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

In the Matter of Aeronet Global Communications Inc.'s Petition for Rulemaking to Amend the Commission's Allocation and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands to Authorize Aviation Scheduled Dynamic Datalinks	))))))))))	RM-________________________

PETITION FOR RULEMAKING OF AERONET GLOBAL COMMUNICATIONS INC.

Samuel L. Feder
Roger C. Sherman
Elliot S. Tarloff
JENNER & BLOCK LLP
1099 New York Avenue, NW
Suite 900
Washington, DC 20001
(202) 639-6000

Counsel for Aeronet Global Communications Inc.

February 6, 2019

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Pursuant to Section 1.401 of the Commission's rules,[1] Aeronet Global Communications Inc. hereby petitions the Federal Communications Commission to initiate a rulemaking to amend its allocation and service rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz spectrum bands (collectively the "E-Band" or the "Band") to authorize the use of aviation scheduled dynamic datalinks ("SDDLs") as described herein.[2]

INTRODUCTION AND EXECUTIVE SUMMARY

With this Petition, Aeronet requests that the Commission adopt minor amendments to its allocation and service rules for the E-Band to authorize Aeronet's planned use of this spectrum to provide high-speed (Gigabit per second or "Gbps") broadband to aircraft. Aeronet's planned service will unlock the "Internet of the Sky," delivering substantial public interest benefits to consumers, airlines, aircraft crew, and public safety.

[1] 47 C.F.R. § 1.401.

[2] In a companion Petition for rulemaking, Aeronet is seeking similar amendments to authorize the use of maritime scheduled dynamic datalinks in the E-Band.

As the Commission is aware, demand for in-flight broadband is outstripping what airlines currently can provide. High Throughput Satellite stations have made in-flight Wi-Fi more commonplace, but connections remain unstable, speeds remain inconsistent, and there simply is not adequate capacity to support the increasing bandwidth demands on each flight—let alone the combined data demands of multiple aircraft.

Aeronet will bring new competition into the aviation market through the introduction of a new connectivity technology, capable of handling the significant demand for high-speed broadband on each equipped aircraft. Consumers will be able to access their own HD content, online and streaming applications, and data services, at terrestrial equivalent speeds and latency, as they travel. This includes recreational passengers, who carry data-intensive devices everywhere they go, and professionals, who will be able to use the faster and more stable connectivity to monitor projects in the air. Moreover, airlines will be able to install and operate new Internet of Things ("IoT") avionics like weather monitors and engine sensors. Crew will be empowered with tablets to support real-time in-flight service, remote organization procedures, and public safety. And recovery expeditions for missing "black boxes" may become less frequent, as airlines that choose to do so will be able to transmit data from aircraft to operation centers in real time.

In short, as travelers, airlines, avionics, and crew utilize more applications, devices, and services that depend on high-speed connectivity, aircraft will increasingly resemble corporate offices in terms of data needs. Indeed, each aircraft requires individualized and dedicated Gbps backhaul service, not shared access backhaul service. And currently, there is no single platform or network—whether terrestrial, low-earth orbit satellites ("LEOs"), or high-altitude platform stations ("HAPs")—that can meet such demand.

Aeronet's SDDLs are an innovative application of a technology that certain industries and the military have long used to transmit large volumes of data over long distances by establishing point-to-point networks with narrow-beam spectrum. Aeronet has demonstrated through live trials the ability to establish, configure, and maintain SDDLs to deliver 1 Gbps download and upload service, continuously, to an aircraft along its test flight route, and 1-3 Gbps speeds to a cruise vessel as it sails. Moreover, Aeronet is engaged in live customer beta testing of the maritime application of its SDDLs, and it is engaged in ongoing internal testing to demonstrate the ability to create sub-mesh networks from ground station to aircraft and from aircraft to aircraft, supporting continuous connectivity along known flight paths.

The spectrum in the E-Band is uniquely suitable for this technology, given its high frequency and high antenna directionality, as well as the large bandwidth that is available. Additionally, the historical light-touch framework governing the E-Band both here and abroad makes this spectrum ideal for coordinating with scheduled known vehicles in motion like aircraft. Given the spatial separation of various uses in the E-Band, Aeronet's SDDLs are unlikely to cause interference with other users—even as E-Band spectrum is adopted more widely for wireless backhaul to support 5G applications in dense urban settings. That is why Aeronet has actively participated in the Commission's *Spectrum Frontiers* proceeding and other dockets to support innovative uses of this spectrum. Our priority, like the Commission's, is ensuring that the E-Band rules are flexible and conducive to the development of multiple new technologies.

While Aeronet's use of SDDLs involves point-to-point datalink communication between network endpoints that are in motion, Commission precedent supports treating the service as "fixed," given the limited and predictable patterns of the movement (*i.e.*, along a flight path) at issue. Over the last 15 years and especially recently, the Commission has taken such an approach, enthusiastically and on a bipartisan basis, authorizing mobile satellite communications in larger amounts of spectrum that is specifically designated for Fixed-Satellite Service ("FSS"), to unleash the benefits that accrue from supporting broadband connectivity to vessels in motion. The same logic applies equally here: Existing regulatory classifications in the E-Band allocation and service rules are impeding Aeronet's deployment of an innovative technology that is functionally and operationally consistent with the Commission's broader framework for the E-Band and the Commission's pro-deployment objectives.

To be clear, Aeronet supports the existing framework for the E-Band and is not requesting changes to the structure of the rules or the process for handling link registration and interference disputes. Instead, Aeronet is requesting a few targeted changes that will allow for limited, predictable, and non-interfering communications between scheduled moving points in the E-Band.[3] Aeronet urges the Commission to move quickly to adopt these amendments. Indeed, in light of the benefits of SDDLs and the virtually limitless demand for in-air broadband, Aeronet expects that regulators in other countries will authorize a variation of this technology in the near future. Aeronet hopes it is the United States, acting through the Commission, that shows leadership in being the first to authorize this exciting new technology, matching its commitment to win the global race to 5G to the benefit of all Americans.[4]

I. Aeronet Is Capable of Enabling Numerous Public Interest Benefits for Consumers, Airlines, and Others by Delivering Gbps Broadband to Aircraft.

Aeronet is a communications services company that has developed an innovative technology to provide Gbps broadband service, on a wholesale basis, to aircraft and maritime

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[3] *See infra* Part III.

[4] *See, e.g.*, *In re Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment*, Declaratory Ruling and Third Report and Order, WT Docket Nos. 17-79, 17-84, FCC 18-133 ¶ 1 (rel. Sept. 27, 2018).

vessels. The aviation market is currently under-served by broadband providers, depriving passengers, airlines, crew, and public safety officials of the numerous benefits that true broadband connectivity would enable.[5] Aeronet has made significant progress by demonstrating that Gbps service in the air is not merely conceptual or conjectural; it is already feasible and inevitable, and the Commission should act quickly to ensure that the United States is the global leader in this exciting new broadband market.

A. Without a New Technology Pathway, Broadband Connectivity in the Air Will Not Keep Pace with Demand, Depriving Consumers, Airlines, Crew, and Public Safety Officials of Innovative Applications.

Consumers want and increasingly expect an "in home" equivalent broadband experience wherever they are. Fueled by near-ubiquitous and ever-faster mobile coverage on the ground, consumers are now demanding faster and more stable connectivity in the air as well.[6] Indeed, as

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[5] *See* Alexander Grous, London School of Economics and Political Science, *Sky High Economics Chapter One: Quantifying the Commercial Opportunities of Passenger Connectivity for the Global Airline Industry* 3 (2017), http://www.lse.ac.uk/business-and-consultancy/consulting/assets/documents/sky-high-economics-chapter-one.pdf ("Currently, 3.8 billion passengers fly annually, with only around 25% of planes in the air offering them some form of onboard broadband. This is often of variable quality, with patchy coverage, slow speeds[,] and low data limits."); *see also In re Amendment of Parts 2 and 25 of the Commission's Rules to Facilitate the Use of Earth Stations in Motion Communicating with Geostationary Orbit Space Stations in Frequency Bands Allocated to the Fixed Satellite Service*, Report and Order and Further Notice of Proposed Rulemaking, IB Docket No. 17-95, FCC 18-138, at 77 (rel. Sept. 27, 2018) ("*ESIM Order*") (Statement of Chairman Ajit Pai) (noting important benefits from "spark[ing] innovation and investment, encourag[ing] deployment, and . . . connect[ing] more consumers" in the "fast-growing segment" of the market for connecting "ships, vehicles, and aircraft"); *id.* at 78 (Statement of Commissioner Michael O'Rielly) ("As any frequent flyer—or not-so-frequent flyer—knows, the Wi-Fi on airplanes is generally lacking. However, this shortcoming doesn't have to be the case."); *id.* at 80 (Statement of Commissioner Jessica Rosenworcel) (commending Commission action that will "expand the reach of [broadband] networks to some of the most challenging environments—our planes, ships, and vehicles").

