CA	37.92543	-121.24657
Stockton	CA	38.0124	-121.32039
Susanville	CA	40.41548	-120.64651
Temecula	CA	33.51536	-117.16674
Victorville	CA	34.4763	-117.29191
Westwood	CA	40.306202	-121.000605
Yreka	CA	41.72205	-122.64336
Los Angeles	CA	34.0622351	-118.3517091
Pleasanton	CA	37.68996	-121.92995
Redlands	CA	34.06819	-117.2196
Sacramento	CA	38.66131	-121.33944
San Diego	CA	32.77489	-117.15777

City	State	Latitude	Longitude
San Francisco	CA	37.7856499	-122.39839
San Francisco	CA	37.80022	-122.39956
San Jose	CA	37.33226	-121.89277
San Luis Obispo	CA	35.25541	-120.64143
Santa Maria	CA	34.94025	-120.43638
Santa Maria	CA	34.91852	-120.45465
Solvang	CA	34.59626	-120.1384
Victorville	CA	34.4763	-117.29191
Alamosa	CO	37.47285	-105.85498
Aspen	CO	39.21936	-106.85968
Aspen	CO	39.1869	-106.81612
Aurora	CO	39.66528	-104.86083
Avon	CO	39.63308	-106.52121
Breckenridge	CO	39.4823499	-106.04762
Canon City	CO	38.46036	-105.22547
Denver	CO	39.62691	-104.89873
Denver	CO	39.62806	-104.91229
Durango	CO	37.2847099	-107.87735
Englewood	CO	39.60942	-104.8982599
Fort Morgan	CO	40.2546	-103.84802
Glenwood Springs	CO	39.5176439	-107.318619
Grand Junction	CO	39.06998	-108.56929
Grand Junction	CO	39.09988	-108.62394
Grand Junction	CO	39.07965	-108.56684
Grand Junction	CO	39.11321	-108.53496
Greeley	CO	40.4246079	-104.696035
La Junta	CO	37.98715	-103.56571
Lamar	CO	38.07682	-102.61703
Lamar	CO	38.1146	-102.62123
Loveland	CO	40.43661	-104.99515
Monte Vista	CO	37.5804	-106.14688
Montrose	CO	38.48686	-107.85951
Pagosa Springs	CO	37.25645	-107.01837
Pueblo	CO	38.29063	-104.60795
Salida	CO	38.53246	-106.01616
Sterling	CO	40.62487	-103.22394
Windsor	CO	40.48036	-104.9062
Bloomfield	CT	41.81324	-72.69625
Bridgeport	CT	41.1635926	-73.18641
Greenwich	CT	41.02914	-73.62458
Hamden	CT	41.36723	-72.93986
Hartford	CT	41.75913	-72.66932

City	State	Latitude	Longitude
Washington	DC	38.8782799	-77.00763
Washington	DC	38.92036	-77.01999
Altamonte Springs	FL	28.6676	-81.431
Blountstown	FL	30.4543875	-85.042653
Bonita Springs	FL	26.3261499	-81.77406
Crestview	FL	30.76668	-86.58532
Cross City	FL	29.6359715	-83.1230751
Defuniak Springs	FL	30.72846	-86.11837
Fort Pierce	FL	27.45517	-80.3669
Fort Walton Beach	FL	30.414	-86.67047
Gainesville	FL	29.65191	-82.33011
Hudson	FL	28.35841	-82.69848
Inglis	FL	28.84899	-82.49559
Jacksonville	FL	30.31201	-81.59235
Jacksonville	FL	30.24172	-81.59604
Jacksonville	FL	30.277	-81.56246
Lake City	FL	30.18748	-82.63916
Lake City	FL	30.15504	-82.63894
Lake City	FL	30.25442	-82.68198
Largo	FL	27.90857	-82.78092
Leesburg	FL	28.82877	-81.78683
Live Oak	FL	30.28709	-82.965
Marathon	FL	24.69255	-81.10848
Marianna	FL	30.77567	-85.23118
Melbourne	FL	28.1123701	-80.6727349
Miami	FL	25.94584	-80.20368
Miami	FL	25.96404	-80.20633
Mims	FL	28.66294	-80.92134
Ocala	FL	29.20711	-82.08654
Ocala	FL	29.18788	-82.10592
Ocala	FL	29.15977	-82.17401
Ocala	FL	29.18038	-82.17896
Ocala	FL	29.18788	-82.10592
Orlando	FL	28.63194	-81.40179
Orlando	FL	28.52852	-81.31134
Palm Beach Gardens	FL	26.80792	-80.10746
Panama City	FL	30.17236	-85.61365
Panama City Beach	FL	30.17967	-85.76163
Pensacola	FL	30.41908	-87.21733
Pensacola	FL	30.4283	-87.18678
Pensacola	FL	30.48218	-87.26163

City	State	Latitude	Longitude
Perry	FL	30.10793	-83.56649
Saint Augustine	FL	29.85076	-81.3298499
Sarasota	FL	27.30873	-82.49644
Starke	FL	29.93108	-82.10337
Stuart	FL	27.22497	-80.26524
Tampa	FL	27.95168	-82.5164999
Vero Beach	FL	27.63128	-80.39576
White Cty/Ft Pierce	FL	27.34123	-80.3262699
Albany	GA	31.60258	-84.15199
Americus	GA	32.08281	-84.25791
Athens	GA	33.94115	-83.39866
Atlanta	GA	33.7874937	-84.3832983
Atlanta	GA	33.78476	-84.3899
Atlanta	GA	33.72375	-84.36929
Atlanta	GA	33.7874937	-84.3832983
Atlanta	GA	33.90741	-84.36228
Augusta	GA	33.4538	-82.02922
Blue Ridge	GA	34.86778	-84.33293
Brunswick	GA	31.2152702	-81.4879879
Cairo	GA	30.90221	-84.2287
Calhoun	GA	34.49471	-84.95124
Clarkesville	GA	34.61757	-83.51743
Claxton	GA	32.16717	-81.90132
Clayton	GA	34.8878	-83.39713
Columbus	GA	32.4724541	-84.9745149
Douglas	GA	31.51426	-82.84902
Du Pont	GA	31.1994119	-83.2264393
Dublin	GA	32.53752	-82.91677
Eastman	GA	32.1887	-83.17216
Elberton	GA	34.11403	-82.88093
Elberton	GA	34.113672	-82.864572
Gainesville	GA	34.31605	-83.82972
Good Hope	GA	33.74697	-83.55597
Greensboro	GA	33.45415	-83.24457
Hawkinsville	GA	32.28063	-83.44159
Hazlehurst	GA	31.85082	-82.55504
Jesup	GA	31.60132	-81.9305
Kingsland	GA	30.80126	-81.67959
La Grange	GA	33.03739	-85.03166
Lafayette	GA	34.71498	-85.26886
Lavonia/Hartwell	GA	34.4352743	-83.1075018
Metter	GA	32.39908	-82.04327

City	State	Latitude	Longitude
Milledgeville	GA	33.08315	-83.2497999
Milledgeville	GA	33.09607	-83.1923
Moultrie	GA	31.16564	-83.76536
Royston	GA	34.27946	-83.11905
Sandersville	GA	32.97405	-82.80388
Savannah	GA	32.08984	-81.14579
Savannah	GA	31.99313	-81.13305
Savannah	GA	32.0415599	-81.08753
Savannah	GA	32.0026183	-81.1119966
Statesboro	GA	32.45528	-81.77379
Swainsboro	GA	32.5799449	-82.3832205
Tallapoosa	GA	33.7410142	-85.27673
Tamuning	GA	13.4867418	144.7802567
Tennille	GA	32.91434	-82.88127
Thomaston	GA	32.8867199	-84.32662
Tifton	GA	31.46648	-83.47425
Toccoa	GA	34.5790539	-83.3316849
Trenton	GA	34.8743615	-85.5078187
Trenton	GA	34.8672933	-85.5128832
Valdosta	GA	30.83123	-83.27937
Vidalia	GA	32.21997	-82.43528
Washington	GA	33.73383	-82.71923
Watkinsville	GA	33.9154	-83.47533
West Point	GA	32.8765	-85.18583
Young Harris	GA	34.92816	-83.84918
Albia	IA	41.0272649	-92.8080499
Algona	IA	43.07014	-94.23828
Ames	IA	42.02529	-93.61622
Cedar Rapids	IA	42.49442	-92.34143
Cedar Rapids	IA	41.97567	-91.6657
Clinton	IA	41.90959	-90.22494
Davenport	IA	41.5322699	-90.5738499
Davenport	IA	41.54883	-90.52338
Des Moines	IA	41.58513	-93.64667
Dubuque	IA	42.50802	-90.75584
Fairfield	IA	41.0060785	-91.9623551
Forest City	IA	43.28428	-93.6312
Fort Dodge	IA	42.50766	-94.1856899
Gilman	IA	41.880119	-92.785273
Goldfield	IA	42.742449	-93.922311
Grinnell	IA	41.74363	-92.72605
Grundy Center	IA	42.362446	-92.765942

