

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of)
)
Ligado’s Petition for Rulemaking) RM-11681
to Consider Reallocating the)
1675-1680 MHz Meteorological Band)
To Allow Terrestrial Mobile Use)

**REPLY COMMENTS OF AIRLINES FOR AMERICA, AVIATION SPECTRUM
RESOURCES, INC., CARGO AIRLINES ASSOCIATION, DELTA AIRLINES, FEDEX
EXPRESS, HELICOPTER ASSOCIATION INTERNATIONAL, NATIONAL AIR
TRANSPORTATION ASSOCIATION, AND NATIONAL BUSINESS AVIATION
ASSOCIATION (“JOINT AVIATION REPLY COMMENTERS”)**

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SUMMARY

Timely weather products generated by both the federal government and non-federal providers made possible by accurate and real-time meteorological data from the Geostationary Operational Environmental Satellite (“GOES”) system is a key enabler for aviation safety and operational efficiency, let alone the benefits such products and data bring to other industries, state and local government, and the people at large. The record makes clear that Ligado’s Petition for Rulemaking asking the Federal Communications Commission (“FCC” or “Commission”) to reallocate the spectrum in the 1675-1680 MHz band to permit terrestrial commercial mobile broadband service threatens the satellite downlink of critical and unique data from the GOES system upon which the aviation industry heavily relies.

Ligado’s current proposal to develop exclusion zones for Ligado base stations only around certain Federal, i.e., National Oceanic and Atmospheric Administration (“NOAA”) sites is flawed and requires further study through a multi-stakeholder process, such as that which occurred before the Commission adopted new AWS-3 allocations in the 1695-1710 MHz band. The operations Ligado envisions would also permanently preclude non-NOAA users receiving GOES system data directly from the satellites at their own ground stations; such direct readout capabilities are a key characteristic of the GOES system and provide the means by which timely weather products the federal government does not supply are made available to the aviation community. The establishment of proper protection for federal earth station sites, but also for non-federal sites, requires additional analysis and should be done through a multi-stakeholder process.

Ligado’s contention that a content delivery network (“CDN”) established by the company as a substitute for direct read-out capability from the NOAA satellites ignores a number of flaws.

Ligado's CDN proposal lacks many details, and it is by no means clear that this arrangement will provide the same throughput and coverage capabilities as direct readout from the GOES system. Before the Commission can consider the Petition for Rulemaking, Ligado should provide a more complete description of the CDN it would establish, addressing the many criticisms – operational, technical, and financial – that have been lodged in the comments and in these reply comments, and offering solutions that ensure the critical requirements of aviation and other users are satisfied.

Based on the record generated by the Commission's April 22, 2016, Public Notice, the Commission should not proceed to grant Ligado's Petition.

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REPLY COMMENTS OF AIRLINES FOR AMERICA, AVIATION SPECTRUM RESOURCES, INC., CARGO AIRLINES ASSOCIATION, DELTA AIRLINES, FEDEX EXPRESS, HELICOPTER ASSOCIATION INTERNATIONAL, NATIONAL AIR TRANSPORTATION ASSOCIATION, AND NATIONAL BUSINESS AVIATION ASSOCIATION (“JOINT AVIATION REPLY COMMENTERS”)

Airlines for America (“A4A”), Aviation Spectrum Resources, Inc. (“ASRI”), Cargo Airlines Association, Delta Airlines (“Delta”), FedEx Express, Helicopter Association International (“HAI”), National Air Transportation Association (“NATA”), and National Business Aviation Association (“NBAA”) (“Joint Aviation Reply Commenters”) hereby submit their reply to those comments filed in the above-referenced proceeding in response to the Federal Communications Commission’s (“FCC” or “Commission”) April 22, 2016, Public Notice seeking comment on the Petition for Rulemaking (“Petition”) filed by LightSquared, the pre-bankruptcy predecessor to Ligado Networks LLC (“Ligado”).¹ The record developed in response