[6] *See* Grous, *supra* note 5, at 9 ("The need to 'always be connected' has continued to grow in the 21st Century, across both business and social segments. Ubiquitous connectivity is no longer the domain of business travelers as Generation Y and Z have normali[z]ed the ingrained nature of mobile connectivity. As connectivity no longer becomes an exception in everyday life, the focus is shifting to areas where it is often less available, including travel." (footnotes omitted)); *see also*,

one content platform recently described, in-flight Wi-Fi became "more ubiquitous" in 2018 "than ever before."[7]

This trend will continue. Consumer online behavior is increasingly data-intensive, involving video streaming, audio streaming, and gaming.[8] And consumers increasingly will demand access to their own cloud-stored HD or 4K entertainment content, online gaming applications, health and fitness live data, and real-time destination services, with at-home-like performance characteristics, while in transit.[9] Additionally, the ongoing development of virtual and augmented reality applications and services will dramatically increase consumer upload and

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e.g., Bank of America and Merrill Lynch, *Aerospace & Defence Update*, *The Connected Aircraft Revolution* 63 (2018) ("In an internet-enabled society, being constantly connected has become a common expectation for the developed world. Over the past few years, in-flight Wi-Fi has gone from a product differentiator and a luxury to being increasingly seen as a basic part of the passenger experience."); *Inmarsat Survey Shows 60% Believe In-Flight Wi-Fi Is a Necessity*, Avionics (July 31, 2017), https://www.aviationtoday.com/2017/07/31/inmarsat-survey-shows-60-believe-in flight-wi-fi-necessity/.

[7] *See* RouteHappy, *RouteHappy 2018 Wi-Fi Report Evaluates Global In-Flight Wi-Fi* (Jan. 30, 2018), https://app.routehappy.com/insights/wi-fi/2018; *see also* Deloitte, *Fasten Your Seatbelts: In-Flight Connectivity Takes Off* 1 (2017), h https://www2.deloitte.com/content/dam/Deloitte/global/Images/infographics/technologymediatelecommunications/gx-deloitte-tmt-2018-connect ivity-report.pdf (projecting that in 2018, one billion passenger journeys—one quarter of total—will be on aircraft equipped with in-flight connectivity, representing 20 percent year-on-year increase).

[8] Sandvine, *The Global Internet Phenomena Report* 4-5 (Oct. 2018), https://www.sandvine.com/hubfs/downloads/phenomena/2018-phenomena-report.pdf (describing, for example, that video is almost 58 percent of the total downstream volume of traffic on the internet despite aggressive management by operators; that gaming is becoming a significant force in traffic volume as games are designed for ubiquitous connectivity; and that live event streaming is beginning); *id.* at 6-7 (ranking global online applications by traffic share); *id.* at 9 (providing analysis of downstream video traffic share even given optimization techniques).

[9] *See, e.g.*, Anne Saita, *The Challenges of Meeting the in-Flight Connectivity Demand*, Via Satellite (June 2018), http://interactive.satellitetoday.com/via/june-2018/the-challenges-of-meeting-the-in-flight-connectivity-demand/ ("98 percent of airline passengers now board a flight with a portable electronic device, and 70 percent carry on at least two devices, depending on the purpose of their travel. . . . The constant rollover to the latest client devices means that the cabin Wi-Fi and cellular infrastructure need[] to keep pace." (internal quotation marks omitted)).

download capacity demands. Likewise, executives and professionals will expect (and be expected) to manage projects and cloud server business processes from cruising altitudes. Moreover, delivering in-flight broadband at a performance level that meets consumers' expectations would unlock further demand among the many passengers who are not currently connecting to in-flight Wi-Fi.[10] Thus, delivering true broadband in flight has the promise to deliver substantial public interest benefits to the nearly 1 billion Americans who travel commercially every year,[11] making their connectivity experience seamless as they travel.

But consumers would not be the sole beneficiaries of Gigabit-speed broadband service in the air. Airlines have already begun to respond to consumer demand, recognizing that in-air connectivity is an opportunity for differentiation, competition, and loyalty.[12] According to one recent study, one in three passengers agreed that in-flight connectivity is the single most needed area of improvement for airlines, and 90 percent of passengers would trade other amenities for

[10] *See* Gogo – Q3 2018 Gogo Inc. Earnings Call, Edited Transcript (Nov. 6, 2018), http://ir.gogoair.com/static-files/8b4f7e15-3ea3-4ebf-ad21-702f13da6631 (describing take rate of 12.4 percent).

[11] *See* Bureau of Transportation Statistics, U.S. Dep't of Transportation, Release No. BTS 12-18, *2017 Annual and December Airline Traffic Data* (updated Mar. 15, 2018), https://www.bts.dot.gov/newsroom/2017-annual-and-december-us-airline-traffic-data; *see also* ITU News, *How Satellite Broadband Can Be a Game-Changer for Connected Planes: Report* (Aug. 13, 2018), https://news.itu.int/space-satellites-connected-planes/ (projecting a global "doubling of passengers by 2035 to 7.2 billion, with this mirrored by a forecast doubling of aircraft to 40,000").

[12] *See* Grous, *supra* note 5, at 10 ("If broadband service is offered by the airlines that meets or exceeds passenger expectations, this can result in greater loyalty; greater loyalty amongst consumers can deliver a 23% premium over the average customer in terms of profitability and revenue."); *see also* Saita, *supra* note 9 (noting that in "the commercial airline space, passengers for whom [high-speed and reliable] connectivity is important are starting to select their airlines or aircraft type based on the connectivity" (quotation marks omitted)); Bank of America, *supra* note 6, at 63 (noting that according to one 2016 survey, 60 percent of customers believe that in-flight Wi-Fi is a "necessity not a luxury" and 44 percent said they would stop using a preferred airline if it did not offer reliable in-flight connectivity"); Press Release, Inmarsat, *Demand for Inflight Wi-Fi Is Driving Airline Loyalty Amongst Passengers* (Aug. 7, 2018), https://www.inmarsat.com/press-release/demand-for-inflight-wi-fi-is-driving-airline-loyalty-amongst-passengers/.

better in-flight broadband service.[13] In its groundbreaking study of in-flight connectivity, the London School of Economics determined that broadband-enabled revenues could reach an estimated $7.6 billion for North American airlines by 2035, and will drive the creation of $130 billion in additional revenues from advertising, e-commerce, and streaming.[14] Nevertheless, in the United States, the fastest available Wi-Fi on domestic commercial flights generally offers only 15 Mbps download.[15]

Airlines have barely scratched the surface of the exciting new innovations that could be supported by Gbps service in the air.[16] In addition to being better equipped to satisfy customer demand, airlines could achieve significant operational and safety efficiencies through the installation and use of real-time smart IoT devices—including engine monitors, weather sensors, remote storage facilities, and flight-crew tablets.[17] "Together," these devices could support

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[13] *See Inmarsat Issues White Paper on In-Flight Connectivity*, Get Connected (July 16, 2015), https://www.getconnected.aero/2015/07/inmarsat-issues-white-paper-on-in-flight-connectivity/; *see also* Deloitte, *supra* note 7, at 3 ("Demand for connectivity is now so strong that consumers would prioritize it over most other amenities. One survey found that if respondents had to select from a range of services, 54 percent would choose Wi-Fi. This is almost three times the proportion (19 percent) that would choose a meal. Another survey conducted among IFC users found that almost 90 percent would trade seats, additional legroom, or another amenity for a faster and more consistent wireless connection." (footnotes omitted)).

[14] *See* Grous, *supra* note 5, at 3-4.

[15] *See* John Dilley, *The 7 Best US Airlines for In-Flight Wi-Fi in 2018*, HighSpeedInternet.com (Mar. 14, 2018), https://www.highspeedinternet.com/resources/best-in-flight-wifi/.

[16] *See* Bank of America, *supra* note 6, at 4 (explaining that airplane connectivity "is one of the most disruptive trends in the industry and is driving an evolution of business relationships and value chains in a number of well-established markets" and noting that "[c]onnectivity has become a dominant theme of airshows in recent years").

[17] *See id.* at 5 ("A connected aircraft allows pilots and an airline to make informed decisions based on access to real-time information—saving fuel, reducing emissions, improving fleet utilization and safety."); *id.* at 10 ("Aircraft are no longer isolated units in the sky. Instead, they are becoming part of a wider network, with the aircraft and flight crew connected to ground crews, airline operations, air traffic management and service providers. This is all part of improving aircraft safety and operating efficiency.").