City	State	Latitude	Longitude
Independence	IA	42.45474	-91.89045
Iowa City	IA	41.68767	-91.54428
Iowa City	IA	41.60073	-91.50099
Knoxville	IA	41.3325699	-93.10959
Martelle	IA	42.020363	-91.356522
Newton	IA	41.71119	-93.02972
Oskaloosa	IA	41.32054	-92.64706
Ottumwa	IA	41.01475	-92.40892
Perry	IA	41.83495	-94.03727
Plainfield	IA	42.843424	-92.53636
Red Oak	IA	41.0170518	-95.204649
Rudd	IA	43.13109	-92.90525
Sioux City	IA	42.50253	-96.40386
Stratford	IA	42.271398	-93.936781
Washington	IA	41.29972	-91.69109
Waterloo	IA	42.4987799	-92.33625
Boise	ID	43.60338	-116.19019
Boise	ID	43.61867	-116.24674
Bonners Ferry	ID	48.75595	-116.28752
Hailey	ID	43.51833	-114.31486
Jerome	ID	42.73042	-114.53932
Lapwai/Lewiston	ID	46.3902423	-117.0828049
Lewiston	ID	46.42287	-117.02796
Lewiston	ID	46.39188	-116.99114
Montpelier	ID	42.31701	-111.32308
Moscow	ID	46.74675	-117.00757
Osburn	ID	47.5072842	-116.0021355
Pocatello	ID	42.86515	-112.45542
Preston	ID	42.09537	-111.87333
Rupert	ID	42.6020053	-113.7246177
Twin Falls	ID	42.54319	-114.47101
Anna	IL	37.45937	-89.24916
Atlanta	IL	40.24418	-89.2634099
Beardstown	IL	40.01799	-90.43474
Belleville	IL	38.5534899	-90.0411
Canton	IL	40.54601	-90.0207
Carlyle	IL	38.63999	-89.3777999
Carthage	IL	40.41272	-91.13673
Centralia	IL	38.525084	-89.0978604
Champaign	IL	40.12454	-88.23357
Champaign	IL	40.08464	-88.2483
Chicago	IL	41.9388999	-87.76138

City	State	Latitude	Longitude
Chicago	IL	41.8853378	-87.6224249
Chicago	IL	41.74033	-87.59931
Chicago	IL	41.88514	-87.62313
Chicago	IL	41.89035	-87.62333
Chicago	IL	41.89221	-87.61975
Chicago	IL	41.89001	-87.6214651
Cissna Park	IL	40.56388	-87.8942
Cissna Park	IL	40.56388	-87.8942
Decatur	IL	39.84501	-88.9537299
DeKalb	IL	41.9525999	-88.74464
DeKalb	IL	41.95343	-88.7234299
Dixon	IL	41.82382	-89.58127
Du Quoin	IL	38.01124	-89.23837
Effingham	IL	39.11889	-88.5459
Elmwood Prk/Chicago	IL	41.8853378	-87.6224249
Farmer City	IL	40.24698	-88.64292
Flanagan	IL	40.8784296	-88.8539776
Freeport	IL	42.31281	-89.59369
Havana	IL	40.31048	-90.0553
Hoopeston	IL	40.4579067	-87.6870174
Marion	IL	37.72947	-88.89813
Marseilles	IL	41.326858	-88.700468
Mattoon	IL	39.48155	-88.37585
Mattoon	IL	39.48075	-88.37675
Metropolis	IL	37.15319	-88.70934
Morris	IL	41.35705	-88.42569
Nashville	IL	38.34353	-89.38191
Oglesby	IL	41.30426	-89.09477
Olney	IL	38.7004	-88.08135
Paxton	IL	40.46344	-88.09432
Peoria	IL	40.69153	-89.59195
Pittsfield	IL	39.6047449	-90.832785
Pontiac	IL	40.8808099	-88.63008
Princeton	IL	41.35284	-89.46804
Quincy	IL	39.93704	-91.1941499
Quincy	IL	39.93583	-91.37739
Ramsey	IL	39.1355999	-89.10118
Rockford	IL	42.33063	-89.08296
Rockford	IL	42.28013	-89.03679
Salem	IL	38.626239	-88.948715
Urbana	IL	40.08335	-88.18763
Watseka	IL	40.7756918	-87.708384

City	State	Latitude	Longitude
Waukegan	IL	42.34879	-87.88246
Wheeling	IL	42.1449	-87.90993
Angola	IN	41.67692	-85.00345
Batesville	IN	39.29739	-85.22366
Berne	IN	40.66585	-84.95517
Bloomington	IN	39.16885	-86.53446
Bloomington	IN	39.16399	-86.4728499
Boonville	IN	38.06481	-87.27419
Brazil	IN	39.52283	-87.12945
Connersville	IN	39.64056	-85.13983
Covington	IN	40.14464	-87.39205
Crawfordsville	IN	40.0653	-86.93226
Evansville	IN	37.9711706	-87.5725197
Fowler	IN	40.6081249	-87.3344229
Franklin	IN	39.51345	-86.06871
Ft. Wayne	IN	41.00447	-85.09857
Ft. Wayne	IN	41.01991	-85.16224
Greenfield	IN	39.87088	-85.76467
Greensburg	IN	39.32813	-85.50147
Hammond	IN	41.58388	-87.48134
Indianapolis	IN	39.9211007	-86.1574439
Indianapolis	IN	39.86501	-86.06093
Indianapolis	IN	39.73874	-86.0907
Jeffersonville	IN	38.2930283	-85.7502265
Kokomo	IN	40.4188856	-86.1148356
La Porte	IN	41.6066905	-86.7296432
Madison	IN	38.7414	-85.36145
Marion	IN	40.49248	-85.6441
Mount Vernon	IN	37.93401	-87.92638
Muncie	IN	40.16076	-85.37797
New Paris	IN	41.500426	-85.833656
North Vernon	IN	39.0215	-85.64698
Oxford	IN	40.51961	-87.24928
Peru	IN	40.7648	-86.04079
Portland	IN	40.43788	-85.01496
Richmond	IN	39.82814	-84.93263
Richmond	IN	39.8893049	-84.9378781
Rochester	IN	41.06621	-86.21527
Rockville	IN	39.72714	-87.29901
South Bend	IN	41.7268	-86.2968099
Sunman	IN	39.238523	-85.09297
Vincennes	IN	38.68622	-87.51997

City	State	Latitude	Longitude
Wabash	IN	40.78592	-85.82042
West Baden	IN	38.59521	-86.61296
Arkansas City	KS	37.06269	-97.03859
Belleville	KS	39.9722904	-97.6128368
Beloit	KS	39.4518234	-98.0866134
Buhler	KS	38.13414	-97.76988
Chanute	KS	37.68848	-95.47042
Dodge City	KS	37.7788174	-100.0164302
Dodge City	KS	37.730549	-100.044804
Emporia	KS	38.40968	-96.22131
Garden City	KS	37.97534	-100.8646
Great Bend	KS	38.36143	-98.80646
Hays	KS	38.8685	-99.3281
Hiawatha	KS	39.77301	-95.52613
Hutchinson	KS	38.05878	-97.9309
Iola	KS	37.89795	-95.40792
Kansas City	KS	39.06854	-94.70244
La Crosse	KS	38.53085	-99.31011
Liberal	KS	37.05365	-100.9411
Mission	KS	39.01672	-94.66645
Overland Park	KS	38.90742	-94.66477
Parsons	KS	37.34023	-95.263
Pratt	KS	37.64617	-98.74878
Ulysses	KS	37.58018	-101.35764
Wichita	KS	37.66342	-97.46167
Wichita	KS	37.7211799	-97.2607
Wichita	KS	37.68453	-97.23227
Winfield	KS	37.2401828	-96.9969864
Ashland	KY	38.47872	-82.64045
Barbourville	KY	36.86606	-83.88627
Barbourville	KY	36.85268	-83.85459
Benton	KY	36.85818	-88.3365199
Bowling Green	KY	36.99433	-86.44033
Campbellsville	KY	37.34072	-85.34507
Campbellsville	KY	37.33538	-85.37585
Danville	KY	37.64624	-84.7746
Franklin	KY	36.72293	-86.58057
Glasgow	KY	37.00069	-85.92439
Glasgow	KY	36.9968999	-85.91336
Grayson	KY	38.32908	-82.97547
Hardinsburg	KY	37.78205	-86.46201
Harlan	KY	36.8461149	-83.3227164

City	State	Latitude	Longitude
Harlan	KY	36.845993	-83.3227467
Henderson	KY	37.84044	-87.59116
Lebanon	KY	37.56852	-85.25579
Leitchfield	KY	37.50859	-86.2898699
Lexington	KY	37.99899	-84.52197
London	KY	37.1415099	-84.0791
Louisville	KY	38.22088	-85.7624
Louisville	KY	38.2512909	-85.7576072
Louisville	KY	38.2495	-85.78579
Louisville	KY	38.19638	-85.68521
Mayking	KY	37.13203	-82.76104
Maysville	KY	38.64202	-83.75066
Monticello	KY	36.83747	-84.8637
Monticello	KY	36.85218	-84.83519
Monticelo	KY	36.86797	-84.81421
Morehead	KY	38.18156	-83.4338
Owensboro	KY	37.74121	-87.1166
Paducah	KY	37.09704	-88.62311
Paducah	KY	37.01317	-88.61548
Pikesville	KY	37.48027	-82.52686
Prestonsburg	KY	37.68133	-82.7804
Russell Springs	KY	37.0784093	-85.174217
Salyersville	KY	37.754963	-83.059024
Scottsville	KY	36.75269	-86.18495
Somerset	KY	37.11775	-84.61124
Somerset	KY	37.08075	-84.66089
Stanford	KY	37.5290899	-84.66067
Vanceburg	KY	38.58547	-83.32628
West Liberty	KY	37.9204099	-83.2574
Alexandria	LA	31.30408	-92.45253
Baton Rouge	LA	30.4502	-91.13326
Baton Rouge	LA	30.42391	-91.13331
Bogalusa	LA	30.84218	-89.83401
Eunice	LA	30.49461	-92.41662
Eunice	LA	30.47194	-92.41365
Ferriday	LA	31.6381926	-91.5545194
Ft. Polk	LA	39.78373	-100.445882
Hammond	LA	30.50425	-90.45968
Jena	LA	31.6840926	-92.1318948
Lafayette	LA	30.22484	-92.0573
Lake Charles	LA	30.23782	-93.22685
Lake Charles	LA	30.23506	-93.20405

