Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of Amendment Of The Commission's Rules To Establish A Next-Generation Air-Ground Communications Service On A Secondary Licensed Basis In The 14.0 to 14.5 GHz Band	RM −11640

REPLY COMMENTS OF QUALCOMM INCORPORATED

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SUMMARY

The Commission has a more than ample record upon which to issue a Notice of Proposed Rule Making ("NPRM") to establish a new communications service that will provide greatly enhanced broadband connectivity to aircraft flying above the continental United States. American Airlines, United Airlines, Virgin America Airlines, and leading air-ground communications service provider, Gogo Inc., all filed comments strongly encouraging the FCC to grant Qualcomm's Petition for Rulemaking and initiate a proceeding to establish the proposed Next-Generation Air-Ground mobile service (the "Next-Gen AG Petition"). The proposed service would operate on a secondary licensed basis at 14.0 to 14.5 GHz and provide 300 Gigabits per second ("Gb/s") connectivity on a combined basis to airline passengers who want to – and in many cases need to – stay fully connected while traveling.

These major U.S. airlines and Gogo are experiencing firsthand that mobile broadband demand onboard aircraft is exploding – just as much, if not more so, than it is on the ground across America. They are seeing more and more of their customers carrying and wanting to use multiple Wi-Fi-enabled devices on-board their planes. There can be no serious question of the need for a high-data-rate air-ground network to maintain high-speed in-flight connectivity such as proposed in the Next-Gen AG Petition.

Nevertheless, a small group of commenters – including those that are authorized to use the Aeronautical Mobile Satellite Service in the 14.0 to 14.5 GHz band to provide satellite-based connectivity to aircraft (the "AMSS Parties") and would experience competition from future Next-Gen AG service providers – oppose the FCC taking further action on the Petition. But, the Commission is charged with acting in the public interest, and as it has said on many occasions, the public interest is furthered by the establishment of competitive markets.

The AMSS Parties contend that Qualcomm has not shown that there is a demand for airborne broadband connectivity requiring the establishment of the Next-Gen AG service. But, the comments of the major U.S. airlines, a successful air-ground communications service provider, and a major equipment manufacturer all verify that the demand for mobile broadband connectivity does not evaporate at the airline check-in gate. Tellingly, the AMSS Parties fail to explain why they are operating and seeking to expand businesses that provide communications services to aircraft if there is no demand. Indeed, the record before the FCC unquestionably confirms that there is substantial and growing demand for air-ground broadband service.

The AMSS Parties also contend in a conclusory fashion that Qualcomm has not adequately explained how the proposed Next-Gen AG service will avoid causing harmful interference to or receiving harmful interference from the existing users of the 14.0 to 14.5 GHz band. The commenters who raise this issue largely avoid dealing with the detailed technical appendix to the Petition ("Appendix A"). Appendix A explains how the proposed service could operate on a secondary licensed basis to, and in successful coexistence with, Geosynchronous Orbit ("GSO") satellite systems used to provide various services, including Qualcomm's own OmniTRACS service, future Non-Geosynchronous Orbit ("NGSO") satellite systems, NASA's Tracking and Data Relay Satellite System ("TDRSS"), and radio astronomy users.

As an incumbent user of the 14.0 to 14.5 GHz band, Qualcomm not only has a direct interest in fully protecting incumbent operations but it also has an intimate understanding of the 14 GHz spectrum environment, as evidenced by its detailed analysis of the band. In the interest of moving forward quickly in this rulemaking proceeding, Qualcomm provides a supplemental appendix herein, with additional technical detail explaining how the Next-Gen AG service can successfully operate in the presence of interference from primary users as well as AMSS users.

The company looks forward to continuing to work with the Commission and all parties through the rulemaking process.

The AMSS Parties' final complaint that Qualcomm seeks to lock in a single technical approach and limit innovation and competition in Next-Gen AG services misreads the Petition. To be clear, Qualcomm provided in Appendix B to the Petition a set of performance-based regulations, based upon reasonable interference protection levels, for the Commission to propose in an NPRM. These regulations actually would encourage innovation and competition in the design of Next-Gen AG equipment and services. The detailed technical description in Appendix A is purely intended to explain how, in Qualcomm's view, such a system can be designed to successfully operate in the 14 GHz band. It is by no means the only way to deploy a high-data-rate air-ground communications system at 14 GHz. Qualcomm took the time and expense to provide such extensive detail so others can understand its proposed Next-Gen AG system design and/or design their own system that complies with the interference protection criteria.

In sum, as the Next-Gen AG Petition and the subsequent supporting record make clear, there is a very real and growing need for a high-speed, high-capacity air-ground communications service, and it is possible, indeed preferable, to deploy such a service at 14.0 to 14.5 GHz. One of the main goals the Commission established in the National Broadband Plan is that "[t]he United States should lead the world in mobile innovation." NBP at 9. Adoption of a Next-Gen AG NPRM will directly contribute to the achievement of that important goal.

Accordingly, Qualcomm respectfully requests that the FCC issue an NPRM proposing to adopt the rules in Appendix B and, as soon as possible thereafter, adopt the regulations and auction the spectrum on a secondary licensed basis for two Next-Gen AG systems as proposed in the Petition.

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REPLY COMMENTS OF QUALCOMM INCORPORATED

QUALCOMM Incorporated ("Qualcomm"), pursuant to FCC Rule Section 1.405(b),[1] hereby replies to the comments filed on its Petition for Rulemaking to establish a Next-Generation Air-Ground communications service on a secondary licensed basis in the 14.0 to 14.5 GHz band ("Next-Gen AG Petition" or "Petition").[2]

INTRODUCTION

Major U.S. airlines and the leading air-ground communications service provider agree with Qualcomm that American consumers' rapid adoption of smartphones, tablets, countless other mobile broadband-enabled wireless devices, and the increasingly useful applications and services that these devices offer, warrant prompt FCC action to establish the Next-Gen AG mobile broadband communications service. These parties are experiencing firsthand American consumers' demand for the same level of broadband connectivity on-board commercial and private aircraft that they enjoy in their homes, offices, parks, cars, trains, and buses. By enabling

[1] 47 C.F.R. § 1.405(b).

[2] *See* FCC Public Notice, Consumer & Governmental Affairs Bureau Reference Information Center Petition For Rulemakings Filed, Report No. 2933 (Aug. 30, 2011).

a combined data rate of 300 Gb/s, the Next-Gen AG service would support that need and allow U.S. airlines to offer their customers a host of compelling in-flight broadband services.[3]

Qualcomm respectfully submits that – contrary to the assertions of several parties, including those authorized to offer a competing service via the AMSS, that oppose the Next-Gen AG Petition[4] – Next-Gen AG services will improve consumers' personal lives and enable countless business efficiencies by providing much needed support to the rapidly developing market for advanced in-flight communications. Favorable action on the Petition also will help spur further technological innovation in the wireless communications industry, facilitate economic growth and job creation, and recoup value through the auction of the right to use up to 500 MHz of spectrum on a secondary licensed basis.

As explained in the Next-Gen AG Petition (and Appendices A and B attached thereto), the proposed service can operate successfully in the presence of, and fully protect, incumbent satellite operations that provide many important services (including Qualcomm's own OmniTRACS service) and other incumbent operations at 14.0 to 14.5 GHz through use of innovative interference mitigation techniques and advanced equipment designs, many of which are already implemented in today's 3G/4G terrestrial mobile broadband systems. Through asking the FCC to adopt the set of reasonable performance-based regulations presented in

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[3] *See* Comments of American Airlines (filed Sept. 29, 2011) ("American Airlines Comments"); Comments of United Airlines (filed Sept. 29, 2011) ("United Airlines Comments"); Comments of Virgin America (filed Sept. 29, 2011) ("Virgin Airlines Comments").

[4] *See* Comments of the Boeing Company (filed Sept. 29, 2011) ("Boeing Comments"); Comments of Panasonic Avionics Corporation (filed Sept. 29, 2011) ("Panasonic Comments"); Comments of Row 44, Inc. (filed Sept. 29, 2011) ("Row 44 Comments"); Comments of the Satellite Industry Association (filed Sept. 29, 2011) ("SIA Comments"). These parties are collectively referred to herein as "the AMSS Parties." While Qualcomm recognizes that SIA has a broad membership that spans well beyond the AMSS licensees, the SIA Comments include many of the same arguments made by the three parties with direct AMSS interests. To the extent there are other issues that only SIA raises, they are specifically addressed herein.

Appendix B to the Petition, Qualcomm expects the FCC to promote continued innovation and increasing data capacity for future Next-Gen AG systems. In sum, Qualcomm looks forward to working closely and quickly with the Commission and all interested stakeholders on a rulemaking proceeding to successfully introduce this advanced – and much needed[5] – mobile broadband service to travelers aboard commercial airlines as well as travelers on-board private aircraft.

DISCUSSION

I. Consumer Adoption Of Mobile Broadband Devices At Unprecedented Rates Is Driving The Need For A High-Data-Rate Air-Ground Communications System

As described in the Petition and in the Comments filed by leading U.S. airlines and Gogo Inc., Americans are enthusiastically embracing mobile broadband and online applications and services at unprecedented rates.[6] Indeed, even the parties seeking to slow the progress of the Next-Gen AG Petition cannot question this undeniable trend that is only underscored by developments since the Petition was filed.