"operational benefits" that "yield savings for the global airline industry of between US$5.5 billion-US$7.5 billion annually based on existing connected aircraft numbers, rising to between US$11.1 billion-US$14.9 billion by 2035."[18] In addition, Aeronet's low weight and low drag solution will save airlines millions of dollars a year in fuel costs over satellite connectivity, as some satellite solutions weigh 350 pounds or more. Lastly, as discussed below, the Aeronet solution could enable additional revenue streams for airlines as their aircraft become "cell towers in the sky" and support the transmission of broadband to rural and other remote areas.[19]

Aeronet's solution for providing this service—establishing sub-mesh SDDL networks, as described at greater length below—would also enhance aviation security and safety.[20] Security is built into the design of Aeronet's architecture: The network is based on point-to-point datalinks that establish specific and individual connections. Because the links are scheduled and dynamic, every network node will have pre-known locations and schedules, allowing for verification against

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[18] Alexander Grous, London School of Economics and Political Science, *Sky High Economics Chapter Two: Evaluating the Economic Benefits of Connected Airline Operations* 4 (2018), http://www.lse.ac.uk/business-and-consultancy/consulting/assets/documents/sky-high-economics-chapter-two-evaluating-the-economic-benefits.pdf; *see also id.* at 10 ("The connected aircraft facilitates efficiencies and enhancements encompassing fuel consumption and emissions; maintenance; flight operations; airspace capacity; and safety. Consolidating these advantages could deliver substantial economic, environmental and, ultimately, social benefits . . . .").

[19] *See infra* at 18.

[20] For example, Aeronet understands that under the recent reauthorization of the Federal Aviation Administration, voice calls on flights are prohibited. *See* Ashley Halsey III, *Senate Gives Final Approval for FAA Reauthorization, Sends Bill to White House*, Wash. Post (Oct. 3, 2018), https://www.washingtonpost.com/transportation/2018/10/03/senate-gives-final-approval-faa-reauthorization-sends-bill-white-house/?utm_term=.24d47d45f1fe; Editorial, *Congress Is Right to Ban Phone Calls on Planes*, Wash. Post (Oct. 5, 2018), https://www.washingtonpost.com/opinions/congress-is-right-to-ban-phone-calls-on-planes/2018/10/05/d8b8ead6-c7ff-11e8-b2b5-79270f9cce17_story.html?utm_term=.25ac7c626163. Aeronet's technology and business model are fully consistent with this prohibition. Indeed, Aeronet intends to offer the ability to parse and permit or disallow specific services consistent with federal law and airline policies.

expected behaviors.[21] It also would be very difficult to intercept a datalink signal, because the beam will be narrow, moving along the airplane's flight path and open to being re-routed by the Aeronet sub-mesh controller. Facilities will be hardcoded to each specific network node (*e.g.*, to the receiving antenna on an individual airplane), a feature which will allow authentication prior to establishing connectivity. The facilities are also self-contained; there is no need to connect them to the aircraft's avionics. And finally, airlines that choose to use Aeronet's connectivity for avionics could transmit telemetry and other flight data to ground stations in real time, potentially preventing the need for Black Box searches.[22]

"The key enabler [of these benefits] is the creation of high bandwidth, reliable connectivity that facilitates a paradigm shift in thinking by both airlines and passengers alike, where the distinction between on-the-ground broadband blurs, or disappears altogether."[23] Unfortunately, as demand for high-speed, in-flight connectivity grows, so too will the difficulty of providing it. The myriad consumer, airline, and third-party applications discussed above will create huge bandwidth demands that are equivalent to demands at medium to large corporate offices, which terrestrially would be directly serviced by a fiber or dedicated cell site capacity. In the airline industry, however, that demand is localized to individual vehicles with their own data needs, operating in dynamic patterns away from traditional terrestrial infrastructures.

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[21] As discussed at greater length below, *infra* at 14, Aeronet has no plans to deliver service to aircraft that travel outside of authorized areas of operation per frequency coordination processes.

[22] *See, e.g.*, Masrur Jamaluddin & Susannah Cullinane, *Lion Air Crash: Signal from Black Box Lost, Searchers Say*, CNN (Nov. 4, 2018), https://www.cnn.com/2018/11/04/asia/lion-air-crash-recovery-efforts/index.html; *MH370: Here's What You Should Know About the Plane's Mysterious Disappearance*, L.A. Times (Jan. 17, 2017), https://www.latimes.com/world/asia/la-fg-malaysia-airlines-370-story-so-far-htmlstory.html.

[23] Grous, *supra* note 5, at 9.

Current technologies are simply not designed to deliver optimal backhaul capacity to each vehicle in such environments. For its part, the mobile industry is preparing to address similar bottlenecks that will arise from the deployment of 5G, which will increase the backhaul demands for mobile data from urban, suburban, and rural sites alike.[24] Ericsson projects that certain urban sites already need 1 Gbps backhaul to satisfy consumer demand, with this requirement growing to 10 Gbps by 2022. As consumers' data demands on flights increasingly resemble their demands on the ground, each aircraft will need similar backhaul capabilities. No single network or platform—not even Aeronet's—can satisfy the total demands of the aviation market.[25] Instead, in-flight connectivity will require backhaul from overlapping and competing service providers, including Aeronet, LEOs, HAPs, and others. Thus, absent action by the Commission to make such connectivity possible, in-flight broadband throughout the United States will continue to lag behind other fixed and mobile broadband services.[26]

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[24] *See* Ericcson, *Microwave Outlook* (Dec. 2018), https://www.ericsson.com/assets/local/microwave-outlook/documents/ericsson-microwave-outlook-report-2018.pdf.

[25] *See, e.g.*, Kandall Russell, *Free In-Flight Connectivity Remains a Long-Term Goal for Airlines*, Via Satellite (June 9, 2017), https://www.satellitetoday.com/mobility/2017/06/09/free-flight-connectivity-remains-long-term-goal-airlines/ ("According to panelists at the Global Connected Aircraft Summit, the technology that powers connectivity must still make some strides before most airlines can afford to offer free Wi-Fi services. . . . [A] business model where customers pay for connectivity will continue to be the norm for the foreseeable future."); Thas Ampalavanapillai Nirmalathas, *Inflight Wi-Fi Highlights Challenges of Satellite Broadband Delivery on Land and in the Sky*, The Conversation (Apr. 18, 2017), http://theconversation.com/inflight-wi-fi-highlights-challenges-of-satellite-broadband-delivery-on-land-and-in-the-sky-75381 (explaining speed limitations where substantial passenger base uses broadband and latency limitations where "data streams need to travel long distances (from ground to satellite, and then satellite to aircraft)"); *see also* ITU News, *supra* note 11 (noting that existing satellites are "limited in bandwidth and other attributes" and do not "facilitate the required degree of functionality").

[26] As discussed below, if the Commission does exercise leadership in this area, other jurisdictions that also have adopted light-touch regulation in the E-Band may follow suit, creating opportunities for further international harmonization. *See infra* note 58.

B. Aeronet Has Demonstrated That Delivering True Broadband Connectivity in the Air Is Possible Through Establishing SDDL Networks Using Spectrum in the E-Band.

Aeronet's solution unlocks the Internet of the Sky by delivering Gbps service via dedicated, high-capacity, low-latency, line-of-sight SDDLs. There is a long history in the information and communications technology industries of using point-to-point datalinks to handle heavy data volumes in a variety of contexts, for example wireless network backhaul.[27] Aeronet has adapted this architecture to meet the challenges of delivering in-flight broadband, and has demonstrated in live trials that in-flight Gbps download and upload broadband service is possible using its technology.[28] Aeronet's business model is consistent with multiple geographic deployments, and interest in unlocking this solution has already allowed Aeronet to actively discuss partnerships with tier-1 in-flight entertainment and communication providers in the aviation market. But full-

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[27] *See* David Abecassis, Janette Stewart, & Alex Reichl, Analysys Mason, *Review of Spectrum Management Approaches for E-Band (70/80 GHz) in Selected Markets* 10 (2016), https://www.telecomnews.co.il/image/users/228328/ftp/my_files/General%20Files/Report_Spectrum_Management_E-Band_AnalysysMason2016.pdf?id=27306642 ("Fixed-wireless links or fixed links provide line-of-sight transmissions between two geographical locations. Fixed links are used extensively for point-to-point telecoms, as well as for point-to-multipoint telecoms to convey voice and data signals. One of their major uses is for backhaul within mobile networks (*i.e.* to connect wireless base stations with the mobile network backbone). Other uses include voice and data communications directly to end users as a replacement for copper or cable communications (*e.g.* the 'last-mile' connection) and point-to-point links with the communications networks used by various enterprises, local governments and other businesses."); *In re Business Data Services in an Internet Protocol Environment*, Tariff Investigation Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 4723, 4753 ¶ 68 (2016) ("In the mobile wireless sector, carriers have historically relied on fixed wireless, *i.e.*, often self-provisioned microwave point-to-point links, to backhaul aggregated traffic from their macro cell sites.").