City	State	Latitude	Longitude
Leesville	LA	31.05126	-93.27942
Leesville	LA	31.1409759	-93.2954168
Many	LA	31.56912	-93.48475
Metairie	LA	30.00192	-90.1842099
Minden	LA	32.63064	-93.28155
Monroe	LA	32.51567	-92.11346
New Orleans	LA	29.95122	-90.07127
New Orleans	LA	29.94831	-90.06799
Shreveport	LA	32.44914	-93.87351
Shreveport	LA	32.5357901	-93.7635549
Slidell	LA	30.25273	-89.76319
Springhill	LA	33.0041147	-93.4613949
Sterlington	LA	32.90897	-92.23514
Thibodaux	LA	29.79817	-90.8201799
Vivian	LA	32.9024	-93.98231
Winnfield	LA	31.94802	-92.62866
Braintree	MA	42.23227	-70.96967
Fairhaven	MA	41.63922	-70.88191
Gardner	MA	42.59057	-71.98724
Great Barrington	MA	42.21324	-73.3446699
Hyannis	MA	41.65302	-70.32199
Hyannis	MA	41.65753	-70.28354
Lowell	MA	42.64211	-71.30884
Medford	MA	42.40541	-71.07455
Milford	MA	42.13794	-71.52099
Needham	MA	42.30525	-71.22787
North Truro	MA	42.0234499	-70.07571
Orange	MA	42.59041	-72.30935
Paxton	MA	42.3086	-71.90138
Pittsfield	MA	42.44993	-73.25287
Pittsfield	MA	42.44446	-73.27854
Russell	MA	42.18989	-72.85598
Annapolis	MD	38.98357	-76.52284
Baltimore	MD	39.38264	-76.73249
Cumberland	MD	39.6460999	-78.75196
Frederick	MD	39.41605	-77.45831
Hagerstown	MD	39.66784	-77.72554
Hagerstown	MD	39.61905	-77.73623
Loch Lynn Heights	MD	39.39352	-79.36699
McHenry	MD	39.5584	-79.36139
Mechanicsville	MD	38.43891	-76.73408
Pocomoke City	MD	38.0529	-75.56877

City	State	Latitude	Longitude
Rockville	MD	39.05951	-77.12299
Salisbury	MD	38.36099	-75.61717
Thurmont	MD	39.62704	-77.40259
Brewer	ME	44.78514	-68.75852
Calais	ME	45.18549	-67.26931
Houlton	ME	46.12417	-67.83985
Houlton	ME	46.1186407	-67.8251933
Kennebunkport	ME	43.36256	-70.47013
Norway	ME	44.21242	-70.53755
Portland	ME	43.6572602	-70.256656
Presque Isle	ME	46.68318	-68.0155599
Waterville	ME	44.54388	-69.66763
Alma	MI	43.36877	-84.60426
Bad Axe	MI	43.8006	-83.02287
Battle Creek	MI	42.29364	-85.18493
Battle Creek	MI	42.32136	-85.18389
Big Rapids	MI	43.6981851	-85.4816609
Burton	MI	42.97298	-83.63927
Caro	MI	43.4755899	-83.41389
Detroit	MI	42.36924	-83.07678
Flint	MI	43.0149	-83.69382
Grand Rapids	MI	42.9642399	-85.67201
Grand Rapids	MI	42.9644	-85.66982
Hancock	MI	47.1264899	-88.58434
Hancock	MI	47.12786	-88.58451
Hastings	MI	42.64903	-85.28831
Iron Mountain	MI	45.82351	-88.06412
Iron River	MI	46.0914242	-88.6475903
Ironwood	MI	46.4646	-90.13815
Ironwood	MI	46.45238	-90.17027
Kalamazoo	MI	42.32756	-85.52573
Lansing	MI	42.68014	-84.50292
Manistee	MI	44.2476	-86.32189
Marquette	MI	46.5474	-87.41731
Midland	MI	43.61469	-84.221
Midland	MI	43.6088499	-84.23652
Monroe	MI	41.91677	-83.39748
Muskegon	MI	43.18792	-86.23632
Negaunee	MI	46.501276	-87.610489
Newberry	MI	46.3132674	-85.5098196
Newbery	MI	46.35507	-85.51158

City	State	Latitude	Longitude
Niles	MI	41.83703	-86.25368
Onaway	MI	45.65844	-84.49002
Ontonagon	MI	46.8729941	-89.3187378
Petoskey	MI	45.3552	-84.96774
Port Huron	MI	42.98238	-82.42441
Prudenville	MI	44.30408	-84.64158
Southfield	MI	42.48885	-83.30445
Sturgis	MI	41.76988	-85.4193
Tawas City	MI	44.2654058	-83.5402393
Three Rivers	MI	41.92794	-85.6373799
Traverse City	MI	44.77543	-85.64105
Traverse City	MI	44.7574477	-85.5767589
West Branch	MI	44.2764552	-84.2549577
Wyoming	MI	42.93575	-85.69971
Aitkin	MN	46.3575299	-94.21544
Albany	MN	45.63162	-94.59933
Albert Lea	MN	43.64464	-93.38883
Albert Lea	MN	43.64739	-93.37935
Alexandria	MN	45.8772	-95.37826
Austin	MN	43.61863	-92.98967
Barnesville	MN	46.647175	-96.412386
Bemidji	MN	47.44168	-94.86632
Benson	MN	45.31487	-95.60027
Brainerd	MN	46.3575299	-94.21544
Buffalo	MN	45.16671	-93.91983
Detroit Lakes	MN	46.81286	-95.83398
Duluth	MN	46.7999	-92.13148
Eveleth	MN	47.47978	-92.5322599
Faribault	MN	44.29719	-93.26787
Glencoe	MN	44.76844	-94.15212
Glenwood	MN	45.64972	-95.38872
Hutchinson	MN	44.9098177	-94.3675567
Marshall	MN	44.44919	-95.76233
Minneapolis	MN	44.9665729	-93.3455711
Minot	MN	48.2114199	-101.30729
Montevideo	MN	44.9337307	-95.7457628
New Prague	MN	44.57757	-93.50378
New Ulm	MN	44.31667	-94.4627299
North Mankato	MN	44.17298	-94.03928
Northfield	MN	44.45822	-93.15938
Owatonna	MN	44.06565	-93.22229
Park Rapids	MN	46.92885	-95.00688

City	State	Latitude	Longitude
Preston	MN	43.6722075	-92.0831435
Princeton	MN	45.5541399	-93.5829
Rochester	MN	44.01905	-92.46559
Rochester	MN	44.00306	-92.48603
St. Cloud	MN	45.5760022	-94.1526735
Stillwater	MN	45.0564944	-92.8062975
Two Harbors	MN	47.035829	-91.670988
Westbrook	MN	44.040073	-95.436008
Windom	MN	43.866555	-95.113332
Worthington	MN	43.63011	-95.67852
Bethany	MO	40.2575269	-94.0270699
Boonville	MO	38.94599	-92.77164
Branson	MO	36.64581	-93.22645
Camdenton	MO	38.0083634	-92.7443717
Cameron	MO	39.7594949	-94.232942
Cape Girardeau	MO	37.27935	-89.55929
Farmington	MO	37.79213	-90.40994
Independence	MO	39.03467	-94.35788
Kahoka	MO	40.4245152	-91.7114204
Kansas City	MO	38.92241	-94.52974
Lake St. Louis	MO	38.80185	-90.76867
Lebanon	MO	37.68586	-92.69355
Louisiana	MO	39.44863	-91.05098
Mexico	MO	39.16665	-91.86219
Moberly	MO	39.41952	-92.43943
Montgomery City	MO	38.9856966	-91.5103627
Piedmont	MO	37.15508	-90.69416
Poplar Bluff	MO	36.75884	-90.40509
Saint Louis	MO	38.62453	-90.1881
Saint Louis	MO	38.6295915	-90.2083892
Sikeston	MO	39.78373	-100.445882
St. Joseph	MO	39.7791	-94.79301
St. Louis	MO	38.59995	-90.39752
St. Louis	MO	38.527784	-90.4033473
St. Louis	MO	38.80185	-90.76867
St. Robert	MO	37.81967	-92.15133
Sullivan	MO	38.22168	-91.16949
Trenton	MO	40.07417	-93.61859
Washington	MO	38.55737	-91.01836
West Plains	MO	36.74372	-91.83532
Columbus	MS	33.49709	-88.4272

City	State	Latitude	Longitude
Corinth	MS	34.931509	-88.517829
Crystal Springs	MS	31.97842	-90.35983
Grenada	MS	33.77958	-89.82635
Hattiesburg	MS	31.40139	-89.39054
Rolling Fork	MS	32.903689	-90.868747
Vicksburg	MS	32.36049	-90.6671
Billings	MT	45.78093	-108.51235
Bridger	MT	45.294649	-108.911273
Butte	MT	45.98294	-112.52614
Forsyth	MT	46.270815	-106.650072
Laurel	MT	45.669291	-108.777508
Missoula	MT	46.85305	-114.0219
Missoula	MT	46.84084	-114.03903
Polson	MT	47.6456	-114.12575
Shelby	MT	48.51336	-111.85511
Three Forks	MT	45.897818	-111.550959
Albermarle	NC	35.36157	-80.17679
Albermarle	NC	35.36157	-80.17679
Asheville	NC	35.5945054	-82.6019268
Belmont	NC	35.2499899	-81.05713
Brevard	NC	35.23431	-82.7351
Charlotte	NC	35.26403	-80.76998
Durham	NC	36.0254057	-78.9028462
Fayetteville	NC	35.04882	-78.86915
Fayetteville	NC	35.04745	-78.92628
Franklin	NC	35.2110399	-83.36866
Greensboro	NC	36.07304	-79.9619
Greensboro	NC	36.079	-79.96361
Greensboro	NC	36.0657	-79.78982
Henderson	NC	36.3378	-78.4199299
Hickory	NC	35.7329999	-81.33034
Highlands	NC	35.07489	-83.18996
Highlands	NC	35.091138	-83.1709317
Jacksonville	NC	34.76605	-77.3922599
Kearnesville	NC	36.12131	-80.0719699
Kenersville	NC	36.12131	-80.0719699
Kings Mountain	NC	35.23589	-81.36215
Laurinburg	NC	34.78384	-79.43859
Monroe	NC	34.96216	-80.5457
Morehead City	NC	34.72978	-76.77069
Murfreesboro	NC	36.44209	-77.11908
Murphy	NC	35.0671899	-83.99906