Just last week, the FCC released a status report on Internet access services as of year end 2010, finding there to be nearly 169 million high-speed Internet connections in the U.S., which is 28% greater than 2009 levels.[7] The Commission found the annual growth in mobile Internet subscriptions to be particularly noteworthy, as there were 84 million mobile Internet subscriptions at year end 2010, a 63% increase in just one year.[8] In addition, CTIA's semi-

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[5] *See* Comments of Gogo Inc. (filed Sept. 29, 2011) ("Gogo Comments"); *see also* American Airlines Comments, United Airlines Comments, and Virgin America Comments.

[6] *See id*.

[7] *See* FCC Wireline Competition Bureau, Internet Access Services: Status as of December 31, 2010, at 1 (Oct. 2011) (high speed Internet connections are those in excess of 200 kb/s in one direction).

[8] *See id*.

annual wireless research survey showed a 111% increase in wireless data traffic from June 2010 to June 2011. CTIA also measured 96 million active smartphones and other pocketable computers as of June 2010, reflecting a 57% increase in one year.[9] These astonishing trends are showing no signs of letting up.

The FCC and CTIA reports come on top of the Consumer Electronics Association's ("CEA's") semi-annual industry forecast, in which it projected: (i) tablet computers to grow 157% in 2011, with more than 26.5 million units being shipped to dealers; (ii) smartphone sales to climb an estimated 45% and reach more than $23 billion in industry revenue; and (iii) eReader unit sales to double this year with more than 16.5 million units being shipped and resulting in $1.8 billion in revenue.[10]

A recent Pew Research Center analysis further confirms the importance of mobile broadband to Americans today.[11] The Pew Research Study found the Internet to be American adults' top source for information about restaurants and other local businesses, and equal with newspapers as their top source for information about housing, jobs, and schools. The Study further concluded that 47% of adults use their smartphones or tablets to get local news and

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[9] *See* CTIA Press Release, *CTIA-The Wireless Association Semi-Annual Survey Reveals Historical Wireless Trend, U.S. Wireless Subscriber Connections Surpassed U.S. Population for First Time, Wireless Network Data Traffic Increased 111 percent and Highlights Industry Need for More Spectrum* (Oct. 11, 2011) *available at* http://www.ctia.org/media/press/body.cfm/prid/2133 (Wireless data traffic increased to 341.2 billion MB in June 2011 from 161.5 billion MB in June 2010).

[10] *See* CEA Press Release, *Mobile Connected Device Sales Bolster 2011 CE Industry Forecast, According to CEA Semi-Annual Report* (July 18, 2011) *available at* http://www.ce.org/Press/CurrentNews/press_release_detail.asp?id=12121.

[11] Pew Research Center, *How People Learn About Their Local Community* (Sept. 2011) *available at* http://pewinternet.org/~/media//Files/Reports/2011/Pew%20Knight%20Local%20News%20Report%20FINAL.pdf (the "Pew Research Study").

information, and 41% of adults "contribute their own information via social media and other sources, add to online conversations, and directly contribute articles about the community."[12]

Simply stated, as these data and the strong record in this proceeding confirm, mobile broadband-enabled smartphones and tablets are now directly woven into the fabric of American life, especially the lives of air travelers and countless road warriors.

A. American Travelers Are Heavy Users Of Mobile Broadband Apps And Services

It is fair to say that many Americans, particularly those who begin and end their work-week on airplanes, depend heavily upon the capabilities that are packed into today's mobile broadband devices.[13] Mobile applications, or "apps," that run on smartphones, tablets, and laptops, and provide quick, anywhere/anytime access to news, weather, email, social networking info, newspapers, books, photos, games, videos, or movies, are a big reason why consumers keep their personal devices within arms length at all time. In contrast to traditional means of accessing information via the Internet and on a desktop or laptop computer, consumers are increasingly finding that apps offer simple and more immediate access to requested information.

These include, not surprisingly, apps aimed directly at airline travelers. American Airlines and United Airlines now have mobile apps that, among other things, allow their passengers to use a mobile device boarding pass to board aircraft.[14] American Airlines recently

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[12] *Id.* at 2, 4, 22 and 29.

[13] *See* Martin Lindstrom, "You Love Your iPhone. Literally," NEW YORK TIMES (Sept. 30, 2011) *available at* http://www.nytimes.com/2011/10/01/opinion/you-love-your-iphone-literally.html?_r=1&nl=todaysheadlines&emc=thab1 (commentary on the level of individuals' attachment and, indeed, affection for mobile devices and the services they offer). *See also* Next-Gen AG Petition at 7 n.16 (35% of American smartphone users begin using their devices each morning before they even out of bed).

[14] *See* American Airlines News Release, *American Leads The Industry With Its Mobile App Offerings, Debuts Apps for Blackberry and Windows Phone Smartphones, Expands Mobile Boarding Pass, Instant Text Message Notification* (June 30, 2011) *available at*

held its "Get Mobile. Get Moving." sweepstakes to encourage its customers to access the company's various mobile products to plan, manage, and enjoy each trip that they take with the carrier.[15]

As a result of persistent consumer thirst for additional features and capabilities, new and improved broadband-consuming mobile products and services are being introduced to the market on a daily basis. For example, just last week, Apple announced the release of the iPhone 4S with a number of new features, including increased download speed and access to a free cloud-based service called iCloud.[16] The iCloud service copies the content on a user's various Apple mobile devices to a cloud server and then makes the content available to each of the user's other devices, such as an iPod touch, iPad, Mac or PC desktops and laptops.[17] Given the popularity of these products, the new iCloud service will result in greatly increased data traffic and demand.

Amazon also recently announced a new line of Kindle e-readers and a new tablet called Kindle Fire.[18] The Kindle Fire provides access to a portfolio of movies, television shows, and

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http://aa.mediaroom.com/index.php?s=43&item=3270; United Airlines Press Release, *United Airlines Offers One-Touch Access to United And Continental Travel Information With New United App For iPad, iPhone And iPod touch* (July 26, 2011) *available at* http://www.united.com/press/detail/0,7056,69083-1,00.html.

[15] American Airlines News Release, *American Airlines Presents 'Get Mobile. Get Moving.' Sweepstakes to Highlight Mobile Product Offerings* (Aug. 30, 2011) *available at* http://aa.mediaroom.com/index.php?s=43&item=3322.

[16] Apple Press Info, *Apple Launches iPhone 4S, iO5 & iCloud* (Oct. 4, 2011) *available at* http://www.apple.com/pr/library/2011/10/04Apple-Launches-iPhone-4S-iOS-5-iCloud.html.

[17] *See id.* Pre-in-store release demand for the iPhone 4S makes it the most successful iPhone launch in history. *See* Nick Bilton, "Disappointment? Apple's iPhone 4S Breaks Sales Records," NEW YORK TIMES, Business Innovation Technology Society (BITS) Blog (Oct. 10, 2011) *available at* http://bits.blogs.nytimes.com/2011/10/10/apple-breaks-pre-sale-records-with-iphone-4s/ (Apple "processed more than one million orders for the iPhone 4S in the first 24 hours it was on sale," surpassing by a large margin the 600,000 first day sales of the iPhone 4.).

[18] Amazon Press Release, *Introducing the All-New Kindle Family: Four New Kindles, Four Amazing Price Points* (Sept. 28, 2011) *available at* http://phx.corporate-ir.net/phoenix.zhtml?c=176060&p=irol-newsArticle&ID=1610968&highlight; Amazon Press

other media; it also provides cloud-based storage. It incorporates a new web browser, called "Amazon Silk," that resides both on the device and on Amazon's cloud servers, and keeps open a persistent connection with the cloud in order to maximize performance.[19] In addition, Facebook, which is Gogo's most popular in-flight application, just released a long-awaited app for the iPad that will undoubtedly increase the popularity and use of tablets, including on-board airplanes.[20]

There is no question that the use of mobile broadband-enabled devices, and the services and applications they provide, are central to the lives of millions of Americans, including those of us who spend hours at a time traveling in an airplane above the Continental United Status ("CONUS"). The Next-Gen AG service is needed.

B. Major U.S. Airlines And The Leading Air-Ground Service Provider Want The FCC To Authorize The Next-Gen AG Service As Soon As Possible

Even as early as 2005, in the pre-smartphone and pre-tablet era, the FCC recognized in the *850 MHz Air-Ground Report and Order*, the "substantial and rapidly growing consumer, airline and service provider interest in access to high-speed Internet and other wireless services onboard aircraft."[21] Supporting comments from major U.S airlines and the leading air-ground service provider Gogo demonstrate that airline travelers today increasingly want and expect to

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Release, *Introducing "Amazon Silk": Amazon's Revolutionary Cloud-Accelerated Web Browser, Available Exclusively on Kindle Fire* (Sept. 28, 2011) *available at* http://phx.corporate-ir.net/phoenix.zhtml?c=176060&p=irol-newsArticle&ID=1610970&highlight.