[28] The air force has incorporated similar technology into certain aircraft. *See* Henry Kenyon, *Programmable System Guides Jet to New Heights*, Signal (June 2008), https://www.afcea.org/content/programmable-system-guides-jet-new-heights (noting that point-to-point narrow-beam datalinks allow aircraft to share data with each other with limited risk of interception of communications).

scale commercialization of this innovative service in the United States will require action by the Commission.

1. Aeronet's SDDL Networks Enable the Delivery of Dedicated Backhaul Connectivity to and from Aircraft.

Aeronet has developed a datalink technology (*i.e.*, SDDLs) that allows it to create, reconfigure, and maintain, in real time, multiple networks involving a variety of point-to-point links between nodes—including ground stations, airplanes, drones, and other vessels capable of carrying the datalink equipment—for data traffic.

Aeronet's ground stations will serve as the terrestrial entry point for aircraft backhaul and as the high-capacity core backbone layer of the Aeronet network. Ground stations will be connected by direct fiber circuits, for which capacity can be managed to suit the aggregated demand based on standard telecommunications network management practices. Each ground station will be designed to establish multiple narrow-beam datalinks, capable of being steered across some or all of the sky within sight, with elevation limitations discussed at greater length below.

Using dedicated and professional installation teams, Aeronet will install SDDL facilities on commercial aircraft subject to FAA Supplemental Type Certification approvals. Up to three SDDL antenna facilities will be installed per aircraft providing an air-to-ground datalink for connection to a ground station and two air-to-air datalinks for connection to other aircraft both forward and aft of the installed aircraft. The combination of these SDDL facilities will provide sufficient look angles to allow line of sight to other nodes within the network.

Aeronet will pre-plan individual network nodes and SDDLs into sub-mesh networks, using historical flightpath data from Aeronet's own network operation, general knowledge of known routes, and the spatial areas of registered E-Band links. Each sub-mesh network will be under the control of its own ground station, based on an aircraft's proximity to the ground station or local conditions, for planned periods of each flight.[29]

After registering each node onto its sub-mesh network, the ground station will coordinate the real-time formation of SDDLs to aircraft within its control to ensure no self-interference and within the authorized aviation SDDL parameters. The coordination area of air-to-ground SDDLs will be defined by three-dimensional cones from the fixed location ground station to a subset of the aircraft assigned to it, all between 10,000 and 50,000 feet of altitude and all above a minimum 5 degree elevation angle from the fixed ground station location. The coordination area of air-to-air SDDLs will be defined by three-dimensional polyhedrons, within a horizontal altitude band from 10,000 to 50,000 feet.

If an aircraft were to deviate from a known flight path in a way that takes it outside of a registered air-to-ground SDDL cone or air-to-air SDDL polyhedron, the ground station would recognize the deviation in real time, based on command channel telemetry. Connectivity would discontinue until the aircraft returned into the registered network along the flight's planned route.

By forming and constantly reconfiguring SDDLs and sub-mesh network assignments, Aeronet can keep aircraft connected, supporting standard IP data traffic into the air and outside of ground-station coverage.[30] Figure 1 illustrates how SDDLs can support ground-to-air and air-to-air SDDLs to form the overall network. The SDDLs would operate akin to terrestrial 5G point-to-point backhaul networks.

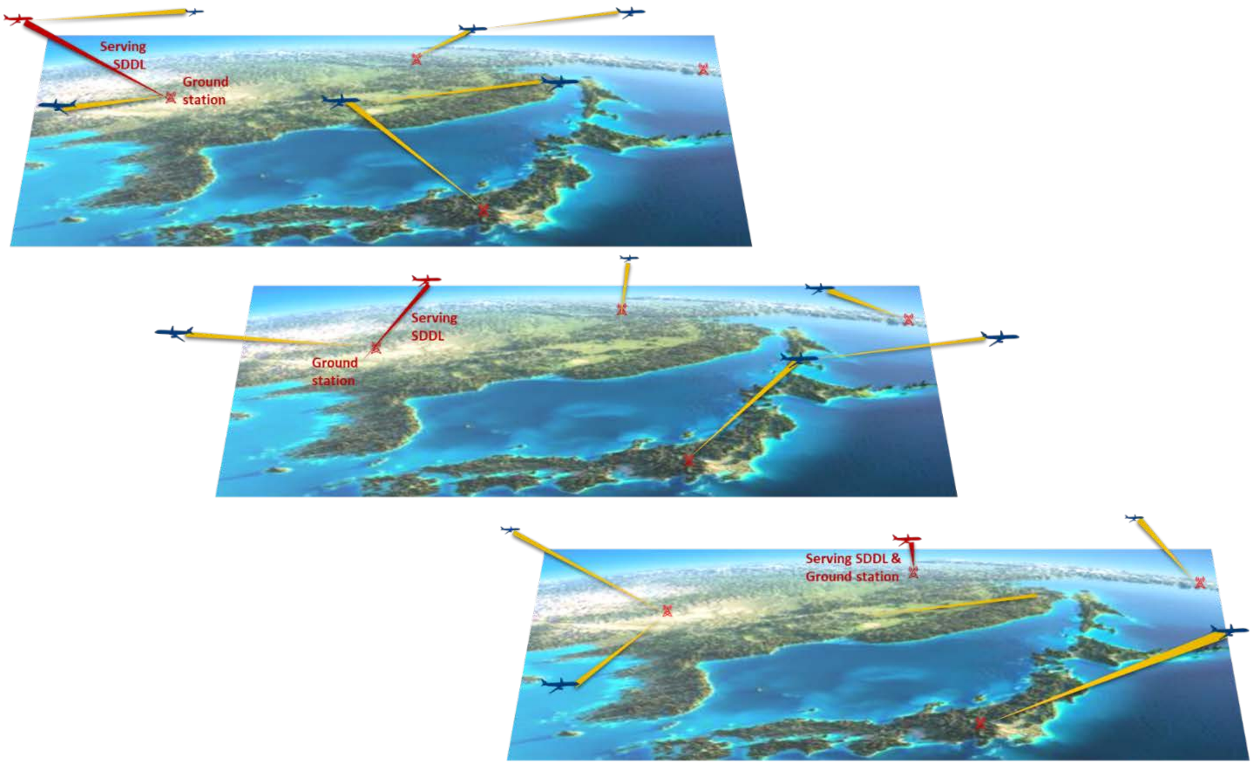
[29] As necessary, Aeronet's command and control center could also disconnect a node from a pre-planned network in real time.

[30] Aeronet's model is easily scalable as demand grows (and as more aircraft join the network) with the support of further ground-station datalinks.

Figure 1: Depiction of Aeronet's SDDL Networks

By delivering point-to-point bandwidth to each airplane, Aeronet avoids having to share spectrum between multiple aircraft, which has been a limitation for other network access layer architectures. Further, Aeronet's ability to reconfigure sub-mesh SDDL networks in real time enables the dynamic selection of the best quality backhaul links to ground stations. Under routine conditions, this will allow Aeronet to deliver service with reduced latency to ground stations, as data is sent via the shortest routes possible. And under other circumstances, this functionality will allow Aeronet to support connectivity by avoiding disruptions associated with storms and other local conditions. Moreover, Aeronet's network management exploits the known and scheduled movement patterns of aircraft to add an additional security control for nodes seeking to access the network and to monitor the behavior of nodes within the network. Figure 2 illustrates these features of Aeronet's network control and operation.

Figure 2: Depiction of Aeronet's Network Control and Operations



This technology is not merely conjectural. In March 2017, Aeronet successfully achieved continuous 1 Gbps download and upload speeds in its test aircraft in Ireland, using datalinks over distances that were three times longer than deployed for similar E-Band radios. This alpha test employed proprietary discovery and tracking techniques for the ground station to establish and maintain the air-to-ground SDDL. Aeronet has achieved similar and higher speed results during beta testing of the maritime application of its SDDLs off the coast of Florida. In these beta tests during 2018, Aeronet achieved 3 Gbps speeds and successfully switched between two SDDLs with near unnoticeable service interruption during handover. Aeronet has since installed further test ground stations in the Bahamas for expanded live environment service testing across multiple network nodes. These tests have involved a substantial investment to date, resulting in technological achievements that evidence Aeronet's ability to deliver the equivalent of fiber-to-the-home performance for in-flight connectivity.

Aeronet has committed "second-generation" technology plans to expand its tests to cover additional aviation use cases. These plans include even more investment in the United States and regions that attract significant American consumer spend (*e.g.*, the Caribbean). An environment of regulatory certainty for its use of spectrum is an important aspect of maintaining Aeronet's investment and spend focus on the United States.