City	State	Latitude	Longitude
Nags Head	NC	35.9746499	-75.64024
Nags Head	NC	35.98686	-75.64418
Newton	NC	35.66556	-81.2443399
North Wilkesboro	NC	36.16282	-81.14032
Oxford	NC	36.3113699	-78.58896
Randleman	NC	35.7644	-79.83422
Roanoke Rapids	NC	36.4451379	-77.6647424
Rockingham	NC	34.92321	-79.74665
Rocky Mount	NC	35.91172	-77.8347299
Rutherfordton	NC	35.37718	-81.94216
Shelby	NC	35.314298	-81.548841
Snow Hill	NC	35.44083	-77.66025
Southern Pines	NC	35.19753	-79.41361
Statesville	NC	35.80399	-80.89092
Statesville	NC	35.79347	-80.85392
Weldon	NC	36.4284	-77.59545
Williamston	NC	35.85769	-77.0427799
Wilmington	NC	34.22716	-77.83188
Highpoint	NC	35.9752819	-80.0423447
Bismarck	ND	46.8095799	-100.73701
Bismarck	ND	46.82613	-100.77569
Bottineau	ND	48.8205951	-100.4668388
Casselton	ND	46.90096	-97.21159
Dickinson	ND	46.8469451	-102.828043
Dickinson	ND	46.87965	-102.7878
Fargo	ND	46.8637	-96.83128
Grafton	ND	48.41231	-97.42305
Grand Forks	ND	47.92525	-97.03601
Grand Forks	ND	47.89084	-97.02903
Harvey	ND	47.77118	-99.93434
Jamestown	ND	46.87991	-98.7183
Mandan	ND	46.8107798	-100.8353191
Rugby	ND	48.35438	-99.99252
Tioga	ND	48.39635	-102.93892
Valley City	ND	46.92367	-98.00292
Williston	ND	48.1499499	-103.61529
Williston	ND	48.14643	-103.60808
Blair	NE	41.53416	-96.14363
Blue Hill	NE	40.33288	-98.44891
Chadron	NE	42.83023	-102.99887
Columbus	NE	41.44044	-97.34451
Hiawath	NE	39.77301	-95.52613

City	State	Latitude	Longitude
Imperial	NE	40.51952	-101.64574
Lincoln	NE	40.8455	-96.66614
Lincoln	NE	40.78738	-96.65528
Omaha	NE	41.26528	-95.99119
Omaha	NE	41.30434	-96.0251
Scotts Bluff	NE	41.86437	-103.66433
Valentine	NE	42.87491	-100.55155
Wayne	NE	42.2340309	-97.0565517
Claremont	NH	43.39172	-72.36641
Concord	NH	43.21474	-71.5425999
Dover	NH	43.1851	-70.85164
Franklin	NH	43.45427	-71.64137
Laconia	NH	43.53244	-71.46315
Laconia	NH	43.52991	-71.4687299
Lebanon	NH	43.64305	-72.25327
Lebanon	NH	43.64305	-72.25327
Manchester	NH	42.99727	-71.46641
New London	NH	43.4219041	-71.9973294
North Conway	NH	44.0229475	-71.1146866
West Lebanon	NH	43.63366	-72.31537
Wolfeboro	NH	43.5912875	-71.2203791
Glassboro	NJ	39.70791	-75.11606
Hackettstown	NJ	40.8427449	-74.8061799
Haddon Heights	NJ	39.8763099	-75.06132
Linwood	NJ	39.34268	-74.58325
Millville	NJ	39.3996799	-75.03842
Northfield	NJ	39.37856	-74.55486
Pleasantville	NJ	39.37726	-74.49296
Princeton	NJ	40.3279	-74.64686
Trenton	NJ	40.1993	-74.73091
Vineland	NJ	39.49773	-75.07476
West Atlantic City	NJ	39.37726	-74.49296
West Orange	NJ	40.78813	-74.25508
Alamogordo	NM	32.8856688	-105.9524849
Alamogordo	NM	32.89237	-105.94574
Alamogordo	NM	32.88628	-105.95174
Albuquerque	NM	35.08998	-106.57789
Albuquerque	NM	35.14351	-106.59868
Carlsbad	NM	32.39619	-104.24729
Carlsbad	NM	32.43176	-104.22872
Chaparral	NM	32.020137	-106.409268
Deming	NM	32.25157	-107.75804

City	State	Latitude	Longitude
Espanola	NM	36.00228	-106.06255
Farmington	NM	36.73127	-108.22984
Farmington	NM	36.7284099	-108.20416
Gallup	NM	35.52606	-108.74346
Hobbs	NM	32.72533	-103.15191
Las Cruces	NM	32.2974884	-106.7779156
Las Vegas	NM	35.59052	-105.22675
Las Vegas	NM	35.57968	-105.21792
Logan	NM	35.363522	-103.414214
Lordsburg	NM	32.346481	-108.694037
Lovington	NM	32.9440649	-103.3603327
Portales	NM	34.19835	-103.3230899
Roswell	NM	33.3937	-104.60525
Ruidoso Downs	NM	33.33184	-105.58884
Santa Rosa	NM	34.94297	-104.63799
Taos	NM	36.42261	-105.57229
Truth Or Consequences	NM	33.13515	-107.23169
Tucumcari	NM	35.17064	-103.70786
Amargosa Valley	NV	39.50547	-119.79571
Elko	NV	40.83011	-115.74461
Elko	NV	40.823851	-115.72702
Elko	NV	40.831706	-115.757665
Ely	NV	39.24822	-114.89339
Ely	NV	30.65535	-97.69083
Fallon	NV	39.474871	-118.781148
Las Vegas	NV	36.11447	-115.28291
Las Vegas	NV	36.16325	-115.10175
Las Vegas	NV	36.09029	-115.1719
Las Vegas	NV	36.06773	-115.1628
Pahrump	NV	36.20695	-115.96029
Reno	NV	39.50674	-119.77913
Sparks	NV	39.5283	-119.73544
Spring Creek	NV	40.84672	-115.74699
State Line	NV	38.96922	-119.92883
Albany	NY	42.64826	-73.75482
Amagansett	NY	40.97289	-72.13104
Amsterdam	NY	42.9362799	-74.18895
Bath	NY	42.3358549	-77.2916244
Beacon	NY	41.5233327	-73.931295
Binghamton	NY	42.09904	-75.91269
Buffalo	NY	42.88621	-78.87345
Buffalo	NY	42.89361	-78.83653

City	State	Latitude	Longitude
Buffalo	NY	42.87946	-78.80687
Champlain	NY	44.94601	-73.42616
Cobleskill	NY	42.6808	-74.47313
Dansville	NY	42.55936	-77.69477
Dansville	NY	42.56115	-77.69655
Elmira	NY	42.11953	-76.8101499
Endicott	NY	42.10625	-76.03
Gloversville	NY	43.02559	-74.35102
Hartsdale	NY	41.02671	-73.82619
Hornell	NY	42.32755	-77.66058
Horseheads	NY	42.15696	-76.83141
Hudson	NY		
Jamestown	NY	42.09628	-79.2429
Johnson City	NY	42.1131	-75.94896
Kingston	NY	41.93097	-74.00997
Lake Placid	NY	44.29218	-73.98973
Lancaster	NY	42.88242	-78.63155
Latham	NY	42.7628049	-73.7488708
Latham	NY	42.7717912	-73.8226992
Lockport	NY	43.17544	-78.71044
Lowville	NY	43.7869986	-75.4922965
Malone	NY	44.8469399	-74.2681999
Malta	NY	42.96807	-73.79853
Marcy	NY	43.13558	-75.2654699
New Hartford	NY	43.05625	-75.2778
New Rochelle	NY	40.92816	-73.77465
New Windsor	NY	41.49077	-74.06095
New York	NY	40.76937	-73.98959
New York	NY	40.72939	-74.00717
New York	NY	40.7506946	-73.9923316
Newark	NY	43.0178265	-77.0793574
Ogdensburg	NY	44.70602	-75.46481
Oneonta	NY	42.45346	-75.06347
Plattsburgh	NY	44.67013	-73.44565
Plattsburgh	NY	44.69779	-73.45384
Potsdam	NY	44.67128	-74.98532
Poughkeepsie	NY	41.72059	-73.90754
Poughkeepsie	NY	41.70505	-73.88731
Queensbury	NY	43.32914	-73.64814
Rochester	NY	43.15419	-77.5063
Rochester	NY	43.15484	-77.6022799
Rochester	NY	43.15578	-77.61302

City	State	Latitude	Longitude
Rochester	NY	43.15636	-77.61131
Rochester	NY	43.16011	-77.61571
Rome	NY	43.23202	-75.43919
Ronkonkoma	NY	40.78921	-73.13706
Salamanca	NY	42.15601	-78.72375
Schenectady	NY	42.73702	-73.8888599
Syracuse	NY	43.0583699	-76.1663
Utica	NY	43.08779	-75.25975
Utica	NY	43.10187	-75.23156
Vestal	NY	42.10202	-75.9943
Warwick	NY	41.2394785	-74.3892264
Wells	NY	43.39116	-74.2899
Ada	OH	40.77001	-83.82338
Archbold	OH	41.52296	-84.30649
Ashtabula	OH	41.815	-80.78281
Bryan	OH	41.49505	-84.55514
Canton	OH	40.79515	-81.37567
Chillicothe	OH	39.33661	-83.0168
Chillicothe	OH	39.33337	-82.98369
Cincinnati	OH	39.20117	-84.36998
Cleveland	OH	41.49992	-81.68443
Columbus	OH	39.98787	-83.06845
Columbus	OH	39.94915	-83.00013
Conneaut	OH	41.94363	-80.55623
Dayton	OH	39.75806	-84.1852399
Dayton	OH	39.7216499	-84.14962
Dayton	OH	39.68129	-84.15929
Defiance	OH	41.27808	-84.39747
Delaware	OH	40.29805	-83.04589
Findlay	OH	41.02229	-83.65771
Hamilton	OH	39.40327	-84.53036
Heath	OH	40.03454	-82.40103
Independence	OH	41.39335	-81.66175
Lancaster	OH	39.74412	-82.64151
Lima	OH	40.7396	-84.11586
Lima	OH	40.74043	-84.10566
Lima	OH	40.75692	-84.1473
Lima	OH	40.737396	-84.111864
Mansfield	OH	40.76674	-82.54689
Marietta	OH	39.41836	-81.47667
Marion	OH	40.61372	-83.13088
Mentor	OH	41.6771	-81.31077