[19] *See id.*

[20] *See* Gogo Comments at 3. *See also* The Facebook Blog, *Introducing Facebook for iPad* (Oct. 11, 2011) *available at* http://blog.facebook.com/blog.php?post=10150311269432131.

[21] *Amendment of Part 22 of the Commission's Rules to Benefit the Consumers of Air-Ground Telecommunications Services*, Report and Order and Notice of Proposed Rulemaking, 20 FCC Rcd 4403, 4411,¶12 (2005) (emphasis supplied). The FCC noted that one third of adults who travel by commercial aircraft wanted to connect to the Internet with a laptop, and airlines reported that "passenger demand for [high-speed] in-flight connectivity for Internet access, email and text messaging is increasing." *Id.*

access the same mobile services and applications on board airplanes that they enjoy on the ground.[22]

In fact, the record in this proceeding unanimously reflects an airline industry that is working hard to keep up with increasing traveler demand for such services. In that light, one has to question the motives of the AMSS Parties who contend that the Next-Gen AG Petition fails to establish a demand for additional in-flight broadband capacity, while they themselves have invested substantial resources to develop satellite-based systems to support that need.[23] There can be no question that the demand for in-flight broadband connectivity is exploding.

For starters, as Qualcomm noted in the Petition, the need to support high-capacity in-flight mobile broadband connectivity was illustrated by American Airlines and Samsung's joint announcement in June 2011 that they will equip the premium cabins of 600 aircraft with Wi-Fi enabled Samsung Galaxy tablets.[24] These passengers will use the tablets to access movies, TV programming, email, entertainment, social networking, and gaming applications, and to review and edit documents. Then, in August, Gogo announced that it had launched, on American Airlines' entire fleet of Boeing 767-200 aircraft, an on-board streaming video service, which the airline plans to expand to approximately 400 Wi-Fi-enabled aircraft by the end of 2012 and

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[22] *See* Comments of American Airlines; Comments of United Airlines; and Comments of Virgin America; *see also* Gogo Press Release, *Gogo In-Flight Wi-Fi Impacting Airline Choices for Travelers* (Sept. 8, 2011) *available at* http://pr.gogoair.com/2011/09/gogo-flight-wi-fi-impacting-airline-choices-travelers ("According to a recent study, one in five Gogo users say they've switched from their preferred airline to be on a flight equipped with in-flight internet. … [M]ore than 50 percent of business travelers and 40 percent of leisure travelers who said they switched airlines for in-flight Wi-Fi would not fly without the service for their next trip.")

[23] *See* Panasonic Comments at 2-3, 5-6; Row 44 Comments at 5; SIA Comments at 2-3, 5-6.

[24] *See* Chloe Albanesius, "American Airlines Adding Samsung Galaxy Tab 10.1 Tablets to Flights," PC MAGAZINE (June 14, 2011) *available at* http://www.pcmag.com/article2/0,2817,2386894,00.asp.

beyond in future years.[25] And, just last week Delta Airlines announced the launch of additional in-flight entertainment and Wi-Fi options.[26]

Without a doubt, the airlines are in the best position to assess their customers' needs. As American Airlines explained: "U.S. travelers increasingly want and need to have broadband access while they are in flight" and "require anywhere/anytime broadband access, including when they are flying on an airplane above the continental U.S."[27] The company confirmed that a higher capacity air-ground communications network, such as that proposed in the Petition, is needed to expand the Samsung Galaxy tablets program to American Airlines' entire fleet.[28]

United Airlines and Virgin America also noted that heavy consumer demand played a key role in their decision to support timely FCC authorization of a Next-Gen AG service. United Airlines stated:

> United strongly encourages the FCC to favorably consider this petition for a rulemaking because customers increasingly are expecting to maintain full broadband connectivity while on-board our aircraft flying above the continental United States. More and more customers are carrying multiple Wi-Fi-enabled devices, all of which require a high-speed air-ground network to maintain full in-flight connectivity. … [I]n order to meet growing broadband connectivity demands on-board aircraft, substantially more spectrum will be needed.[29]

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[25] Gogo Press Release, *Gogo Vision Goes Live on American Airlines* (Aug. 3, 2011) *available at* http://pr.gogoair.com/press-room/2011/08/gogo-vision-goes-live-american-airlines. *See also* American Airlines Comments; American Airlines News Release, *American Airlines to Roll Out Entertainment on Demand Across Entire Wi-Fi Narrowbody Fleet* (Sept. 14, 2011) *available at* http://aa.mediaroom.com/index.php?s=43&item=3333.

[26] Delta News Release, *Delta Launches Expanded In-Flight Wi-Fi, Entertainment on Demand Options* (Oct. 5, 2011) *available at* http://news.delta.com/index.php?s=43&item=1461.

[27] American Airlines Comments at 1 and 2.

[28] *Id.* at 2.

[29] United Airlines Comments at 1.

Similarly, Virgin America's "guests are increasingly coming on-board Virgin America flights with their smart phones, laptops, tablet computers, and e-readers, and they want to use these devices online while in flight."[30] Virgin America explained that it has entered into an agreement with Google to provide Wi-Fi enabled Chromebook devices to its passengers for in-flight use, adding that "grant of Qualcomm's proposal will support the significant growth in mobile broadband demand" in the air.[31]

The leading air-ground communications service provider and a major communications equipment provider also see greatly increased demand for in-flight broadband connectivity. Gogo expects that "more than 200 million people will travel on Wi-Fi enabled flights this year alone, most of whom will carry at least one Wi-Fi equipped device."[32] Not surprisingly, Gogo expects that consumer demand for broadband access onboard some flights will outstrip the capacity of its existing 3 MHz air-ground system.[33] In addition, Alcatel-Lucent supports the need for more spectrum to meet the increasing demand for in-flight mobile broadband, noting that the "flying public is a particularly communicative population of 'road warriors' and generally people who are engaged in time-critical coordination of travel plans and business arrangements."[34] Finally, Qualcomm demonstrates in the Supplement to Appendix A attached to these Reply

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[30] Virgin America Comments at 1. As Virgin noted in mid-September, "[w]e want to give our travelers more options instead of fewer, including the ability to multitask across platforms – just as they do in their lives on the ground." *See* http://www.airlinetrends.com/2011/09/25/virgin-america-hybrid-inflight-entertainment-system/.

[31] *Id.*

[32] Gogo Comments at 3, 4.

[33] *Id.* at 4. *See also* Comments of Alcatel-Lucent at 3 (filed Sept. 29, 2011) ("Alcatel-Lucent Comments") ("Indeed, Aircell's 3 MHz of spectrum is likely to be insufficient to support the rapidly growing demand for wireless data services on aircraft.").

[34] Alcatel-Lucent Comments at 3 ("[I]t is not unusual to observe a majority of passengers using smart phones, ebooks, tablets and laptops on a typical flight."). Alcatel-Lucent forecasts wireless data growth of 30 times by 2015 when compared to 2010. *Id.*

Comments that significant additional capacity is needed to support in-flight communications needs.[35]

Comments from major U.S. airlines, technology providers, and the leading air-ground communications service provider, coupled with the detailed presentation in the Next-Gen AG Petition and supplemental data herein, firmly establish the need for a high-capacity in-flight broadband access solution to serve the increasing data connectivity needs of airborne travelers.[36]

Unfortunately, as noted above, the AMSS Parties, ostensibly due to concern over potential competition, take a very different view. They claim that current in-flight data connectivity options are sufficient to meet consumer demand and that Qualcomm has not shown a link between the rapidly growing consumer demand for terrestrial mobile broadband connectivity and airborne communications needs.[37] However, the AMSS Parties offer no evidence that consumers' need for mobile broadband access suddenly ceases at the airplane gate. Indeed, the AMSS Parties are investing in satellite-based aircraft communications technologies because they too believe that there is a growing market for full in-flight broadband connectivity. As the record herein demonstrates, American, United, Virgin, and other major airlines are expanding their airborne offerings and capabilities because their customers are in fact demanding enhanced in-flight broadband connectivity. And Gogo, which operates the current air-to-ground system used by some 6000 aircraft that may soon be overwhelmed, unequivocally supports the

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35 *See* App. A Supplement at A-5 to A-6.

36 *See* American Airlines Comments; United Airlines Comments; Virgin America Comments; *see also* Gogo Comments.

37 *See* Row 44 Comments at 5; Panasonic Comments at 2-4; SIA Comments at 5-6; Boeing Comments at 7.

Petition.[38] Accordingly, the AMSS Parties' claim of the lack of a link ignores the record of comments, the reality of the consumer marketplace, and the AMSS Parties' own business model.

C. Commission Authorization Of A Next-Gen AG Communications Service Furthers Key Federal Policies and Objectives

The Next-Gen AG service will support the objectives set out in the FCC's National Broadband Plan, and the federal government's broadband policies and spectrum initiatives – all of which recognize the need to find additional spectrum for mobile broadband connectivity. Chairman Genachowski recently touted the importance of broadband in reinvigorating the national economy and creating jobs, for it is a "bright spot in our overall economy that helps light a path to broad economic health and widespread opportunity."[39] Also, as the Chairman has repeatedly stated, there is a pressing need for more mobile spectrum, for the "spectrum crunch is the single biggest threat to one of the most promising parts of our economy."[40]

These statements also apply to in-flight broadband. As explained above, consumer demand for advanced on-board communications is growing by leaps and bounds. If properly cultivated, competition in the in-flight market will continue to drive the creation of more advanced service offerings, spawn new mobile products and apps, further feed Americans' demand for mobile broadband services, and, as a result, grow the economy and create jobs.