2. Aeronet Has the Vision and Credentials to Disrupt the Aviation Market Through Expanded Operations in the E-Band.

Given the virtually limitless demand for in-flight broadband and its currently constrained supply, there is significant interest throughout the aviation market for new connectivity technologies. Aeronet's wholesale business model allows it to package service to support both customer-facing connectivity as well as airline and crew operational capabilities. Aeronet is an attractive partner for both major airlines themselves and for other in-flight entertainment service partners. Aeronet is actively exploring partnerships with other technology companies and aircraft carriers to support the commercialization of this service.

Aeronet's service is likely to be highly attractive to other stakeholders and in other markets as well. For example, given the security and control features that are inherent in Aeronet's network architecture, in-flight crew are likely to view our service as beneficial.[31] And looking beyond aviation, Aeronet anticipates that its SDDLs could have future applications in other un- and underserved environments. For example, this technology could support the delivery of broadband

[31] *See* Deloitte, *supra* note 7, at 4 ("American Airlines . . . equipped all its flight attendants with internet-enabled tablets as early as 2012. This enables them to carry out mileage upgrades, read and respond to corporate emails, get real-time access to passenger seat assignments, file reports, and do remote maintenance." (footnote omitted)).

to remote areas, such as rural America, offshore windfarms, and other infrastructure. It also has promising applications in disaster recovery situations, where existing broadband networks may be compromised, but connectivity remains essential. Each such application would deliver public interest benefits, as well as supporting a new revenue model for airlines, as aircraft could function as cell towers in the sky.[32]

Moreover, Aeronet is ready to compete with the other providers, including satellite-based providers, who are developing broadband solutions with potential in-flight applications. SDDLs will offer a unique value proposition to airlines and third-party service providers. That is so because, among other things, the SDDL technology is based on a cost-effective operating model that does not depend on already having or building expensive satellite network assets. By providing a dedicated datalink to each airplane, Aeronet also can combine Gbps download and upload speeds with 5G-like latency, while avoiding the complications of shared coverage in congested areas.[33] And, as discussed at greater length below, Aeronet's SDDLs are unlikely to present interference concerns with other users in the E-Band, including potential satellite-based competitors. Consistent with its mandate, the Commission should encourage the nascent competition among broadband providers in the aviation market.

Aeronet is poised to move quickly once this Petition is granted. Committed plans are already in place for further air-to-ground live trial testing for large aircraft. Aeronet also has worked collaboratively with other regulators—including ComReg in Ireland and, through an

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[32] *See, e.g.*, Inside Towers, *Blimp Tower Makes First Test 'Flight' over New England Town* (Dec. 10, 2018), https://insidetowers.com/cell-tower-news-blimp-tower-makes-first-test-flight-over-new-england-town/.

[33] *See* Nirmalathas, *supra* note 25 (describing that techniques currently in play to improve delivery of satellite broadband include compression (to reduce the amount of data to be transferred), buffering (by caching every byte of information transmitted) and acceleration (techniques relating to how packets of information are handled and how connections are managed)).

affiliate, the Utilities Regulation & Competition Authority in the Bahamas—to obtain necessary authorizations and licenses for its testing. Given the urgent demand for in-flight broadband, Aeronet anticipates that other countries will take the initiative to authorize the use of E-Band spectrum to provide a variation of this service.[34] But Aeronet hopes that, with its long history of global leadership on connectivity issues, the United States will seize this opportunity and act quickly to authorize Aeronet's use of aviation SDDLs in the E-Band.

II. The E-Band Is Uniquely Suitable for Aeronet's Technology and Service Offering.

The E-Band is uniquely suitable for Aeronet's SDDLs—for technical, regulatory, and practical reasons. The spectrum is technically ideal for these purposes, because it supports narrow and dedicated beams that are perfect for establishing high bandwidth interference-free networks. Authorizing aviation SDDLs in the E-Band also would be consistent with the Commission's regulatory goals, including commercialization of millimeter wave and higher-frequency spectrum bands, while also encouraging international harmonization of the regulatory framework for the E-Band. And the E-Band is largely uncongested, meaning there is ample spectrum to support multiple innovative uses, including Aeronet's.

A. The Technical Characteristics of Spectrum in the E-Band Are Ideal for Use in Aviation SDDL Networks with Minimal (if Any) Interference Risks.

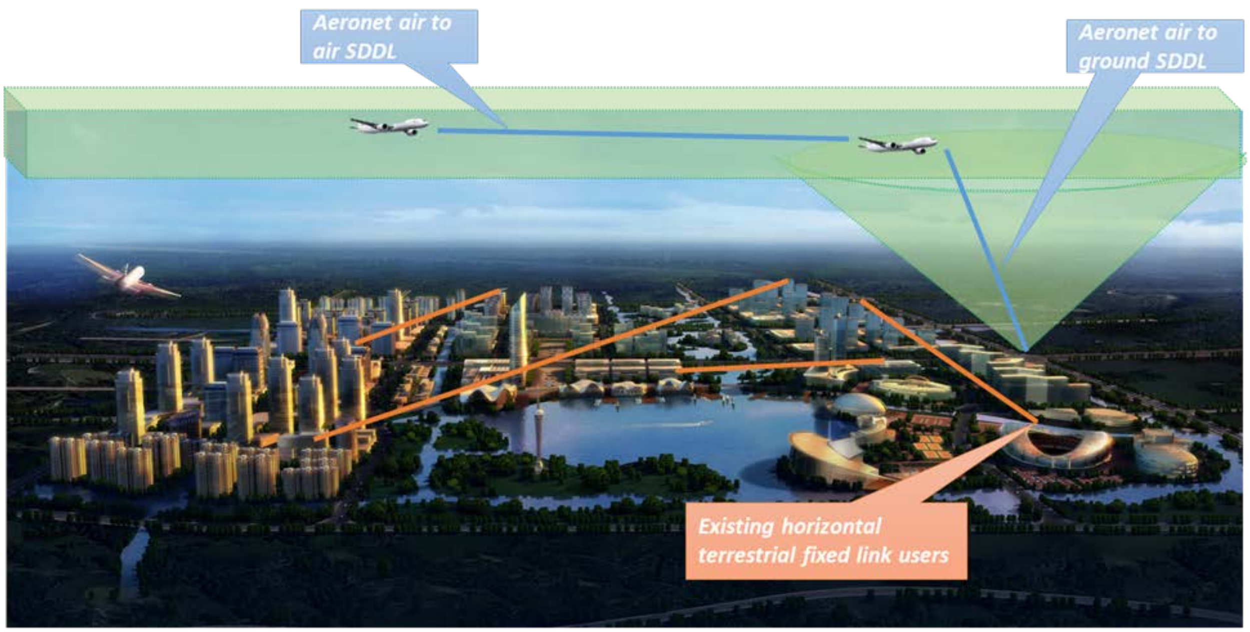
The technical characteristics of spectrum in the E-Band are ideal for sub-mesh SDDL networks involving aircraft and ships. The narrow beam widths in the E-Band support angular separation mechanisms, preventing interference amongst Aeronet's SDDLs, and between Aeronet's use and other uses including terrestrial backhaul.[35] For ease of coordination, Aeronet's

[34] As noted below, many countries follow a light license regime to the E-Band and thus could authorize a similar application with similarly streamlined rule changes. *See infra* note 56.

[35] *See* Abecassis, Stewart, and Reichl, *supra* note 27, at 1 ("[T]he short wavelength of frequencies in the millimetre portion of the radio spectrum, where E-band sits, means that the potential for

links can be organized within separated three-dimensional polyhedron networks and angular separated three-dimensional cone networks. As depicted below in Figure 3, Aeronet plans to use the former, above a minimum altitude, for air-to-air links between aircraft based on known paths of flights, and use the latter for a limited number of ground sites for ground-to-air links which are also formed based on known flight paths and with a minimum elevation angle. Critically, these polyhedrons and cones are not intended to represent exclusive use areas; Aeronet anticipates that, just as two fixed terrestrial links can be coordinated to cross without interference today (except where highly aligned), links for current and future services will be able to pass through Aeronet's networks in most instances following routine coordination procedures.

Figure 3: Depiction of 3D Polyhedron and Cone Links Avoiding Interference with Fixed Terrestrial Users



As explained below, both uses (*i.e.*, air-to-air polyhedrons and ground-to-air cones) present minimal, if any, interference concerns for current terrestrial fixed link users.

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interference between neighbouring links is reduced, compared to the lower-frequency bands. This implies that regulators have much more scope to implement simplified coordination mechanisms for the licensing of links in E-band . . . .").