City	State	Latitude	Longitude
Mount Vernon	OH	40.40327	-82.43763
Nelsonville	OH	39.4331952	-82.198941
Orwell	OH	41.519059	-80.867937
Piqua	OH	40.14011	-84.26855
Plain City	OH	40.16577	-83.1771
Portsmouth	OH	38.7371	-82.99405
Sidney	OH	40.30056	-84.20571
Steubenville	OH	40.37701	-80.67496
Toledo	OH	41.60503	-83.66613
Waverly	OH	39.12989	-83.0129
Wooster	OH	40.79415	-81.90412
Zanesville	OH	39.89206	-82.0457
Altus	OK	34.6398651	-99.3355217
Altus	OK	34.64588	-99.33338
Ardmore	OK	34.17536	-97.13682
Blackwell	OK	36.804218	-97.295746
Broken Bow	OK	34.02793	-94.738
Cache	OK	34.6389689	-98.6502242
Cushing	OK	35.9868499	-96.71081
Durant	OK	34.00463	-96.37245
Elk City	OK	35.40869	-99.4344799
Frederick	OK	34.38988	-99.01867
Grove	OK	36.5935846	-94.7695049
Guymon	OK	36.70378	-101.47785
Hulbert	OK	35.92976	-95.1361
Jay	OK	36.422464	-94.796385
Lawton	OK	34.59482	-98.42425
Lawton	OK	34.60368	-98.39804
Marlow	OK	34.66008	-97.95849
Miami	OK	36.87473	-94.87779
Oklahama City	OK	35.56607	-97.65352
Okmulgee	OK	35.6223245	-95.971566
Pawhuska	OK	36.66366	-96.34108
Ponca City	OK	36.70124	-97.06464
Poteau	OK	35.0152213	-94.649718
Sallisaw	OK	35.46324	-94.775
Sand Springs	OK	36.1335351	-96.0991414
Tulsa	OK	36.1575	-95.97604
Woodward	OK	36.4272641	-99.4072651
Beavercreek	OR	45.26469	-122.52492
Bend	OR	44.05866	-121.30045

City	State	Latitude	Longitude
Bend	OR	44.04683	-121.32582
Bend	OR	44.0907	-121.30231
Cottage Grove	OR	43.79706	-123.06439
Enterprise	OR	45.42525	-117.27981
Eugene	OR	44.00598	-124.10069
Eugene	OR	44.06636	-123.09649
Gold Beach	OR	42.41623	-124.41971
Hermiston	OR	45.86618	-119.31342
Hood River	OR	45.70164	-121.53474
John Day	OR	44.417838	-118.950193
La Grande	OR	45.32527	-118.07198
La Grande	OR	45.32978	-118.09577
Lebanon	OR	44.57346	-122.91935
McMinnville	OR	45.21459	-123.18501
Medford	OR	42.34037	-122.89257
Medford	OR	42.36909	-122.88204
Monmouth	OR	44.85117	-123.21706
Newport	OR	44.64847	-124.05218
Ontario/Payette	OR	44.0435299	-116.9715
Oregon City	OR	45.344243	-122.491085
Pendleton	OR	45.66548	-118.80383
Portland	OR	45.42312	-122.74625
Portland	OR	45.4930151	-122.6707812
Portland	OR	45.60216	-122.7201
Reedsport	OR	43.70085	-124.10103
Roseburg	OR	43.21359	-123.3658
Salem	OR	44.96698	-122.98176
Scio	OR	44.703172	-122.846724
Seaside	OR	46.00287	-123.92013
Sherwood	OR	45.37648	-122.83885
Springfield	OR	44.06601	-123.03014
Sweet Home	OR	44.41416	-122.73954
The Dalles	OR	45.59829	-121.17806
The Dalles/Hood Riv	OR	45.59875	-121.17584
Tillamook	OR	45.45629	-123.87261
Addison	PA	39.753543	-79.358231
Annville	PA	40.4322	-76.54785
Bellefonte	PA	40.919108	-77.763538
Edinboro	PA	41.889632	-80.120222
Millheim	PA	40.898779	-77.479501
Union City	PA	41.8967	-79.8465
Westfield	PA	41.90728	-77.55667

City	State	Latitude	Longitude
Youngsville	PA	39.78373	-100.445882
Belle Fourche	SD	44.67056	-103.85011
Brookings	SD	44.30319	-96.76734
Deadwood	SD	44.37459	-103.7321599
Huron	SD	44.3461908	-98.2140451
Lemmon	SD	45.93992	-102.1578
Milbank	SD	45.21897	-96.64214
Mitchell	SD	43.7054551	-98.0266633
Pierre	SD	44.3694382	-100.3520322
Rapid City	SD	44.08111	-103.24711
Rapid City	SD	44.06499	-103.23005
Rapid City	SD	44.0800399	-103.21832
Rapid City	SD	44.0707	-103.27889
Rosebud	SD	43.2313666	-100.8542119
Sioux Falls	SD	43.54228	-96.72633
Sioux Falls	SD	43.49924	-96.76756
Spearfish	SD	44.47542	-103.81128
Sturgis	SD	44.4084	-103.50885
Ardmore	TN	34.99286	-86.85599
Athens	TN	35.46501	-84.59944
Brownsville	TN	35.59325	-89.26182
Camden	TN	36.05719	-88.10394
Chattanooga	TN	35.06066	-85.12816
Chattanooga	TN	35.04517	-85.36234
Clarksville	TN	36.55459	-87.323742
Columbia	TN	35.61916	-86.98078
Cowan	TN	35.16089	-86.031
Crossville	TN	35.94715	-85.03748
Crossville	TN	35.98529	-85.04163
Dickson	TN	36.0771299	-87.38856
Dunlap	TN	35.37089	-85.3867999
Dyersburg	TN	36.06829	-89.33189
Etowah	TN	35.32288	-84.5271999
Franklin	TN	35.90714	-86.90571
Gallatin	TN	36.40106	-86.45087
Gray	TN	36.410274	-82.4546604
Huntingdon	TN	35.95093	-88.4626
Jackson	TN	35.61461	-88.82013
Jackson	TN	35.61545	-88.82082
Jamestown	TN	36.42578	-84.94139
Knoxville	TN	35.979	-83.9081999
Knoxville	TN	35.92311	-84.09178

City	State	Latitude	Longitude
Knoxville	TN	35.95547	-83.97084
Knoxville	TN	35.9807877	-83.8959465
Knoxville	TN	35.9373099	-84.09326
La Follette	TN	36.38094	-84.12578
Lawrenceburg	TN	35.2548	-87.325
Livingston	TN	36.37749	-85.33719
Madisonville	TN	35.5078699	-84.37919
Manchester	TN	35.46781	-86.09549
Maryville	TN	35.7436613	-83.9959327
Memphis	TN	35.0829349	-89.8982555
Memphis	TN	35.10121	-89.87481
Memphis	TN	35.07226	-89.86136
Morristown	TN	36.20672	-83.33281
Mountain City	TN	36.47398	-81.80326
Nashville	TN	36.0486803	-86.6575166
Nashville	TN	36.18798	-86.80195
Nashville	TN	39.78373	-100.445882
Newport	TN	35.9671	-83.2042
Portland	TN	36.58059	-86.51578
Ripley	TN	35.7294	-89.54257
Savannah	TN	35.22784	-88.23456
Soddy Daisy	TN	35.27494	-85.13964
Springfield	TN	36.49592	-86.90746
Tazewell	TN	36.4487499	-83.56935
Tullahoma	TN	35.359	-86.21598
Wartburg	TN	36.10709	-84.59915
Winchester	TN	35.18061	-86.0922
Woodbury	TN	35.82752	-86.10198
Abilene	TX	32.45073	-99.77139
Abilene	TX	32.45319	-99.73428
Abilene	TX	32.41773	-99.77955
Abilene	TX	32.44907	-99.78465
Abilene	TX	32.45047	-99.74329
Alpine	TX	30.3735	-103.66251
Alpine	TX	30.361134	-103.652876
Amarillo	TX	35.177	-101.90549
Arlington	TX	32.76241	-97.07022
Austin	TX	30.276	-97.8171799
Austin	TX	30.40039	-97.67388
Austin	TX	30.22775	-97.76067
Beaumont	TX	30.07954	-94.13428
Beeville	TX	28.38572	-97.72865

City	State	Latitude	Longitude
Big Spring	TX	32.21359	-101.49301
Bonham	TX	33.57849	-96.17904
Brady	TX	31.13464	-99.33386
Breckenridge	TX	32.75642	-98.90174
Brenham	TX	30.1662264	-96.4041712
Brownwood	TX	31.71882	-98.97954
Bryan	TX	30.65017	-96.34916
Bryan	TX	30.60062	-96.29182
Cameron	TX	30.84755	-96.96964
Clarendon	TX	34.9381353	-100.8892545
Colorado City	TX	32.39262	-100.92625
Comfort	TX	29.976664	-98.905592
Conroe	TX	30.330624	-95.423076
Corpus Christi	TX	27.79627	-97.41373
Corsicana	TX	32.08817	-96.46084
Cypress	TX	29.972728	-95.690305
Dallas	TX	32.6772631	-96.8572549
Dallas	TX	32.80258	-96.81175
Dallas	TX	32.8148399	-96.79103
Dallas	TX	32.78939	-96.81065
Dallas	TX	32.92439	-96.83496
Del Rio	TX	29.37257	-100.9025
Del Rio	TX	29.38666	-100.91249
Del Rio	TX	29.37355	-100.87164
Denison	TX	33.75627	-96.53428
Denison	TX	33.69242	-96.55844
Eagle Pass	TX	28.7324	-100.49424
El Paso	TX	31.78962	-106.50792
El Paso	TX	31.79474	-106.51012
Eldorado	TX	30.866154	-100.5939931
Fredericksburg	TX	30.28746	-98.88461
Glen Rose	TX	32.24391	-97.7464
Graham	TX	33.10492	-98.59168
Greenville	TX	33.1674999	-96.09882
Haskell	TX	33.15804	-99.7456
Henderson	TX	32.33968	-94.64791
Hereford	TX	34.8123	-102.40627
Houston	TX	29.7282	-95.46484
Houston	TX	29.73752	-95.46968
Houston	TX	29.74546	-95.46318
Houston	TX	29.7103694	-95.5494251
Huntsville	TX	30.69465	-95.55165