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[38] Gogo Comments at 5; Gogo Inflight Internet – Company info, *available at* http://www.gogoair.com/gogo/cms/company.do (last visited Oct. 6, 2011). The company further explained that "satellite may not always provide the best solution for all aircraft and all customers" in part because "many regional jets and general aviation aircraft are too small to mount a typical Ku/Ka band aircraft antenna." Gogo Comments at 4.

[39] FCC Chairman Julius Genachowski, Remarks entitled "Jobs and the Broadband Economy" at 2, 6-7 (Sep. 27, 2011) *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-309898A1.pdf.

[40] *Id.* at 7.

The Next-Gen AG Petition specifically calls for the Commission to auction to the highest bidders two 250 MHz-wide licenses to use the 14.0 to 14.5 GHz band on a secondary basis. The benefits of auctioning these spectrum rights are not only that competitive forces will ensure that the spectrum is being fully utilized, but also that it will result in payments to the U.S. Treasury reflecting the highest value placed on those rights. Only by commencing a rulemaking proceeding can the federal government and the American people reap these rewards.[41]

II. A Next-Generation Air-Ground Mobile Broadband Communications Service Can Successfully Operate On A Secondary Licensed Basis At 14.0 to 14.5 GHz

Commenting parties recognize that Qualcomm has designed a Next-Gen AG mobile broadband communications system that can operate successfully in the Ku band at 14.0 to 14.5 GHz on a secondary licensed basis to geosynchronous ("GSO") satellite systems, future non-geosynchronous ("NGSO") satellite systems, NASA's Tracking and Data Relay Satellite System ("TDRSS"), and radio astronomy users.[42] The Appendices to the Next-Gen AG Petition detail how the proposed service will provide full protection to these users.

As it has explained, Qualcomm has a direct, vested interest in fully protecting primary GSO satellite operations, for it has used this Ku band spectrum for more than two decades for its own successful GSO satellite-based OmniTRACS mobile communications and information service. Also, this experience has given Qualcomm an intimate understanding of the operating environment in the band, and the company has integrated that learning into the preparation of the Next-Gen AG Petition.

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[41] Moving forward on the Petition also is consistent with Section 706(a) of the Telecommunications Act, which requires the Commission to "encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans," which includes airline travelers. 47 U.S.C. § 1302(a).

[42] *See, e.g.*, Gogo Comments; American Airlines Comments, and United Airlines Comments.

As noted, the proposed service will operate on a secondary licensed basis, which means that Next-Gen AG licensees will need to fully protect the primary operations. The AMSS Parties allege that while Qualcomm is proposing a secondary allocation, it will seek additional protection (*e.g.*, by requesting primary status) at some point in the future.[43] While some, like the AMSS Parties, have taken that approach[44] and Qualcomm cannot control what future Next-Gen AG licensees might do, Qualcomm is not planning to seek primary status or else it would have proposed a primary allocation. Indeed, as demonstrated in the Petition and explained further below, Qualcomm has designed a Next-Gen AG system that can operate successfully on a secondary basis in the 14.0 to 14.5 GHz band, taking into account the primary Fixed Service Satellite ("FSS") services, including earth stations on vessels ("ESVs") and vehicle mounted earth stations ("VMESs"), as well as AMSS operations, and all other users.

A. The Proposed Rules Will Enable Ongoing Innovation And Competition In The Next-Generation Air-Ground Communications Ecosystem

The AMSS Parties contend that the Petition's detailed analysis may not be consistent with FCC policies against favoring specific technical implementations, claiming that FCC authorization of the proposed system may depend upon using Qualcomm technology and thus "leave little room for innovation … and competition."[45]

To the contrary, Qualcomm is not proposing a technology-specific service or regulatory regime. Qualcomm has proposed a set of performance-based rules, *see* Appendix B to the Petition, that will foster innovation in the development of air-ground technology. The proposed

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43 *See, e.g.*, Boeing Comments at 3-4; Panasonic Comments at 5 n.8.

44 *See, e.g.*, Panasonic Comments at 6 (citing Boeing Request for Elevation to Primary Status, IB Docket No.5-20 (April 20, 2010). *See also* Boeing Comments at 4-6; Row 44 Comments at 3.

45 *See* Panasonic Comments at 4; SIA Comments at 9.

rules set forth interference protection criteria for primary operations, and, in Appendix A to the Petition, Qualcomm has presented one means of designing an air-ground system to comply with these criteria. Qualcomm invites other technology developers to improve upon the proposed system design in the Petition.[46] Indeed, the proposed interference protection criteria are based on ITU-R S.1432, as recognized by SIA in connection with the UTC Petition.[47] Qualcomm in no way intends for the Commission to adopt a set of rules that would limit competitive opportunities for interested service providers.

1. The Proposed Interference Protection Levels Are Consistent With ITU Recommendations

The 14 GHz FSS uplink band has well developed and internationally recognized criteria to limit interference into satellites. These criteria allowed Qualcomm to calculate the worst case interference potential into GSO satellites and provide ΔT/T or Rise over Thermal ("RoT") noise levels from the proposed Next-Gen AG into uplink of GSO satellites that are significantly less than the levels adjacent satellites are allowed.

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[46] The AMSS Parties' reliance on the 2002 *NGSO Order* to support their contention that Qualcomm is asking the FCC to favor a particular technology is wide of the mark. *See* Panasonic Comments at 4 n.7 *and* SIA Comments at 9 n.14 (both citing *Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band*, Report and Order and Further Notice of Proposed Rulemaking, 17 FCC Rcd 7841 (2002) ("*NGSO Order*")).

Qualcomm seeks no such advantage or preference, and firmly believes there are alternative system designs that can satisfy the interference protection criteria. Unlike the *NGSO Order*, Qualcomm seeks no preference in the licensing process. The Petition proposes to award two equal licenses by competitive spectrum auctions.

[47] *See* Opposition of the Satellite Industry Association at 6-7 and Annex 1, in RM-11429, Utilities Telecom Council and Winchester Cator, LLC Petition for Rulemaking to Establish Rules Governing Critical Infrastructure Industry Fixed Service Operations in the 14.0-14.5 GHz Band (filed June 26, 2008) ("SIA Opp.") ("For secondary users, the appropriate interference threshold is set forth in Recommendation ITU-R S.1432, which provides that FSS links should be designed to allow for an aggregate allowance of 1%.").

Specifically, Qualcomm proposed that the aggregate RoT ($\Delta T/T$) from the Next-Gen AG system into the uplink of GSO satellites shall not exceed 1%. As a matter of fact, the 1% RoT threshold level is the level that SIA said applied to secondary operations in the 14.0 to 14.5 GHz band. In its Opposition to the UTC Petition, SIA explained that for secondary operations, the "appropriate interference threshold is set forth in Recommendation ITU-R S.1432, which provides that FSS links should be designed to allow for an aggregate allowance of 1%."[48]

SIA's Opposition went on to explain that the "corresponding interference allowance [for secondary operations] would have to be a fraction of the 1% allowance given to all other sources of interference operating under a non-primary allocation," and SIA used a 0.5% allowance in its interference calculations.[49] In its Comments on the Next-Gen AG Petition, however, SIA says that "the fact that Qualcomm's proposed operations alone could occupy all <u>or even half of the 1% allocated for non-primary sources raises significant concerns about aggregate interference from all such sources</u>."[50] SIA also takes issue with Qualcomm's proposed protection criteria for NGSO systems even though there are no such systems operating in the 14 GHz band.[51]

As detailed in Appendix A to the Next-Gen AG Petition, the designed system meets the 0.5% RoT level for GSO operations and is even under the 1% RoT level for future NGSO operations. In order to provide necessary flexibility in system design and operation, Qualcomm has proposed rules that allow a 1% RoT level for GSO satellite operations and a 6% RoT for

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48 SIA Opp. at 6 and Annex 1.

49 *Id*.

50 SIA Comments at 7 n.9 (emphasis added).

51 *See* SIA Comments at 7 ("[A] 6% RoT for primary NGSO FSS systems raises even greater concern since this would bootstrap the secondary ATG service into a "quasi" primary status.").

NGSO satellite operations.[52] In light of the different interference protection levels – even among SIA's own filings – Qualcomm respectfully submits that the FCC seek comment on the appropriate levels of protection in the NPRM to establish the Next-Gen AG service.

2. The Next-Gen AG Service Can Share Spectrum Successfully With All Primary Users As Well As AMSS Services

Qualcomm also explained in the Petition how the proposed service can operate successfully in the presence of VSAT terminals, NGSO terminals, and GSO and NGSO hubs. The Appendix A Supplement to these Reply Comments provides additional detail on how Next-Gen AG Ground Stations ("GSs"), in particular, can cope with interference from these sources.[53] The Next-Gen AG system can make use of many of the same system features that are used in today's 3G/4G networks, which include forming nulls, handoffs to adjacent GSs, as well as reassignment to another portion of the band away from the potentially interfering source. These techniques are not just part of Qualcomm's Next-Gen AG design but rather are techniques employed in today's 3G/4G advanced wireless access systems. The Next-Gen AG system will, of course, need specific system design features and functionality, but most of the techniques discussed in the Petition are well known to the wireless industry.