First, the 12.9 GHz of spectrum in the E-Band is largely uncongested, because incumbent fixed-link user volume remains relatively low. Indeed, in 2016, after a review of operations in the Band, the Commission described that it was "relatively lightly used both in terms of the number of registered sites (especially on a large geographic scale) and with respect to the quantity of spectrum available."[36] Moreover, the Commission continued, "the great majority of existing links in the [B]and[] are concentrated in just a few localities."[37] The Commission thus concluded that, based on the "narrow beam[] widths and limited path legends involved, it would be reasonable to treat" the E-Band as being "the functional equivalent of a green field" throughout the majority of the United States.[38] Aeronet has mapped the registered links as of February 2019, included below as Figure 4, demonstrating that the E-Band remains lightly used and that the great majority of links are still concentrated in a few localities.

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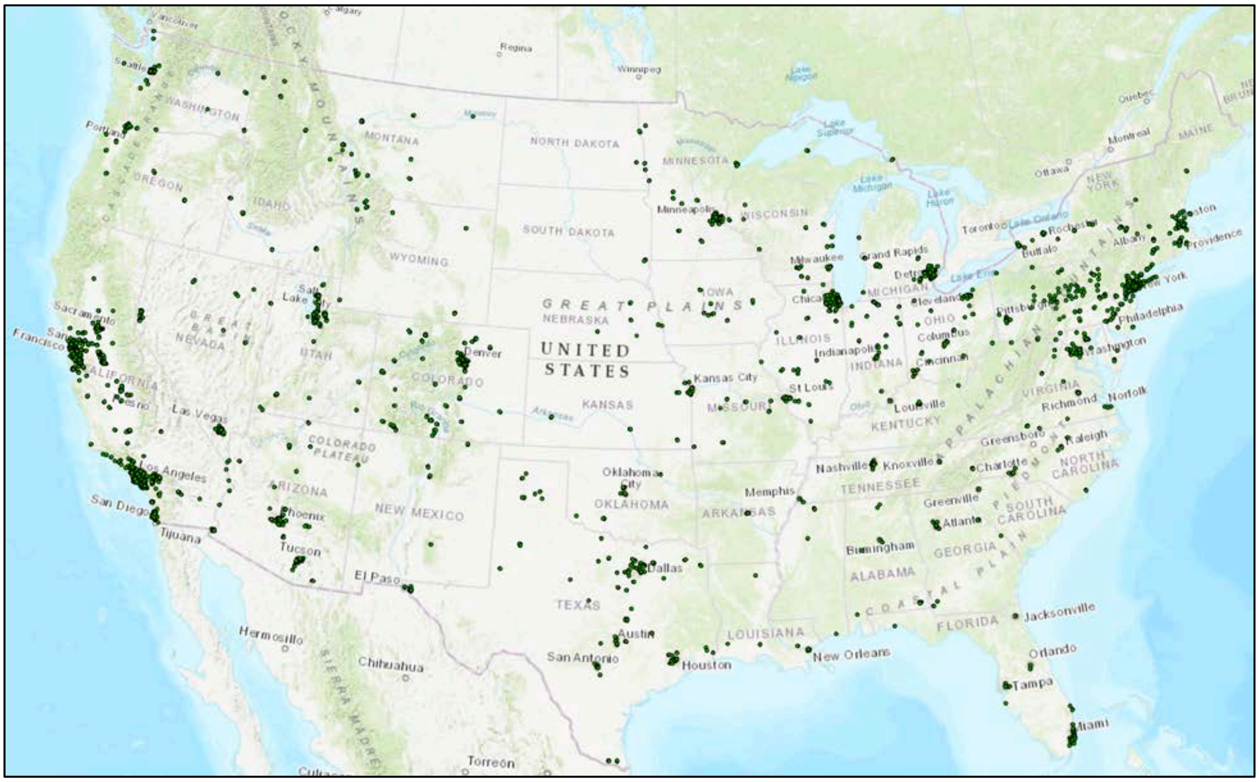
[36] *In re Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014, 8161 ¶ 432 (2016) ("*Spectrum Frontiers First Order*").

[37] *Id.*; *see also id.* Figure 3 (mapping 70/80 GHz Registered Sites).

[38] *Id.*

Figure 4: 70/80 GHz Registered Links



To be sure, terrestrial fixed link usage in the E-Band is expected to increase as 5G services come online, but Aeronet does not anticipate a meaningful risk of interference between its aviation SDDLs and 5G backhaul. 5G backhaul is likely to be located primarily in and around dense population centers. Indeed, commenters in the *Spectrum Frontiers* proceeding who supported mobile use in the E-Band generally did not identify other use cases.[39] And, as explained above, Aeronet's use case is consistent with locating substantial amounts of its network architecture (fixed

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[39] *See In re Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order, 32 FCC Rcd 10,988, 11,053 ¶ 198 (2017) ("*Spectrum Frontiers Second Order*") ("Commenters initially raised considerable doubt about the advisability and desirability of introducing mobile services into the 70/80/90 GHz bands in the near future. . . . In a subsequent *ex parte*, CTIA now supports mobile use of the 70 GHz band [and] . . . Ericsson believes these bands could represent up to 20 percent of all new backhaul deployments as early as 2020.").

ground-based transmitters and receivers) and network activity away from dense urban areas. By so locating its operations, Aeronet can maximize efficient spectrum use across more land mass, and further mitigate any risk of interference with both mobile terrestrial use of the spectrum to support 5G backhaul and Federal FSS operations located at the 28 military bases and the 18 Federal radio astronomy observatories.

Second, the highly directional beams that exist in the E-Band are appropriate for aviation needs, because they support the delivery of targeted bandwidth with propagation losses that ensure very limited signal leakage beyond the intended range.[40] As the Commission previously has described, the E-Band is best suited for systems that "concentrate radiated power in a very narrow path and have considerable attenuation at much shorter distances than occurs in the lower microwave bands."[41] Likewise, the comparatively poor propagation and atmospheric absorption characteristics in the E-Band effectively require providers to utilize high radiated power and directional gain in order to achieve significant range, making the spectrum less well suited for wide area uses. Aeronet's request, discussed in Part III, that the Commission slightly increase the transmitter power limitations for SDDLs does not meaningfully change the interference risk analysis; Aeronet's sub-mesh networks will extend to, but not past, aircraft along flight paths.[42]

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[40] *See* Abecassis, Stewart, and Reichl, *supra* note 27, at 2 ("An interesting feature of E-band is that, although located high in the millimetre-wave region of the radio spectrum, where signal absorption levels are high, E-band is located above the oxygen absorption peak occurring at around 60 GHz and hence the usefulness of the band (in terms of the operating ranges that are possible) is more similar to fixed service bands around 30-40 GHz.").

[41] *See In re Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands*, Report and Order, 18 FCC Rcd 23,318, 22,338 ¶ 45 (2003) ("*70/80/90 Band Order*").

[42] Moreover, Aeronet plans to employ automatic power control, which will ensure that the system uses only enough power to close the link, rather than always using the maximum power.

Third, the large amount of bandwidth in the E-Band is necessary for the delivery of Gbps speeds to support the Internet of the Sky, while minimizing the link budget dedicated for higher modulation schemes.[43] But because this is a new innovative application at the beginning of its efficiency cycle, Aeronet expects to achieve significant improvements both in the short and long term.

Aeronet anticipates sharing spectrum in the E-Band with other new and innovative users, including possible competitors, who share its view that the Band's allocation and service rules should be flexible to permit multiple innovative operations. As explained below, Aeronet's requested modifications are minor and should present minimal concerns for others.

B. Authorizing Aviation SDDLs in the E-Band Is Consistent with the Commission's Regulatory Goals and with International Frameworks.

Since 2003, the Commission has maintained service rules to promote development and use of spectrum in the E-Band, which is allocated to non-Federal and Federal users on a co-primary basis.[44] "Based on [its] determination that highly directional, 'pencil-beam' signal characteristics permit systems in these bands to be engineered so that many operations can co-exist in the same vicinity without causing interference to one another," the Commission has maintained flexible allocation and service rules for the 12.9 GHz of spectrum in the E-Band.[45] The rules create a two-

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[43] *See* Abecassis, Stewart, and Reichl, *supra* note 27, at 1 ("In general, millimetre-wave bands above 60 GHz have favourable properties for providing high-capacity wireless links, due to the large amounts of spectrum available in these bands (making wide channel widths a possibility, to achieve very-high-capacity links.)").

[44] *See 70/80/90 Band Order*, 18 FCC Rcd 23,318.