City	State	Latitude	Longitude
Jacksonville	TX	31.96215	-95.27072
Jasper	TX	30.91928	-93.9716399
Keller	TX	32.938338	-97.260194
Kerrville	TX	30.06807	-99.11344
Lamesa	TX	32.712759	-101.9373481
Lampasas	TX	31.07143	-98.18497
Levelland	TX	33.59861	-102.38552
Lexington	TX	30.416639	-97.012821
Littlefield	TX	33.93972	-102.345
Livingston	TX	30.710862	-94.942393
Llano	TX	30.7509979	-98.6761006
Longview	TX	32.51547	-94.80115
Lubbock	TX	33.50476	-101.87108
Lubbock	TX	27.8052062	-97.3970731
Lubbock	TX	33.51909	-101.90669
Lufkin	TX	31.33882	-94.72982
Lufkin	TX	31.32454	-94.72775
Madisonville	TX	30.94927	-95.91412
Malakoff	TX	32.18101	-95.96701
Marble Falls	TX	30.58045	-98.27432
Mason	TX	30.74934	-99.23297
McAllen	TX	26.2108494	-98.2023167
Midland	TX	31.99771	-102.07781
Midland	TX	31.9739	-102.25193
Midland	TX	32.02082	-102.12606
Ozona	TX	30.710195	-101.199833
Palestine	TX	31.76948	-95.62669
Palestine	TX	31.76894	-95.6413
Pampa	TX	35.55441	-100.97346
Paris	TX	33.6605051	-95.5556483
Perryton	TX	36.3882548	-100.8277977
Plainview	TX	34.2132999	-101.72366
Robstown	TX	27.79355	-97.6696599
San Angelo	TX	31.44831	-100.4425399
San Angelo	TX	31.44844	-100.47469
San Angelo	TX	31.54886	-100.31898
San Antonio	TX	29.49596	-98.41481
San Antonio	TX	29.508	-98.5523599
San Antonio	TX	29.51527	-98.56866
Seguin	TX	29.56859	-97.95932
Seminole	TX	32.71943	-102.65752
Seymour	TX	33.5959421	-99.2794416

City	State	Latitude	Longitude
Shamrock	TX	35.2158299	-100.24939
Sherman	TX	33.65677	-96.6002
South Padre Island	TX	26.12272	-97.17084
Spur	TX	33.47754	-100.85454
Sulphur Springs	TX	33.14469	-95.62834
Sulphur Springs	TX	33.1205294	-95.584441
Sulphur Springs	TX	33.12552	-95.59772
Sweetwater	TX	32.48717	-100.39106
Temple	TX	31.11009	-97.36626
Temple	TX	31.094698	-97.325019
Terrell	TX	32.7379195	-96.2988944
Tyler	TX	32.30693	-95.30862
TYLER	TX	32.30261	-95.30708
Uvalde	TX	29.17199	-99.77265
Victoria	TX	28.83856	-97.0044099
Wichita Falls	TX	33.88468	-98.52751
Cedar City	UT	37.67756	-113.062
Kamas	UT	40.644777	-111.28288
Moab	UT	38.5572299	-109.53869
Richfield	UT	38.76192	-112.07761
Roosevelt	UT	40.28749	-109.95866
Saint George	UT	37.11962	-113.59921
Saint George	UT	37.0542	-113.56572
Salt Lake City	UT	40.76882	-111.90086
Salt Lake City	UT	40.77043	-111.89996
Sandy/Salt Lake Cty	UT	40.564	-111.93934
St George	UT	37.11962	-113.59921
Vernal	UT	40.4912	-109.52931
Amherst	VA	37.58348	-79.05167
Bristol	VA	36.6323436	-82.1560351
Bristol	VA	36.59961	-82.20138
Bristol	VA	36.61049	-82.15723
Bristol	VA	36.630919	-82.144429
Chester	VA	37.35551	-77.44683
Clintwood	VA	37.1453124	-82.3906938
Covington	VA	37.78485	-79.99224
Danville	VA	36.58778	-79.39823
Emporia	VA	36.69921	-77.54811
Falls Church	VA	38.87576	-77.21093
Farmville	VA	37.32647	-78.3853199
Forest	VA	37.36512	-79.298
Fredericksburg	VA	38.30201	-77.4654599

City	State	Latitude	Longitude
Grundy	VA	37.3046591	-82.1260062
Grundy	VA	37.36478	-82.07775
Jonesville	VA	36.68258	-83.14105
Lebanon	VA	36.8983216	-82.1068742
Lexington	VA	37.7671235	-79.4301691
Lovingston	VA	37.760455	-78.870674
Madison Heights	VA	37.42057	-79.11584
Marion	VA	36.85597	-81.50528
Martinsville	VA	36.69997	-79.85168
Martinsville	VA	36.6919899	-79.87221
Norton	VA	36.93423	-82.62898
Orange	VA	38.25255	-78.1198
Richmond	VA	37.61428	-77.51456
Richmond	VA	37.50362	-77.5808799
Roanoke	VA	37.26833	-79.91279
Roanoke	VA	37.27968	-79.9909799
Staunton	VA	38.14906	-79.07602
Virginia Beach	VA	36.845174	-76.165223
Williamsburg	VA	37.2797256	-76.7173944
Brattleboro	VT	42.86743	-72.55709
Burlington	VT	44.38809	-73.22465
Colchester	VT	44.53695	-73.20923
Manchester	VT	43.17384	-73.04644
Middlebury	VT	44.0161	-73.16995
Montpelier	VT	44.24922	-72.56002
Morrisville	VT	44.57867	-72.59703
Poultney	VT	43.50402	-73.21074
Rutland	VT	43.6072599	-72.98069
South Burlington	VT	44.458	-73.13898
Wilmington	VT	42.856455	-72.80787
Aberdeen	WA	46.958572	-123.8115451
Bluefield	WA	37.2657	-81.23533
Charleston	WA	38.38588	-81.71583
Colville	WA	48.52097	-117.90873
East Wenatchee	WA	47.405833	-120.263952
Ellensburg	WA	47.0023399	-120.52634
Everett	WA	47.98148	-122.20813
Fairmont	WA	39.4729852	-80.1386167
Forks	WA	47.9537	-124.39005
Goldendale	WA	45.837874	-120.815911
Grand Coulee	WA	47.9334	-119.01755
Kennewick	WA	46.2141499	-119.15643

City	State	Latitude	Longitude
Kennewick	WA	46.23295	-119.12928
Lakewood	WA	47.16554	-122.50739
Longview	WA	46.123237	-122.937102
Moses Lake	WA	47.10199	-119.24095
Moses Lake	WA	47.10845	-119.30443
Mount Vernon	WA	48.4388099	-122.34555
Omak	WA	48.39949	-119.53281
Pasco	WA	46.22786	-119.12642
Port Angeles	WA	48.11436	-123.4213
Seattle	WA	47.60571	-122.33027
Seattle	WA	47.59942	-122.29842
SEATTLE	wa	47.6619	-122.3131
Shelton	WA	47.2123	-123.10179
Spokane	WA	47.65173	-117.43004
Spokane	WA	47.69774	-117.41141
Sumas	WA	48.997384	-122.264968
Walla Walla	WA	46.06706	-118.40273
Walla Walla	WA	46.0669351	-118.3384424
Wenatchee	WA	47.4251099	-120.3137
Wenatchee	WA	47.43793	-120.32517
Wenatchee	WA	47.42837	-120.31382
Adams	WI	43.95798	-89.83011
Amery	WI	45.25655	-92.36788
Ashland	WI	46.5718699	-90.8648
Baraboo	WI	43.46925	-89.74287
Beaver Dam	WI	43.46079	-88.83704
Beaver Dam	WI	43.46948	-88.82745
Beloit	WI	42.5004351	-89.0304905
Berlin	WI	43.96812	-88.94908
Boulder Junction	WI	46.1279899	-89.61597
Cody	WI	44.51551	-109.04992
Dallas	WI	45.25919	-91.880686
Dodgeville	WI	42.91963	-90.13678
Eagle River	WI	45.92772	-89.2557
Eau Claire	WI	44.81609	-91.51931
Fond Du Lac	WI	43.79223	-88.4374799
Green Bay	WI	44.4932	-87.98734
Green Bay	WI	44.47798	-87.99861
Greenfield	WI	42.97554	-88.06569
Hales Corners	WI	42.94605	-88.06081
Hayward	WI	46.0197711	-91.5091671
Hayward	WI	45.98565	-91.53979