Moreover, if there is a case of a permanent FSS installation near a Next-Gen AG GS, and if the new installation is located such as to cause excessive interference to the GS and reduce the Next-Gen AG system capacity, then it is the responsibility of the Next-Gen AG operator as a

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[52] For NGSO systems, Qualcomm used an RoT of 6% because NGSO systems do not exist in the Ku band today, and they can be designed in the future to cope with 6% RoT that existing systems are required to meet. Nonetheless, even in this case, baseline system assumptions of the Next-Gen AG system led to an RoT below 1% from Next-Gen AG-equipped aircraft into NGSO system and below 1% from Next-Gen AG GS to NGSO satellites. *See* Next-Gen AG Petition, App. A at A-42; *see also id*., App. B.

[53] *See* App. A Supplement, *infra*, at A-4 to A-5 (responding to Boeing Comments at 3, Panasonic Comments at 4-5, and SIA Comments at 8).

secondary licensee either to move the particular GS being impacted or to make modifications to the GS to mitigate the interference.

Qualcomm provides herein additional detail on how the Next-Gen AG service will operate in the presence of interference from AMSS operations.[54] The design of the Next-Gen AG system (where the aircraft antenna is mounted on the bottom of the fuselage) and the design of an AMSS system (where the antenna is mounted on the top of the fuselage) actually enable the two systems to successfully co-exist. Even when the AMSS-equipped plane and the Next-Gen AG-equipped plane are in alignment and there is excessive degradation to the Next-Gen AG receiver, such as when the Next-Gen AG plane is between the AMSS plane and the serving satellite, only a small portion of the spectrum used by the Next-Gen AG system will be impacted; it also is possible to reassign the affected Next-Gen AG aircraft to a portion of the spectrum that the nearby AMSS aircraft is not using. For the case where the AMSS-equipped plane is between the Next-Gen AG GS and plane, the Next-Gen AG system can handoff that plane to another GS. Thus, even in the extreme corner cases where the AMSS transmitter will cause excessive degradation to the Next-Gen AG receiver, the effect on the receiver will be quite small because the AMSS transmitter affects only a small portion of the 14.0 to 14.5 GHz band. Moreover, the Next-Gen AG receiver can mitigate the effect through modulation symbol interleaving techniques, changing the frequency assignment, or handing off the aircraft to

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[54] *See* App. A Supplement, *infra*, at A-4 to A-5 (responding to Boeing Comments at 3. In Section 3 of the Appendix A Supplement, at A-6 to A-7, Qualcomm addresses questions that the accuracy of its assessment of interference into primary FSS operations because it assumed (i) uniformity of coverage by satellite receive beams and not increasingly more common focused spot beams over areas with higher population; and (ii) uniformity of aircraft across U.S. and not the more accurate concentration of aircraft over and between areas of high population density. *See* Boeing Comments at 2.

another GS where an AMSS-equipped aircraft is blocking the Next-Gen AG aircraft from the serving GS.[55]

In sum, the Next-Gen AG system protects current and potential future operations from harmful interference and avoids interference from all other users of the band through the use of: (i) advanced RF equipment and antenna designs; (ii) tightly-focused GS communications beams that point north (*i.e.*, away from GSO satellites); (iii) low transmit power from aircraft, and (iv) seamless hand-offs to successive GSs to avoid interference and track the flight path. In this way, the system proposed herein will provide millions of airplane travelers with high-speed in-flight broadband connectivity and fully protect primary users and successfully coexist with other secondary users of the 14.0 to 14.5 GHz band.

III. The Commission Has An Ample Record Upon Which To Move Forward

As explained above, the Commission has a very strong record on which to issue a Notice of Proposed Rulemaking proposing to establish the Next-Gen AG service. And, as explained below, the AMSS Parties have not offered any credible reason for the FCC to do otherwise.

A. The FCC Need Not, And Indeed, Should Not Delay Action On The Next-Gen AG Petition Until It Rules On Other Pending Matters

The AMSS Parties ask the FCC to delay action on the Petition until it concludes the AMSS proceeding.[56] They ask the Commission to complete the AMSS Docket to ensure

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[55] It is not possible for the Next-Gen AG service to affect the downlink (*i.e.*, the space-to-earth connection) of AMSS system, because AMSS uses spectrum in the 11 GHz band for that purpose.

[56] *See* Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum in the 14-14.5 GHZ Band to the Aeronautical Mobile-Satellite Service ("AMSS") and To Adopt Licensing and Service Rules for AMSS Operations in the Ku-Band, The Boeing Company, *Petition For Rulemaking*, IB Docket No. 05-20 (filed July 21, 2003) and *Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Earth Stations in Frequency*

regulatory "certainty" for the AMSS secondary licensees, but they provide neither authority to support that entitlement nor any technical analysis to justify their claims.[57]

While Qualcomm is not opposed to the FCC addressing the AMSS Docket, there is no good reason to tie the Next-Gen AG rulemaking proceeding to that Docket. The AMSS and the Next-Gen AG service involve completely different technologies (*i.e.*, satellite vs. terrestrial) and are by no means mutually exclusive. In contrast to Qualcomm's detailed technical presentation on how the two systems can operate successfully in the same band, the AMSS Parties have made no credible attempt to show that the Next-Gen AG service will cause harmful interference to AMSS systems.[58] And, while the SIA asks the Commission to "facilitate continued innovation" in the band on the one hand, its comments then seek to stifle that innovation by denying consideration of new, competing technology that provides greater mobile broadband capacity.[59]

Bands Allocated to the Fixed Satellite Service, Notice of Proposed Rulemaking, 20 RCC Rcd 2906 (2005) (collectively the "AMSS Docket").

Also, the pendency of the UTC Petition, *see Petition for Rulemaking to Establish Rules Governing Critical Infrastructure Industry Fixed Service Operations in the 14.0-14.5 GHz Band*, Petition for Rulemaking, RM-11429 (filed May 6, 2008) ("UTC Petition"), does not justify delay. Qualcomm opposes the UTC Petition because of concerns about interference to Qualcomm's OmniTRACS® and OmniVision® systems and the broad authority sought by UTC – two concerns not implicated in the Next-Gen AG Petition.

[57] SIA Comments at 9; Panasonic Comments at 6; Row 44 Comments at 3.

[58] In fact, Qualcomm explained in the Petition how the proposed service will operate in the presence of potentially interfering signals, *see* Appendix A to Petition at A-28 to A-39, and provides additional detail in this filing specifically relating to how it will successfully share spectrum with AMSS operations, *see* Appendix A Supplement at A-2 to A-3. For this reason alone and the longevity of the existing operations in the 14 GHz band, the situation here is clearly distinguishable from the facts and circumstances in *Amendment of the Commission's Rules to Provide Ancillary Services in the 849-851 and 894-896 MHz Bands*, 8 FCC Rcd 3920, 3921 (1993) cited by the AMSS Parties.

[59] SIA Comments at 4.

Indeed, as all of the commenting parties well know, the FCC has a statutory duty "to protect efficient competition, not competitors."[60]

The AMSS Parties also claim that the Petition should be denied because new Next-Gen AG licensees "operating on a secondary basis could arguably demand the cessation of interfering transmissions from AMSS networks operating on a non-interference/non-protected basis."[61] The Next-Gen AG Petition explains how the proposed service will avoid receiving interference from, and causing interference to, the AMSS service.[62] The AMSS Parties' contention is also contradicted by the fact that the Commission's authorizations for Panasonic, Row 44, ViaSat, and ARINC only require those licensed systems to protect other secondary services in the 14.0 to 14.5 GHz band that were authorized prior to the issuance of their respective authorizations.[63]

B. <u>The Cases Cited By The AMSS Parties Do Not Apply Here</u>

The FCC cases that the AMSS Parties seek to use to support their opposition in no way justify denial or deferral of the Next-Gen AG Petition. The AMSS Parties cite *Industrial*

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[60] *In re Bell Atlantic Mobile Systems, Inc. and Nynex Mobile Communications Company*, Memorandum Opinion and Order, 12 FCC Rcd 22280, 22288 (1997) (citing SBC Communications Inc. v. FCC, 56 F.3d 1484, 1491-92 (DC Cir. 1995)).

[61] Boeing Comments at 4-5; *see also* Panasonic Comments at 5.

[62] *See also* A-2 to A-3, *infra*.