[45] *Spectrum Frontiers First Order*, 31 FCC Rcd at 8158 ¶ 424.

pronged authorization scheme for non-Federal entities: First, a putative licensee applies for a non-exclusive nationwide license; second, the licensee registers individual point-to-point links.[46]

In 2014, the Commission identified spectrum in the E-Band, along with other frequency bands above 24 GHz, as potentially being suitable for mobile service.[47] In its subsequent *Spectrum Frontiers* actions, the Commission has made certain spectrum bands available through both licensed and unlicensed mechanisms, but deferred any allocation or service rule changes for the E-Band.[48] Critically, however, the Commission consistently has emphasized the importance of preserving flexibility in the Band to enable innovative new users and uses. For example, when the Commission initially adopted the current rules for the Band, it described that the rules comprised a "flexible and streamlined regulatory framework . . . designed to encourage innovative uses" of the spectrum.[49] In the *Spectrum Frontiers First Order*, the Commission reiterated that its existing flexible and streamlined approach to the E-Band was adopted to encourage innovative uses and to facilitate further development in technology.[50] And, in the *Spectrum Frontiers Second Order*, the Commission again described its decisions regarding the E-Band as "further[ing] the public interest

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[46] Indeed, as noted below, *infra* at 29, the table of "Frequency availability" already notes that E-Band spectrum is allocated for Fixed, Mobile, and Temporary Fixed, but there are not currently service rules for mobile use in the Band.

[47] *See In re Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Notice of Inquiry, 29 FCC Rcd 13,020, 13,042-44 ¶¶ 75-82 (2014).

[48] *See Spectrum Frontiers First Order*, 31 FCC Rcd at 8160-69 ¶¶ 428-441 (seeking comment on proposals for 70/80/90 allocation and service rules); *see also Spectrum Frontiers Second Order*, 32 FCC Rcd at 11,054 ¶¶ 200-201 (deferring action on E-Band rules to separate *Wireless Backhaul* proceeding).

[49] *70/80/90 Band Order*, 18 FCC Rcd at 23,319 ¶ 1.

[50] *Spectrum Frontiers First Order*, 31 FCC Rcd at 8158-59 ¶ 424.

by protecting existing operations and successful services in the 70 GHz and 80 GHz bands without foreclosing future innovations in these bands."[51]

Aeronet's aviation SDDL technology is precisely the type of innovation that the Commission has always invited for the E-Band.[52] And while Aeronet appreciates the Commission's intent to address proposals regarding the allocation and service rules for the E-Band holistically in the *Wireless Backhaul* proceeding,[53] it should act now for two reasons. First, the Commission's decision not to adopt new service and allocation rules for the E-Band in the *Spectrum Frontiers* proceeding was based in part on the lack of "consensus among the proponents" regarding how mobile and fixed operations could coexist, especially in light of the not-yet-fully developed proposals from Aeronet, Loon, the Elefante Group, and others; the Commission thus urged parties to develops the record on "possible methods of promoting coexistence" between innovative and traditional applications.[54] This condition has since been satisfied: There is a robust record that supports prompt action on the E-Band.[55] Second, for the reasons discussed above, time

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[51] *Spectrum Frontiers Second Order*, 32 FCC Rcd at 11,056-57 ¶ 207.

[52] The Commission previously has expressed interest in Aeronet's plans for the E-Band, noting that it fits "neither . . . traditional mobile broadband nor fixed link models," while deferring action on certain specific proposals that risked "foreclosing future innovation in these bands." *See Spectrum Frontiers Second Order*, 32 FCC Rcd at 11,054, 11,057 ¶¶ 201, 207.

[53] *See In re Amendment of Part 101 of the Commission's Rules to Facilitate the Use of Microwave for Wireless Backhaul and Other Uses and to Provide Additional Flexibility to Broadcast Auxiliary Service and Operational Fixed Microwave Licensees*, Second Report and Order, Second Further Notice of Proposed Rulemaking, Second Notice of Inquiry, Order on Reconsideration, and Memorandum Opinion and Order, 27 FCC Rcd 9735 (2012).

[54] *Spectrum Frontiers Second Order*, 32 FCC Rcd at 11,054 ¶¶ 200-201.

[55] *See, e.g., In re Petition to Modify Parts 2 and 101 of the Commission's Rules to Enable Timely Deployment of Fixed Stratospheric-Based Communications Services in the 21.5-23.6, 25.25-27.5, 71-76, and 81-86 GHz Bands*, Elefante Petition for Rulemaking, RM-11809 (filed May 31, 2018); *In re WorldVu Satellites Limited, Petition for Declaratory Ruling Granting Access to the U.S. Market for the OneWeb V-Band System*, Legal Narrative, IBFS File No. SAT-LOI-20170301-00031 (Mar. 1, 2017) ("OneWeb/WorldVu V-band Petition"); *In re WorldVu Satellites Limited, Amendment to Petition for Declaratory Ruling Granting Access to the U.S. Market for the OneWeb*

is of the essence—both for Aeronet specifically, and for the aviation industry more generally. Furthermore, the amendments that Aeronet is seeking to the Commission's rules are minor and generally consistent with the existing light-license regime.

The Commission's light-touch approach to the E-Band is also mirrored by light-license regimes in the UK, Australia, and other countries.[56] And while other countries have adopted link-by-link coordination, their rules often are functionally equivalent to light-license regulation.[57] If the Commission exercises leadership in this proceeding, there is thus the opportunity for harmonization and replication by other countries, which, in turn, will expand the delivery of in-flight broadband connectivity for global passengers, and lock in U.S. leadership in another critical broadband marketplace.[58]

W-band System, Legal Narrative, IBFS File No. SAT-AMD-20180104-00004 (Jan. 4, 2018) ("OneWeb/WorldVu Amendment Legal Narrative"). These proposals are further developed by the commenters and reply commenters in the respective dockets.

[56] *See* Mario Giovanni Luigi Frecassetti et al., *E-Band and V-Band – Survey on Status of Worldwide Regulation* 23 (ETSI White Paper No. 9, June 2015), https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp9_e_band_and_v_band_survey_20150629.pdf; *see also* Abecassis, Stewart, and Reichl, *supra* note 27, at 3 ("It is notable that the majority of the countries surveyed have adopted either self-provided or license-exempt approaches when opening up E-Band for commercial use."); *id.* at 15-32 (summarizing light-license regimes to E-Band in United States and other countries).

[57] *See* Frecassetti, *supra* note 56, at 23.

[58] *See* Abecassis, Stewart, and Reichl, *supra* note 27, at 2 ("A further factor which should favour wider take-up is the flexibility in the use of [the E-Band] that a number of regulators have offered by opening it for use on a self-coordinated . . . basis. The self-coordinated management approach to E-band was originally introduced in the USA and a number of other markets have subsequently adopted similar approaches."); *id.* at 3 ("The fact that regulators around the world are increasingly adopting self-coordinated management approaches in E-band is also a factor that can support the emergence of innovative applications in such bands—as evidenced in the USA, where experimental licen[s]es filed for E-band demonstrate possible new uses that may emerge in [the] future.").

III. The Commission Should Adopt Minor Modifications to the E-Band Allocation and Service Rules to Authorize the Use of Aviation SDDLs.

The Commission can authorize Aeronet's planned use of spectrum in the E-Band to establish aviation SDDLs through minor modifications to the service rules. Indeed, as Aeronet emphasized in the *Spectrum Frontiers* proceeding, the current rules for the E-Band have been largely effective at facilitating private-sector innovation, while causing minimal interference to Federal and non-Federal incumbents. Aeronet thus supports the Commission's maintaining and promoting a light-touch regulatory framework for this spectrum.

The Commission should modify its rules, however, expressly to authorize Aviation Scheduled Dynamic Datalinks as a "fixed service" and "permissible operation" in the E-Band. Specifically, Aeronet requests the following modifications to the Commission's rules:

- 47 C.F.R. § 101.3. As used in this part: . . .
    - *Aviation Scheduled Dynamic Datalink*. A scheduled dynamic datalink serving aircraft, including a link between a fixed ground station and an aircraft or between two aircraft.
    - *Scheduled Dynamic Datalink*. A point-to-point link between fixed stations and mobile stations, or between mobile stations, where the mobile stations generally follow known routes at known times.

- 47 C.F.R. § 101.113. . . .

Frequency Band (MHz)	Maximum Allowable EIRP[1,2]	
	Fixed [1,2] (dBW)	Mobile (dBW)

…

71,000-76,000[13]	+ 55	+ 57
81,000-86,000[13]	+ 55	+ 57

. . .

[13] The maximum transmitter power is limited to 3 watts (5 dBW) unless a proportional reduction in maximum authorized EIRP is required under § 101.115. The maximum transmitter power spectral density is limited to 150 mW per 100 MHz. For Scheduled Dynamic Datalinks, the maximum transmit power is 5 watts (7 dBW) and the maximum power spectral density is 500 mW per 100 MHz.

- 47 C.F.R. § 101.147(a) . . .

(a) . . .

71,000-76,000 MHz (5) (17) (35)

81,000-86,000 MHz (5) (17) (35)

92,000-94,000 MHz (17) (35)

94,100-95,000 MHz (17) (35)

Notes . . .

(35) Scheduled Dynamic Datalinks are permitted in the bands 71,000-76,000 MHz, 81,000-86,000 MHz, 92,000-94000 and 94,100-95,000 MHz bands.