City	State	Latitude	Longitude
Independence	WI	44.363314	-91.409771
Lacrosse	WI	43.81438	-91.25284
Ladysmith	WI	45.46483	-91.13873
Madison	WI	42.99959	-89.43008
Madison	WI	43.05931	-89.51469
Marinette	WI	45.074359	-87.6595612
Marinette	WI	45.0966	-87.62915
Marshfield	WI	44.6848699	-90.1616
Mauston	WI	43.82574	-90.08074
Medford	WI	45.13176	-90.3313
Merrimac	WI	43.372244	-89.628155
Milwaukee	WI	43.03935	-87.91516
Milwaukee	WI	43.09067	-87.90248
Monroe	WI	42.59593	-89.59426
Niagara	WI	44.8878104	-87.8547858
Onalaska	WI	43.8977687	-91.2406487
Oshkosh	WI	44.0144	-88.5829399
Park Falls	WI	45.91748	-90.44977
Pleasant Prairie	WI	42.55339	-87.89201
Plymouth	WI	43.74196	-87.9408751
Portage	WI	43.52831	-89.4338
Racine	WI	42.71066	-87.83033
Reedsburg	WI	43.54282	-90.04359
Rhinelander	WI	45.63805	-89.41213
Sheboygan	WI	43.7205299	-87.73369
Solon Springs	WI	46.345601	-91.81971
Tomah	WI	44.00022	-90.50423
Waupun	WI	43.643	-88.72377
West Bend	WI	43.39021	-88.18221
Whitehall	WI	44.35795	-91.30523
Beckley	WV	37.7781373	-81.1878
Beckley	WV	37.77672	-81.18709
Berkeley Springs	WV	39.6180319	-78.2219376
Bluefield	WV	37.3104599	-81.1402767
Charleston	WV	38.34607	-81.63248
Charleston	WV	38.38588	-81.71583
Danville	WV	38.0817114	-81.8336654
Elkins	WV	38.9259	-79.86069
Fisher	WV	39.0516999	-79.00626
Kingwood	WV	39.47999	-79.71862
Logan	WV	37.8469956	-81.9926309
Martinsburg	WV	39.46346	-77.98612

City	State	Latitude	Longitude
Morgantown	WV	39.6305596	-79.9554416
Mount Clare	WV	39.243045	-80.3128902
Mount Clare	WV	39.24306	-80.31288
Parkersburg	WV	39.31637	-81.52699
Ravenswood	WV	38.96388	-81.76622
Ronceverte	WV	37.7757793	-80.4598114
Spencer	WV	38.8069174	-81.3615401
St Marys	WV	39.3810261	-81.1914907
Summersville	WV	38.28279	-80.85729
Weirton	WV	40.41945	-80.56073
Wheeling	WV	40.0680196	-80.7236335
Afton	WY	42.72182	-110.93801
Casper	WY	42.85086	-106.33067
Cheyenne	WY	41.13501	-104.81007
Douglas	WY	42.76143	-105.40288
Jackson	WY	43.47381	-110.78957
Jackson	WY	43.42761	-110.77717
Kemmerer	WY	41.8009062	-110.5480148
Laramie	WY	41.3108795	-105.5951033
Laramie	WY	41.28366	-105.58249
Newcastle	WY	43.8499	-104.23085
Pinedale	WY	42.86726	-109.85777
Powell	WY	44.71678	-108.76149
Powell	WY	44.7529933	-108.7573426
Rock Springs	WY	41.586237	-109.219471
Saratoga	WY	41.4549982	-106.8078249
Torrington	WY	42.06909	-104.20164
Wheatland	WY	42.04505	-104.9465

C-Band Alliance

Our Commitment to C-band Users

Our proposal is founded on a commitment to protect C-band services in the United States and the rest of the world, thereby continuing to provide the quality, reliability and certainty that our customers need to successfully operate and grow their businesses.

We are not willing to compromise on any element that would limit our ability to serve our customers. Key features of our proposal:

- Continued access to C-band for your services at a comparable Quality of Service for so long as we are licensed to provide C-band services in the continental U.S.
- Exclusion of Alaska and Hawaii—no transfer of spectrum in these regions
- Retain priority for satellite services in remaining band
- Work cooperatively with FCC and terrestrial wireless carriers to establish and codify the 5G parameters that would ensure compatibility with fixed satellite services ("FSS")
- Responsibility for designing and implementing the technical solution and transition plan to protect incumbent FSS services
- New satellite capacity and innovative technical solutions to maintain supply and Quality of Service
- Continued full-band, full-arc protection to maintain contracted protection levels and ensure a vibrant news and sports-gathering capability
- Commitment to make users whole, including hardware and its installation, equipment rentals (e.g., cranes/lifts), dual illumination of uplinks and reasonable labor costs (stipend), with all transition costs covered by the CBA

We will stand by this commitment, assuming our proposal is adopted by the FCC in all material respects.

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www.C-bandAlliance.com

How Our Proposal Stacks Up to Other NPRM Proposals

	Proposal Element	Our Proposal	The Others
	Managed transition plan protecting services	Provided	Unaddressed
	User transition costs	Covered	Not covered
	Entry of other terrestrial services into satellite spectrum	Portion cleared, remainder protected	Other terrestrial services contemplated in all or the remaining portion of satellite band
	New satellite capacity to replace repurposed spectrum	Maintain existing supply and quality of service	Not provided
	Full-band, full-arc protection	Continues	Eliminated
	Alaska and Hawaii carve-out	Provided	Unclear
99.999% availability	Continued high quality, reliable and resilient C-band operations in the U.S.	Guaranteed	No longer assured

C-band Alliance Membership

INTELSAT SES eutelsat Telesat

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SES
beyond frontiers

C-Band Proposal:
Antenna Protection/Transition Expense

Association and Customer
Discussion Guide

21 September 2018

Introduction

Dianne VanBeber

Vice President, Intelsat

Today's Discussion

- Our proposal to the FCC is founded on a commitment to protect C-band services in the United States, and continuing access to the quality, reliability and certainty that our customers need to successfully operate their businesses
- Should we transition to the reduced spectrum environment contemplated by our proposal, our plan is to cover all reasonable costs associated with the technical and operational impacts of the clearing of C-Band capacity
- Today's discussion of the expenses to be covered by the consortium is based on the assumption that our proposal under FCC GN 17-183 is adopted by the FCC in all material respects
- Should our proposal not be adopted, it is unclear who, if any entity, will be responsible for the operational and technical impacts of the new spectrum allocation
- We want your feedback; the approach to transition expenses we are describing today is a work in progress that will change based upon our discussions today
- Our goal is to build and provide further definition around this topic, enabling to you conclude that our proposal provides best protection for current users of C-band services in the U.S.

Antenna Protection/ Transition Expense

Tom McNamara

Vice President, Program Management, Intelsat

Steve Corda

Vice President, North America Media Platform, SES

Agenda:

- An overview of how the plan to clear C-band spectrum may impact current C-band users
- Details of the three primary potential impacts
- The costs to be covered as a result of the impacts
- Initial views on management of the transition

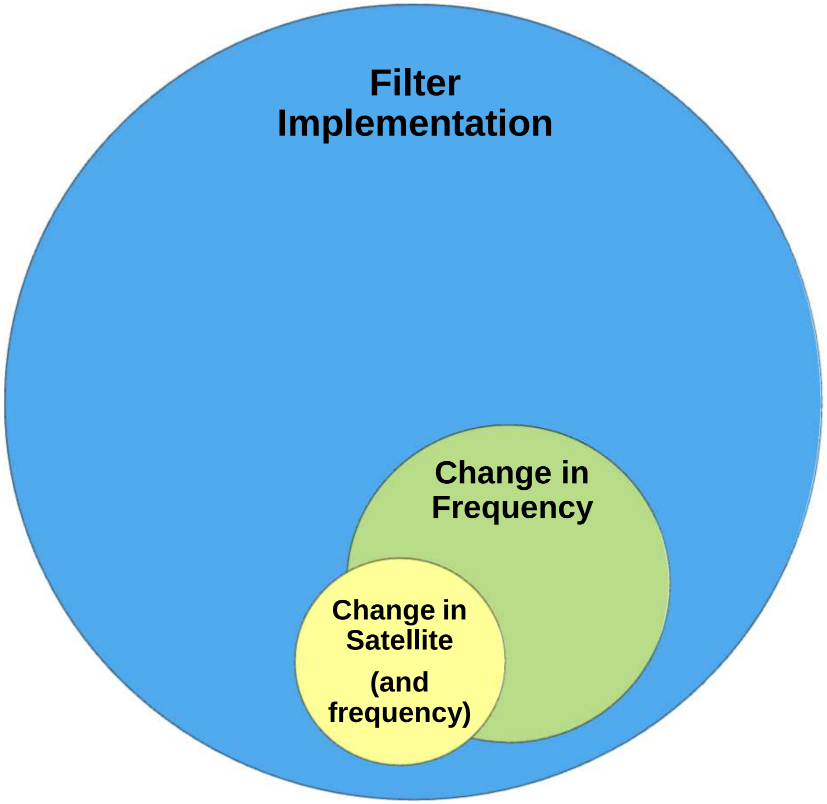
We will pause in each section to take questions and gather your feedback

The Consortium is the Focal Point for the Transition Program

Users of C-Band may be subject to one or all of the following impacts to spectrum clearing

1. Implementation of a filter to mitigate potential interference
2. A change in frequency on a current satellite
3. A change in satellite that requires an antenna repoint

The impacts may differ whether a Broadcaster / Programmer / Service Provider or an Earth Station / Downlink Operator