[63] *See Panasonic Avionics Corporation, Application for Authority to Operate Up to 50 Technically Identical Aeronautical Mobile-Satellite Service Aircraft Earth Stations in the 14.0-14.4 GHz and 11.7-12.2 GHz Frequency Bands*, Order and Authorization, 26 FCC Rcd 12557, 12569 (IB & OET 2011); *Row 44, Inc., Application for Authority to Operate Up to 1,000 Technically Identical Aeronautical Mobile Satellite Service Transmit/Receive Earth Stations Aboard Commercial and Private Aircraft*, Order and Authorization, 24 FCC Rcd 10223, 10239 (IB & OET 2009); *ViaSat, Inc., Application for Blanket Authority for Operation of 1,000 Technically Identical Ku-Band Aircraft Earth Stations in the United States and Over Territorial Waters*, Order and Authorization, 22 FCC Rcd 19964, 19973 (IB & OET 2007); *ARINC Inc., Application for Blanket Authority for Operation of Up to One Thousand Technically Identical Ku-Band Transmit/Receive Airborne Mobile Stations Aboard Aircraft Operating in the United States and Adjacent Waters*, Order and Authorization, 20 FCC Rcd 7553, 7572 (IB & OET 2005).

Telecommunications Association to support their assertion that the Petition should be denied because it is supported entirely by hypothetical scenarios and not factual data and evidence.[64] The Next-Gen AG record to date is replete with uncontroverted evidence on the need for the Next-Gen AG service and a full-blown interference analysis detailing how the proposed service can successfully operate in the band. Moreover, whereas the petitioner in *Industrial* was seeking to prohibit others from continuing to use certain radio frequencies,[65] Qualcomm is asking the FCC to enable the reuse of spectrum in a novel way, and increase competition in the aircraft communications market.

Equally misplaced is the AMSS Parties' reliance on *Checkpoint Systems* where the petitioner did "not submit[] any information supporting its assertion" regarding the need for the rule change, nor "any scientific evidence to support its claim that building attenuation will act to prevent interference."[66] By contrast, Qualcomm has provided an extensive technical analysis in the Petition and supplemental information herein demonstrating how a Next-Gen AG service can operate at 14.0 to 14.5 GHz without causing harmful interference.[67]

SIA also cites the Wireless Bureau's 2004 letter to the Federal Law Enforcement User's Group to justify denial of the Petition on the grounds that Qualcomm has failed to provide

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[64] Panasonic Comments at 3 n.4; SIA Comments at 6 n.6; Boeing Comments at 7 n.6. *See also In re Industrial Telecommunications Association, Inc., Amendment of Part 95 of the Commission's Rules To Establish a Very Short Distance Two-Way Voice Radio Service*, Order, 19 FCC Rcd 6988 (WTB 2004) (*"Industrial")*.

[65] *Industrial, 19 FCC Rcd at 6988.*

[66] *See* SIA Comments at 6 n.7*; In re Petition for Rulemaking Filed by Checkpoint Systems, Inc., to amend Part 15 of the Commission's Rules to Permit Increased Emissions for Electronic Article Surveillance Systems*, Order, 13 FCC Rcd 21600, 221602 (OET 1998).

[67] *See* Appendix A to Next-Gen AG Petition; *see also* Letter from Dean R. Brenner, Vice President, Government Affairs, Qualcomm to Marlene Dortch, Secretary, FCC (filed Sept. 2, 2011). Qualcomm also responds herein to technical questions raised in the comments.

concrete rule proposals.[68] Such use of the *Fed Law* letter decision is likewise misplaced because the petitioner there did "not set forth the text or substance of *any* proposed Commission rule change or amendment."[69] In contrast, Qualcomm has, in accordance with FCC Rule Section 1.403(c), set forth "concrete proposals regarding the definition and implementation"[70] of the proposed Next-Gen AG service covering the frequency band, interference protection criteria, out-of-band emissions levels, the number of licenses, and the process for selecting licensees.

Thus, none of the cases cited by the AMSS Parties apply to the Next-Gen AG Petition. If anything, they stand in stark contrast to those cases and serve to highlight the solid record that Qualcomm and the supporting commenters have established. The Commission should now move forward and issue an NPRM in accordance with the proposals in the Petition.

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68 Letter from Cathy Seidel, Deputy Chief, Wireless Telecommunications Bureau, to James J. Flysak, Federal Law Enforcement Wireless Users Group, RM-10432, 199 FCC Rcd 11500 (2004) ("*Fed Law*").

69 *See id*. at 11501.

70 This is the standard noted by the Bureau in *Fed Law*. *Id*. *See also* 47 C.F.R. § 1.403(c).

CONCLUSION

For all of the foregoing reasons, Qualcomm respectfully requests that the FCC swiftly issue a Notice of Proposed Rulemaking proposing to establish a Next-Generation Air-Ground communications service at 14.0 to 14.5 GHz. Qualcomm looks forward to working with the Commission and all interested stakeholders, including current licensees of the band, to enable multi-gigabit-per-second air-ground broadband communications technology to support the exploding population of mobile broadband devices and applications well into the future.

Respectfully submitted,

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Dated: October 14, 2011

CERTIFICATE OF SERVICE

I, John W. Kuzin, certify that on October 14, 2011, a copy of the REPLY COMMENTS OF QUALCOMM INCORPORATED was sent via First Class mail to the following parties that filed opening comments with the Commission on the Next-Gen AG Petition:

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Appendix A Supplement

Additional Interference Analysis & Related Information

1. AMSS Interference to Next-Gen AG Aircraft Receivers

It is envisioned that if both Next-Gen AG and AMSS systems are installed on the same plane that only one will operate at a given time. For instance, AMSS may be installed for over the ocean coverage and Next-Gen AG for over CONUS. In this case, the operation will switch from one system to the other.

There may be cases, however, where there is an operating AMSS transmitter on a plane (mounted on the top of the fuselage) flying close to a plane operating a Next-Gen AG transceiver and antenna (which will be mounted below the fuselage). As discussed in detail below, because of the designs of the Next-Gen AG system and the AMSS system, these are extreme corner cases.[71] Also, even when the AMSS-enabled plane and the Next-Gen AG-enabled plane are in alignment such as to cause excessive degradation to Next-Gen AG receiver, only a small portion of the spectrum used by the Next-Gen AG system will be impacted, and the Next-Gen AG air interface's modulation symbol interleaving and forward error correction will mitigate the effect of lost symbols. Alternatively, the affected Next-Gen AG aircraft may be readily assigned to a different portion of the spectrum that the nearby AMSS aircraft is not using.

The Next-Gen AG aircraft antenna is, by design, located on the bottom of the fuselage and pointing down toward negative elevation angles. The AMSS antenna on the other hand is mounted atop the plane's fuselage and pointing at high elevations angles of at 20° or greater and with a very narrow beamwidth. In fact, the average elevation angle of an AMSS transmitter over the CONUS is about 40 degrees. Therefore in order for the AMSS-enabled aircraft to cause harm to the Next-Gen AG aircraft receiver, the two aircraft must very close; the AMSS-enabled aircraft must be flying roughly in parallel and to the north of the Next-Gen AG aircraft, and the AMSS aircraft must be flying at a lower altitude than the Next-Gen AG aircraft so that the boresight of the AMSS transmitter antenna points toward the Next-Gen AG aircraft antenna's backlobe. Even if the two aircraft become aligned in altitude and proximity so that the AMSS transmitter, the Next-Gen AG antenna, and the satellite that serves the AMSS unit line up, the effect of interference caused by the AMSS transmitter may be mitigated as described above.

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[71] It is not possible for the Next-Gen AG service to affect the downlink (*i.e.*, the space-to-earth connection) of AMSS system, because AMSS uses spectrum in the 11 GHz band for that purpose.

Also, for the AMSS transmitter to cause excessive interference to the Next-Gen AG receiver the two aircraft need to be within a few kilometers of each other, which may not occur very often in light of typical flight patterns.

Another case where the AMSS transmitter may interfere with the Next-Gen AG receiver is where the AMSS-enabled aircraft is located between the Next-Gen AG enabled aircraft, and the Ground Station (GS) that serves the Next-Gen plane, and AMSS enabled plane is flying at a lower altitude than the Next-Gen AG enabled plane so that the backlobe of the AMSS transmitter is aligned with the peak antenna gain of the Next-Gen AG aircraft antenna. Note that in this case it is possible to handoff the Next-Gen AG-equipped aircraft to another GS so that the Next-Gen aircraft antenna points away from the AMSS transmitter.

In other flight cases, the Next-Gen AG antenna rolls off from its peak gain relative to the AMSS transmitter and is also well outside of the beamwidth of the AMSS beam enabled plane; as a result for the Next-Gen AG enabled receiver to receive interference from the AMSS enabled plane the two planes be closer than is typically permitted under FAA regulations.

In addition, the Next-Gen AG system design uses many techniques from today's 3G and 4G cellular systems, and, like those systems, it is highly rate adaptive and can adjust its data rate to the C/(I+N) at the receiver. Therefore, in most cases interference from other sources, many of which were described in Appendix A to the Petition,[72] will mostly reduce the margin that was included in the system design and will not result in any data rate reduction. Where interference increases temporarily to the point of lowering the C/(I+N) seen by the receiver below what is needed by the highest data rate, then the data rate will be reduced temporarily until the interference source or the aircraft has moved away. In the limited set of cases described above where the AMSS transmitter will cause excessive interference on the portion of spectrum it is using the Next-Gen AG-enabled plane will be assigned to a different piece of the spectrum not used by the AMSS transmitter or be switched to another GS not within the path of the AMSS transmitter. Note that depending on the bandwidth of the AMSS transmitter, interference from the AMSS transmitter – even in the worst case – is only a small part of the Next-Gen AG receiver bandwidth, and, as mentioned above, may be mitigated through modulation symbol

[72] *See* Next-Gen AG Petition at A-28 to A-39.

interleaving and forward error correction, resulting in only a temporary and small reduction of data rate; and there may be no need to assign the Next-Gen AG transceiver to a different portion of the spectrum.