- 47 C.F.R. § 101.1507. Licensees may use the 70 GHz, 80 GHz and 90 GHz bands for any point-to-point, non-broadcast service including Aviation Scheduled Dynamic Datalinks. . . .

Aeronet does not need, and is not requesting, other changes to the current allocation and service rules. The table of "Frequency availability" already notes that E-Band spectrum is available for Fixed, Mobile, and Temporary Fixed, so further changes are unnecessary.[59] The same is true for the Commission's Transmitter power limitations table, which also already includes the maximum allowable EIRP for both "Fixed" and "Mobile" services in the E-Band, although as discussed above, Aeronet is requesting a 2dB increase in the mobile EIRP.[60] Nor is Aeronet requesting any Commission action with respect to the geographic licensing or licensing term of E-Band spectrum.

Most importantly, because Aeronet does not anticipate interference concerns or risks, it is not requesting any modifications to the existing *process* for addressing interference between registered datalink holders. Under the current regime, "[t]hird-party database managers maintain a database of all registered links for the purpose of interference protection and establishing first-

[59] 47 C.F.R. § 101.101.

[60] 47 C.F.R. § 101.113.

in-time rights" and are "responsible for coordinating with NTIA through an automated 'green light/yellow light' mechanism to avoid harmful interference to federal operations which share the spectrum."[61] "[W]hen registering a point-to-point link, licensees are required to submit an interference analysis to the database manager that demonstrates that the proposed link will neither cause nor receive harmful interference relatively to previously registered non-federal links"; "[i]f harmful interference does occur, the earliest registered link will have the right to interference-free operation."[62] "If [a] complaining first-in-time licensee is not satisfied that the interference [is] resolved, . . . a complaint may be filed with the Commission."[63] This process is suitable to address interference issues, if any, associated with Aeronet's use of aviation SDDLs.[64]

Aeronet acknowledges that minor modifications to specific link databases may be appropriate. For example, databases likely will need to implement changes to effectively represent Aeronet's link registrations as establishing three-dimensional cones and polyhedrons for ground-to-air and air-to-air networks, respectively. But, as noted, Aeronet does not need these three-dimensional networks to be exclusive use areas. Instead, Aeronet believes that existing methods

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[61] *In re Spectrum Horizons Battelle Memorial Institute Petition for Rulemaking To Adopt Fixed Service Rules in the 102-109.5 GHZ Band*, Notice of Proposed Rulemaking, 33 FCC Rcd 2438, 2452 ¶ 29 (2018).

[62] *Id.* at 2452-53 ¶ 30.

[63] *In re Allocations and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands*, Memorandum Opinion and Order, 20 FCC Rcd 4889, 4896 ¶ 13 (2005).

[64] As Aeronet has previously explained, SDDLs also would be amenable to coordination if the Commission were to adopt its prior proposal to move toward a spectrum allocation model for the E-Band that relied on a Spectrum Access System. *See, e.g.*, Letter from Brian Russell, Chief Operating Officer, Aeronet Global Communications Inc. to Marlene Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177, IB Docket Nos. 15-256 and 97-95, RM-11664, and WT Docket No. 10-112 (July 12, 2017); Letter from Ivor Patrick, Director, Aeronet Global Communications Inc. to Commission's Secretary, Federal Communications Commission, GN Docket No. 14-177 (Sept. 28, 2016).

will allow coordination between Aeronet's SDDLs and incumbent terrestrial-link uses, as well as innovative new uses.

There is recent Commission precedent holding that, under certain circumstances, a service like SDDLs, involving communications between moving points, should be treated as fixed, rather than mobile. The Commission historically authorized FSS as "communications between satellites in orbit and earth stations in fixed locations. However, as the need for broadband communications to vessels, land vehicles, and aircraft . . . evolved, it . . . bec[a]me clear that Mobile-Satellite Service . . . spectrum was not adequate to meet this need."[65] Thus, in a series of actions in 2005, 2009, and 2012, the Commission authorized certain "[e]arth [s]tations in [m]otion" (collectively "ESIM")—earth stations on vessels, vehicle-mounted earth stations, and earth stations aboard aircraft ("ESAA")—to operate in the FSS spectrum, even though the earth stations were not fixed.[66] The Commission described that an ESAA terminal, for example, "would appear *almost fixed* from the perspective of the [geostationary-orbit] [Geostationary Orbit ("GSO")] FSS space station. . . . Accordingly, transmissions from a GSO FSS space station to an earth station fixed to airborne aircraft are not materially different from any other transmission from a GSO FSS space station and would be unlikely to result in interference events to other co-primary services."[67]

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[65] *See In re Amendment of Parts 2 and 25 of the Commission's Rules to Facilitate the Use of Earth Stations in Motion Communicating with Geostationary Orbit Space Stations in Frequency Bands Allocated to the Fixed Satellite Service*, Notice of Proposed Rulemaking, 32 FCC Rcd 4239, 4241 ¶ 3 (2017) ("*ESIM NPRM*").

[66] *See id.* at 4240-42 ¶¶ 1, 4-6.

[67] *In re Revisions to Parts 2 and 25 of the Commission's Rules to Govern the Use of Earth Stations Aboard Aircraft Communicating with Fixed-Satellite Service Geostationary-Orbit Space Stations Operating in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14.0-14.5 GHz Frequency Bands*, Notice of Proposed Rulemaking and Report and Order, 27 FCC Rcd 16,510, 16,518 ¶ 16 (2012) (emphasis added).

In 2017, the Commission proposed further action to reduce regulatory barriers that prevented ESIM operations while still "maintain[ing] those [rules] that ensure that FSS earth stations operating while in motion do not cause more interference than FSS earth stations at fixed locations."[68] In 2018, based on its prior successes, the Commission expanded the FSS spectrum in which ESIM could operate and requested comment on "allowing ESIMs to operate in" still more "frequency bands in which earth stations at fixed locations operating in GSO FSS satellite networks can be blanket-licensed because in this situation operation of earth stations in motion should not introduce a material change to the interference environment created or to the protection required."[69] And more recently, the Commission considered applying the same rules to allow communications between ESIM and non-geostationary orbit satellites in the FSS.[70]

The Commission should take a similar approach here. Aeronet's SDDL networks would function as "almost fixed" from the perspective of other users of the E-Band. While the far and/or near ends of the link would be dynamic, they would still operate in a point-to-point fashion, via connection beams with very narrow widths. Moreover, in the aviation context, the dynamic path of the near and far ends would follow a known and pre-scheduled route—*i.e.*, a flight path. These characteristics mean the service can be considered as a forecasted series of fixed point-to-point broadband links: The location of any given node at any given moment would be knowable in advance and known in real time.[71]

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[68] *See ESIM NPRM*, 32 FCC Rcd at 4242 ¶ 7.

[69] *ESIM Order*, ¶ 91.

[70] *See In re Facilitating the Communication of Earth Stations in Motion with Non-Geostationary Orbit Space Stations*, Notice of Proposed Rulemaking, IB Docket No, 18-315, FCC 18-160 (rel. Nov. 16, 2018).

[71] Moreover, like ESIM, Aeronet's aviation SDDLs are an innovative technology that will facilitate connectivity in the highly challenging environment of air travel. *See ESIM Order*, at 77 (Statement of Chairman Ajit Pai) (emphasizing importance of establishing "on-the-road connectivity" to

CONCLUSION

This Petition affords the Commission the opportunity to support competition in an underpenetrated market, while fostering the development of an innovative technology and further commercializing relatively greenfield spectrum. Aviation broadband has failed to keep pace with demand, depriving consumers, airlines, aircraft crew, and public safety officials of myriad innovative applications and uses that are in the public interest. Aeronet has demonstrated the ability to deliver Gbps, low-latency connectivity to aircraft using scheduled dynamic datalinks in the E-Band. And Aeronet is in a prime position to expand this service to airlines, third-party service providers, and other partners in the United States and abroad. The Commission should act promptly to expressly authorize this use of spectrum in its allocation and service rules for the E-Band by implementing the minor amendments identified herein. By doing so, the Commission will ensure that the United States is the world leader in a new broadband market with virtually limitless demand.

Respectfully submitted,

/s/ Samuel L. Feder

Samuel L. Feder
Roger C. Sherman
Elliot S. Tarloff
JENNER & BLOCK LLP
1099 New York Avenue, NW
Suite 900
Washington, DC 20001
(202) 639-6000

Counsel for Aeronet Global Communications Inc.

February 6, 2019

"ships, vehicles, and aircraft—basically any non-stationary platform, especially those that can't be served using other communications technologies"). As noted above, Aeronet has no plans to maintain connectivity when aircraft leave a flight path and thereby exit 3D cone or polyhedron SDDL sub-mesh networks.