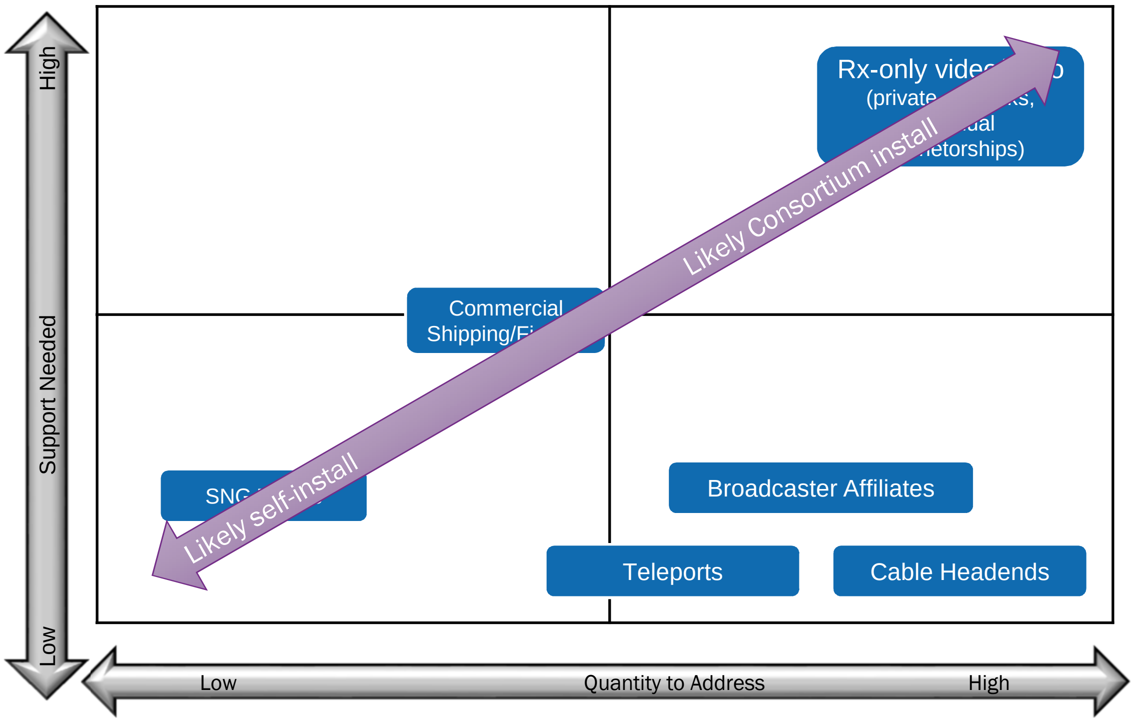
1. Interference Mitigation

Making C-band users "whole" requires a multi-pronged implementation attack

Based on technical ability on the site that require filters, the Consortium envisions the following scenarios:

1. A Consortium-led installation program for high-volume sites to install filters on behalf of the owners
2. A Self-install program for the technically capable sites that desire to install filters and manage the impact themselves

In both cases, the Consortium will cover reasonable expenses to complete the work and may have a preference on which program certain customer types use.



1. Filters Will Be Required at All CONUS Downlinks

- Filter Program

Equipment Paid and Shipped by Consortium

- All filters will be sourced by the consortium and shipped to site or to installers

Installation & Ancillary Included

- Labor
- Equipment Rental
- Tools
- Basic hardware

Warranty

- Labor
- Interference mitigation
- Filter manufacturer to warrant filter hardware

Underlying <u>Assumptions:</u>

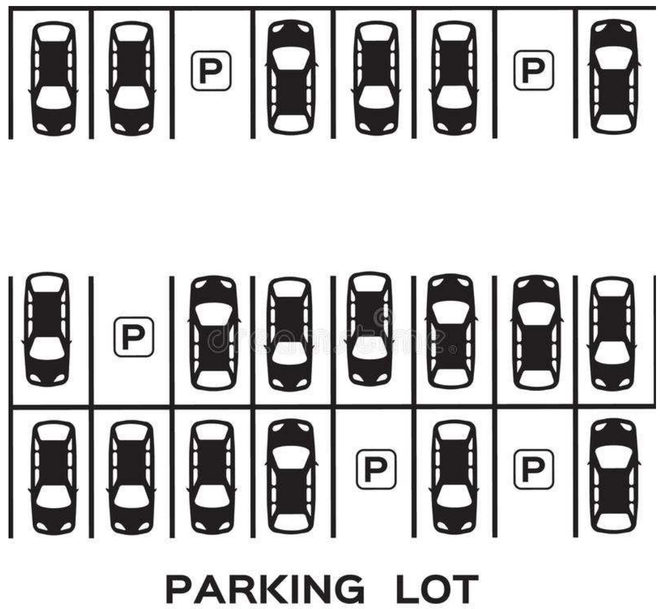
- Installation to be performed during defined maintenance windows
- All earth stations are expected to be in working condition

2. Planning for Frequency Changes

Users may need to change frequencies on a given satellite for one of two reasons:

1. The customer occupies a frequency that is being cleared

2. A customer does not occupy spectrum being cleared, but must be moved to accommodate optimized fill



2. Frequency Change Support

- Frequency Changes and Associated Costs

Dual Illumination Capacity

- Will be provided by the Consortium members to Broadcasters to support end user modem changes

Ground Equipment and Antenna

- Potential use of existing broadcast uplinks
- Ensure R/O hardware is frequency agile
- Compensation for manpower

And if not…

- Consortium members will downlink the existing signal and rebroadcast on the target spectrum

Underlying Assumptions:

- Dual illumination will be capped at a reasonable number of days to ensure capacity and facilities are available to support everyone who needs it

3. Satellite Repoints and Migrations

The Consortium will launch new satellites to support current and future C-band requirements

- The only way to support our users and enable 5G in the mid-band is to add new satellites
- Some customers will need to transition to the new satellites and may need to repoint networks to new orbital locations
- Where cable headend penetration is required, new antennas will be provided as needed

3. Satellite Repoints and Migrations Support

- Transition costs include capacity, uplink and seeding

Capacity & Uplink

- Dual illumination capacity provided
- Dual uplink to be provided to target satellite if the Broadcaster doesn't have the capability

Receive Station

- Consortium will repoint the end terminals if the users are not able to
- Remediation of situations where downlinks cannot be repointed

Headend Seeding

- New antennas will be furnished (and installed, depending upon capability)

Underlying <u>Assumptions:</u>

- Dual illumination will be capped at a reasonable number of days to ensure capacity is available to support everyone who needs it

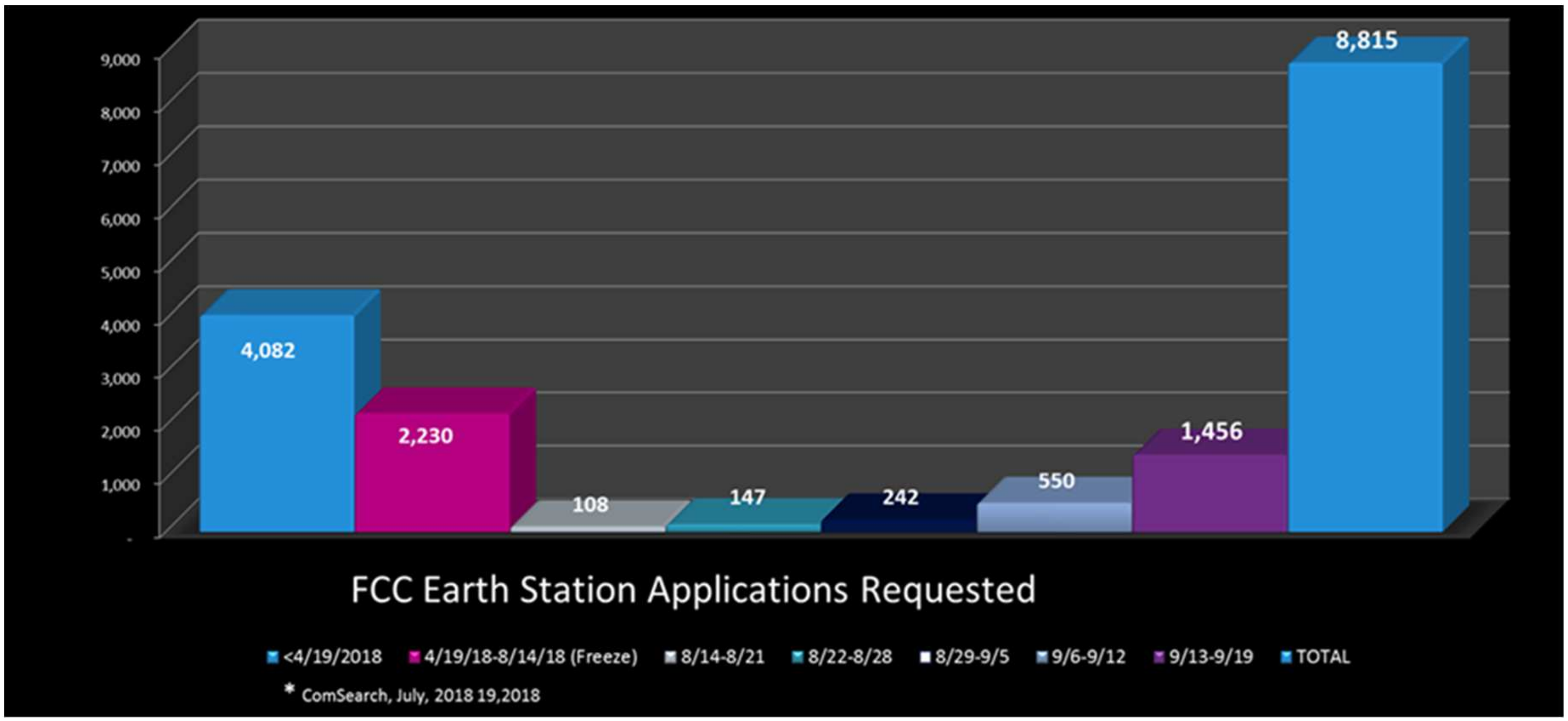
- Assumes the ground equipment is functional and compliant with current standards.

Next Steps

Future Discussions

- On-line Customer portal…to manage customer and earth station transitions…accurate data is key to protecting all sites
- Defining flat fee reimbursable expenses to minimize administration
- Advisory Board Concept: comprised of broadcast, programmer, headend, private network and service provider representatives
- The concept of an Ombudsman to ensure exception process is working and fair
- Trust fund/escrow to cover post-transition realities

How Is It Going? Antenna Registration Results



Next Steps

- What is the right plan and working group to engage with when we reflect today's inputs?
- Are other areas of mutual interest, combined or individually, where we could combine forces on NPRM Comments
- The technical and operational prospects are not favorable in any respect should our proposal not be adopted

We believe that the success of our proposal is strategic to operators and users of C-band in the U.S.

Our goal is to obtain your endorsement of our proposal

INTELSAT

SES beyond frontiers

C-Band Proposal: Antenna Protection/Transition Expense

Thank you!

21 September 2018