Accordingly and as explained above, the Next-Gen AG system can successfully coexist with AMSS systems, and Qualcomm is not requesting the FCC to impose any rules on the AMSS system. FCC proceedings relating to AMSS can and should be treated independently from the Next-Gen AG rulemaking.

2. Interference from VMES (Vehicle Mounted Earth Station) and ESV (Earth Station Vehicle) to Next-Gen AG Ground Stations

If VMESs (Vehicle Mounted Earth Stations) and ESVs (Earth Station Vehicles) come very close to a Next-Gen AG GS and are positioned such that the GS is between the VMSE/ESV and its serving satellite then VMES/ESV may cause excessive interference to the Next-Gen AG GS on the portion of the spectrum being used by the ESV/VMSE. The actual distance at which harmful interference occurs depends on the propagation environment and factors such as clutter. In cellular deployments, Hata models typically are used to estimate cell sizes for distances of larger than a few hundred meters; Hata models uses path loss exponent of 3.5 or higher in urban and suburban environments which result in much higher path loss than free space model. Therefore, probability of harm from a VMSE/ESV station to the Next-Gen AG GS is, around many GSs, very small. But there can be cases, such as GSs in open environments, where a VMES/ESV station will cause excessive interference to the GS on a piece of spectrum. In these cases, there are a number of mitigation techniques designed into Next-Gen system to mitigate the interference from these sources.

One mitigation technique involves creating nulls toward the nearby vehicle using active beam steering or other similar antenna techniques. In order to provide high capacity and avoid interference to GSO and NGSO satellite systems, the Next-Gen AG GS antenna system needs to create narrow beams and be capable of beam steering. This capability also may be used to attenuate the effect of interference from VMSE/ESV. The null toward the vehicle may be formed because the vehicle will be almost at horizon or even below horizon relative to the GS antenna, whereas the aircraft will be served by a GS beam that is formed above horizon. It is

true that as a null is created toward the vehicle, the main antenna gain toward the aircraft on the Return Link ("RL") will be reduced resulting in a reduction in the data rate on the RL from that particular aircraft to the GS. Therefore, the effect of this interference source will be lower data rate on the RL for some planes which again will last for a short period of time because of movement of the plane.

Another technique to mitigate the interference from the vehicle is to handoff the aircraft to a different GS, which is referred to as cell site diversity. Note that each aircraft will be able to connect to at least two GSs. Yet another mitigation technique is to assign the particular aircraft to a different piece of the spectrum which is not being used by the nearby truck. The frequency assignment is an integral part of the system scheduler and can be easily accommodated by the Next-Gen AG system and will mitigate the interference source with minimal impact to data rate. Advanced wireless access systems, such as the 4G cellular system, employ sophisticated schedulers to "optimally" assign bandwidth to different users. These techniques can be used in Next-Gen AG system.

Therefore, if a VMES/ESV is close enough to a GS and aligned with the GS and its serving satellite as described above then either the portion of spectrum used by the VMES/ESV will not be used by the GS or it will be used at a lower rate. As a result, the average RL throughput of the site is slightly reduced. But as described above because of the handoff feature the reduced RL throughput is in fact shared with adjacent cell sites and the net effect will be rather small.

In sum, the Next-Gen AG system has additional built-in margin and several system features to mitigate the effects of sources of interference such as VSATs and Hubs discussed in the Next-Gen AG Petition in detail as well the AMSS and VMES/ESV discussed above. Many of these system features, such as forming nulls, handoffs, and frequency reassignment also are designed into today's cellular systems and are not just part of Qualcomm's design but rather are well-known techniques that are employed in advanced 3G/4G wireless systems. Therefore, the Next-Gen AG proposed rules need not include any restrictions on VMES/ESV system operation near Next-Gen AG GSs. As explained above the Next-Gen AG system will be able to cope with VMES/ESV systems. If there is a case of a permanent FSS installation near a Next-Gen AG GS, and if the new installation is located such as to cause excessive interference to the Next-Gen AG GS and reduces the Next-Gen AG system capacity, then it is the responsibility of the Next-Gen

AG operator to either move the particular GS being impacted or to add structural changes to the GS to mitigate the interference.

3. The Need for a High-Bandwidth, High Capacity System

According to cnet.com,[73] Netflix HD videos are streamed at about 4,800 kbps. However, a typical sustainable average data rate for Netflix video streaming was measured at about 2,667 kbps over a three months period. But the higher the bit rate that can be sustained throughout the viewing of the video, the better the performance and ultimately the better the quality of the image over the duration that the video is played. Therefore, assuming 30% onboard service penetration, with an average number of 100 passengers per plane (based on data from the U.S. Department of Transportation, *i.e.*, an average capacity of 120 seats and 80% load factor), a data rate of about 40 Mb/s to 70 Mb/s (depending on video quality) would be required to support simultaneous video streaming sessions for only 50% of the serviced passengers per aircraft (*i.e.*, 15% of the passengers, depending upon the video quality, 15 passengers x 2,667 kb/s ~ 40 Mb/s or 15 passengers x 4,800 kb/s ~ 70 Mb/s). Capacity also is needed to support the other 50% of the serviced passengers (*i.e.*, the other 15% of the total passengers) with web browsing or other applications. In addition, a high-capacity system will become even more essential to the extent service penetration exceeds the 30% amount estimated above.

Hence, a system capable of delivering data rates of roughly 100 Mb/s per plane is needed to support high quality service – a true broadband experience in the sky that is comparable to what is offered at home or office today; such a system will be needed to meet consumer expectations as demand for mobile data continue to grow at an astounding pace. As explained in Section II.A of the Next-Gen AG Petition, the proposed system is designed to support an aggregate throughput of 300 Gb/s in 500 MHz spectrum, and capable of servicing up to 3000 airplanes simultaneously with data rates up to 100 Mb/s per plane.

The above example illustrates that a new Next-Gen AG broadband service will be needed to meet consumer demands on-board aircraft. Qualcomm expects there to be a continued need for multiple systems and technologies (possibly terrestrial and satellite-based) to support the demand.

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[73] *See* http://news.cnet.com/8301-31001_3-20029794-261.html.

4. Concentration Of Aircraft Above High Population Areas And Use Of Satellite Spot Beams

Note that regardless of concentration of aircraft across the CONUS, the maximum number of aircraft that may transmit on the same piece of spectrum at any given time within a GS is limited to the number of co-frequency beams in that GS. Therefore, if GSs are uniformly deployed across the CONUS, then in areas of higher aircraft concentration, each aircraft will get a smaller portion of bandwidth or time to transmit. In other words, the EIRP transmitted from all aircraft will be uniform across different areas regardless of concentration of aircraft.

If it is desired to provide higher capacity in areas of the CONUS with a higher concentration of airplanes, such as the west and east coasts, then more GSs need to be deployed in those areas. However, if in some parts of the CONUS more GSs are deployed to increase capacity, the EIRP of each GS will be reduced by the same factor such that the effective EIRP into the geostationary arc is unchanged compared to the baseline analyzed. Increased capacity can be obtained by increasing the frequency reuse but not by increasing the total EIRP. For instance, if the radius of a GS is reduced by a factor of $\sqrt{2}$, then the total number of sites is increased by a factor of 2, but to achieve the same signal power at the cell edge, the EIRP may be reduced by 3 dB due to 3 dB path loss at the cell edge, both from the GS on the Forward Link ("FL") and also from the aircraft on the RL. Therefore, the system capacity is increased by a factor of 2 but the total EIRP over all sites is unchanged because each site transmits half the power as the previous configuration. The total EIRP from all aircraft in the area with twice as many GSs also remains the same because each aircraft transmits at half the power in comparison to the baseline case.

As discussed in Section 3.3.1.1 of Appendix A to the Petition, the CONUS beam RoT interference calculations carry over to spot beams. The reason is that the increased G/T of the spot beam is compensated for by a decrease of the same amount in total EIRP seen by the spot beam from the GSs or the aircraft. For example, in moving from one beam to two beams, the G/T of the satellite beam will increase by 3 dB. But, as discussed above, the EIRP from Next-Gen AG GSs or aircraft in each of the two spot beams will be half as much as in the CONUS beam regardless of distribution of number of GSs or aircraft in different areas, which results in the same RoT in the spot beam case as in the CONUS beam case.

5. Responses To Other Technical Issues Raised In The Opening Comments[74]

Impact of Ground Reflection of Aircraft Transmissions Upon GSO Satellite Operations**.** Reflections off the ground are a combination of specular and diffuse components. Diffuse energy reflected off of the earth's surface can be modeled simply as a lambertian surface, which means that the energy that hits the surface gets reradiated in all directions at much lower power in any direction throughout the hemisphere above it (2π steradians) rather than the single specular direction off of the surface. This effectively reduces the amount of energy in any single direction by a large amount. In addition, the reradiated signal is distributed into all polarizations, and half the power can couple into either polarization reception at the GEO arc linear elements (or circular polarization receivers). Although the power addition may be coherent, the reflected power is reduced by the reflection coefficient of the earth, plus the diffuse scattering, plus the coupling of only half the power. For these reasons, the diffuse component has a much smaller effect than the specular component, and Qualcomm thus has focused on computing the effect of the specular component of the reflected signal in increase in RoT of the satellite.

The power reflection coefficient is somewhere between 15% and 45% (in power) for the majority of elevation angle distribution to the geostationary orbit arc, which covers 20° to 60° of elevation for the CONUS locations. The average elevation angle over CONUS is about 40°, and a reflection coefficient of 23% based on field measurements. Elevation angles lower than 20° would have higher reflection coefficients but would suffer more losses due to obstructions, and experience higher atmospheric losses on the way down to the ground or back out towards the sky. Therefore, accounting for those directions would result in a negligible contribution to the interference calculation. Furthermore, elevation angles below 20° to the geostationary arc correspond to a small number of CONUS service areas.

Accordingly, the effect of the reflection for the 40° elevation case is considered. To compute the effect of the reflected component on overall interference, the phase of the reflected component relative to the line of sight component is added to the voltages of the two signal components and then the combined power is averaged over all possible phase differences. For the case of 40° elevation angle (23% reflected power, typical dielectric constant of 4), the average increase to

[74] This section responds to technical comments made by Alcatel-Lucent.

the interference seen by the satellite (over all phase differentials of line of sight and reflected components) is computed to be about 0.86 dB above what was computed in Appendix A to the Petition. That case was a RoT of about 0.14% (-28.63dB), so increasing that for the reflected specular component would make the total about 0.17% , still well below the 1%. Note that in the above calculation we assumed that all reflected power is concentrated onto the specular component. Since the diffused reflected power, as discussed above, has a much smaller effect into the GEO-arc, the above calculation is in fact a worst case calculation.

Need for 500 MHz of Ku band spectrum. The spectrum options being considered in Europe are aimed at a total of 20 MHz of spectrum in the L band or 3.6 GHz band. Although that is about 5 times higher than the 4 MHz initially allocated in the US, of which 3 MHz is used by GoGo, it is still considerably smaller than what would be needed to support the type of services that new devices require (as explained in Section 3 above). Note that not only the capacity of the system envisioned in Europe would be less than that proposed in the Petition by a factor of 500/20 = 25 times just due to the spectrum difference, the capacity would be even lower because the bands considered in Europe are not high enough to permit the use of highly directional antennas at the GS or the aircraft. Operation in the Ku band enables the use of highly directional antennas with small antenna size and allows spatial reuse of the spectrum in non-overlapping beams, resulting in a significant increase of overall system throughput. The system being considered in Europe is effectively an incremental improvement, in terms of bandwidth and throughput, over the first generation AG system deployed in the U.S. A 500 MHz air-ground broadband system is needed.

Number of Ground Stations. The 150 GS sites discussed in Appendix A were used to illustrate the interference calculations, and to demonstrate that it is possible to provide the service in a non-interfering manner. However, the proposed rules in Appendix B did not assume any specific value for the number of GSs, but left that as a parameter to be used in determining that the sum total of all power from all GSs is below a certain level to avoid interference to GSO operations.

Number of Planes That Can Be Simultaneously Supported**.** The number of aircraft that the Next-Gen AG system supports is not limited to 600. Pursuant to the system example set forth in Appendix A to the Petition, there are 150 GSs and 4 co-frequency beams in each site, resulting in 600 co-frequency beams over the CONUS. This does not imply that only 600 planes may be supported over the CONUS. If the 500 MHz of spectrum is divided into say five 100 MHz

pieces and each aircraft is allocated 100 MHz of bandwidth, then 3000 planes can be supported over the CONUS on 500 MHz of spectrum and with 600 co-frequency beams. Note that there could be as many as 20 beams or more in a ground station, but only 4 beams may be operating on the same frequency. Note also that the Petition does not imply that the system consists of only 150 sites. 150 sites is an estimate of the number of GS sites that are needed. The actual deployment could include more sites, perhaps 200 to 250, to account for specific terrain characteristics as well as the need to accommodate non-uniform capacity across the CONUS. If more than 150 sites are used, then based on the rules in Appendix B to the Petition, the EIRP of each beam needs to be reduced commensurate with the increase in the number of GSs to ensure that the interference into existing services and other licensed services is not increased. For example, if 300 sites with 4 co-frequency beams in each site are deployed, then a total of 6000 planes may be serviced with each plane using 100 MHz of spectrum.

Aircraft Roll Angles. As described in Section 3.3.1.2 of Appendix A to the Petition, the aircraft roll angle for commercial planes and private jets are around 15 degrees during turns. The fraction of time the aircraft spend during turns is a fraction of average flight time. As the Petition explains, to avoid increased interference into the geo-arc during aircraft turns, the aircraft antenna beam may be steered down and away from the geo-arc; the transmitter also may be turned off at certain roll angles. The aircraft roll angle may be estimated using equipment with axis accelerometer / gyroscope combination tools (designed for avionics use) that have better than 1° of sensitivity. Therefore, the EIRP of the aircraft may be controlled during the flight to ensure that the RoT limit into the geo-arc is not exceeded. Note that the aircraft transmitter also will be turned off when the aircraft transceiver does not receive a FL signal strong enough for demodulation. In other words, during large turns if the antenna beam is not steered toward a GS, the FL would be lost and the transmitter would turn off even without the information from accelerometer/gyroscope device. (Note that Qualcomm's Omni-TRACS system shuts off transmission in absence of a FL signal.) Therefore, many layers of safety can be built into the Next-Gen AG system to maintain RoT from aircraft transmitters well below 1%.

Also, based on the calculations in Appendix A to the Petition, the RoT from aircraft into the CONUS beam was about 0.14%, well below the 1% target. Even if an aircraft transmitter were to point directly at the GEO-arc (although impossible by design) the rogue aircraft transmitter

would count as 100 transmitters (due to loss of 20 dB antenna roll off) and with the example of 600 simultaneous transmitter on the same piece of spectrum, the increase in RoT would be 0.7 dB (10log(700/600)), which would increase the 0.14% RoT only to about 0.16% and still well below 1%. As noted, many layers of safety can be built into the system design, and the RoT margin further ensures that RoT due to the Next-Gen AG system is well below 1%. The interference calculations were conservative in a number of other ways. For instance, Qualcomm's calculations assumed that all aircraft are transmitting at the maximum power allowed and simultaneously (100% load), which is not the case in practice. Qualcomm also assumed that there is no polarization mismatch between the aircraft antenna and the satellite receive antenna which also is quite pessimistic.

Doppler Compensation. The Next-Gen AG Petition did not imply the use of any specific air interface (e.g., LTE) or related parameters. The choice of air interface and actual implementation is left to Next-Gen AG technology developers and service providers. In any case, the searcher, frequency acquisition, and tracking loops in the Next-Gen AG transceivers may be designed to compensate for the expected Doppler frequencies.

NGSO Satellite Ephemeris Data. As discussed in Appendix A to the Petition, the Next-Gen AG GSs may be designed to avoid interference to NGSO satellites without any knowledge of ephemeris information. If ephemeris data is available, however, it may be used to point the GS beams away from the location of the NGSO satellites (on an as needed basis) to control interference when the aircraft and an NGSO satellite happen to align briefly. If the ephemeris data is reasonably accurate (like the almanac data in the GPS system), it typically can be trusted from days to weeks, although it would not be difficult to maintain regular updates from the NGSO system or other orbit information services. Additionally, if a Next-Gen AG service provider uses ephemeris data to control interference into the NGSO satellite, the provider can build a margin of safety into the system by turning off the beam earlier and turning it on later than the ephemeris data would suggest. However, as described in Appendix A to the Petition, ephemeris data is not needed to avoid interference to NGSOs; ephemeris data simply offers an additional tool to the Next-Gen AG technology developer/service provider to use in designing the best system.

As is the case with the Globalstar SATCOM phone system, which Qualcomm helped develop, and even in GPS or other multi-constellation systems, the NGSO system's orbit constellation integrity and spacing is a key component for managing, planning and operation of all segments of the system. These systems use station keeping precision to maintain specific relationships of the orbiting satellites relative to each other in the constellation, and phasing with respect to the earth surface and coverage. Thus, orbit "locations" are expected to be well-known and maintained within certain tolerances. In addition, satellite repositioning maneuvers typically are known well in advance and preplanned. And, when repositioning is performed, satellites (particularly NGSO satellites) will likely be required to shut down operation until the satellite is stabilized into its new orbit position for operational use. The NGSO system would require accurate knowledge of its orbit positions, even for operation of its ground segment terminal community so that pointing from the ground stations is properly managed and avoids errant radiation, thereby providing protection to the GEO-arc services. This knowledge would therefore be readily available and known in advance for the Next-Gen AG system to use for coordination purposes. Thus, as noted herein, there are a number of techniques available to the Next-Gen AG system designer to protect NGSO satellites.