¹ *Comment Sought to Update the Record on Ligado’s Request that the Commission Initiate a Rulemaking to Allocate the 1675-1680 MHz Band for Terrestrial Mobile Use Shared with Federal Use*, RM-11681, DA 16-443 (Apr. 22, 2016) (“Public Notice”). The Commission extended the period for reply comment until August 11, 2016, in an order released on July 20, 2016. *Comment Sought on Ligado’s Request that the Commission Initiate a Rulemaking to Allocate the 1675-1680 MHz Band for Terrestrial Mobile Use Shared with Federal Use, Extension of Reply Comment Deadline*, RM-11681, DA 16-825 (July 20, 2016).

to the Public Notice underscores the extensive use of critical meteorological data that is downlinked co-frequency, or in close proximity to the 1675-1680 MHz band, by the Geostationary Operational Environmental Satellite (“GOES”) system (and will continue under the soon to be launched next generation GOES-R system)² to numerous industries, including aviation and aerospace, as well as state and local governments. Federal and non-federal products generated in real-time from GOES system data is a crucial facilitator of aviation safety and operational efficiency. In Ligado’s Petition for the Commission to reallocate the National Oceanic & Atmospheric Administration (“NOAA”) spectrum for its terrestrial commercial mobile broadband services, Ligado fails to adequately explain in sufficient detail how it plans to address the impacts on the existing federal and non-federal users of the spectrum. For these reasons, the Joint Aviation Reply Commenters view Ligado’s proposal as premature, and the Commission should shelve the Petition unless significant additional information is forthcoming that explains how existing uses of the NOAA data will be safeguarded.

DESCRIPTION OF THE JOINT AVIATION REPLY COMMENTERS

A4A is the industry trade organization for the leading U.S. airlines. Annually, commercial aviation helps drive nearly \$1.5 trillion in U.S. economic activity and more than 11 million U.S. jobs. A4A vigorously advocates on behalf of the American airline industry as a model of safety, customer service and environmental responsibility and as the indispensable network that drives our nation’s economy and global competitiveness.

² The GOES-R series is a four-satellite program (GOES-R/S/T/U) that will extend the availability of the operational GOES satellite system through 2036. The first launch is scheduled for November 4, 2016. See <http://www.goes-r.gov> (“Mission Overview”).

ASRI is the communications company of the U.S. air transport industry, and is owned by U.S. airlines and other U.S. airspace users. ASRI is also the licensee for U.S. Aeronautical Enroute Service (“AES”) used for aeronautical operational communications and the sponsor of the Aeronautical Frequency Committee (“AFC”).³ This enables ASRI to draw on the expertise and opinions from across the U.S. aviation sector, promoting the safe and efficient operation of civilian aviation radio communications systems operating within the U.S. By coordinating with the AFC, ASRI supports the safe operation of U.S. aviation in an international environment through participation with the International Civil Aviation Organization (“ICAO”), IATA, and International Telecommunication Union Radiocommunications Sector (“ITU-R”).

The Cargo Airline Association is the nationwide voice for members of the all-cargo air carrier industry, and others in the air cargo marketplace that depend on these services.

Delta has grown into one of the world’s largest global airlines, helping more than 160 million travelers get to the places they want to go to each year. The airline and its subsidiaries operate over 5,400 flights daily and serve an extensive domestic and international network that includes 333 destinations in 64 countries on six continents.

HAI is a not-for-profit, professional trade association that represents the interests of the helicopter community. HAI has over 4,000 members, including 1,727 companies in 74 nations. Since 1948, HAI has provided its members with services that directly benefit their operations by offering programs to enhance safety, encourage professionalism, and promote the unique benefits of vertical flight. HAI’s first priority is – and always will be – safety.

³ AFC membership includes all major U.S. airlines, cargo carriers, and helicopter operators; U.S. Communication Service Providers, Airlines for America, Aircraft Owners and Pilots Association, Helicopter Safety and Advisory Conference (HSAC), National Air Transport Association, Helicopter Association International, the Federal Aviation Administration and the International Air Transport Association.

NATA is the leading organization representing aviation service businesses such as fixed based operators, charter providers, maintenance and repair organizations, flight training, airline service companies and aircraft management companies, including those supporting fractional shareholders. NATA's mission is to empower its members to be safe and successful aviation businesses.

Founded in 1947 and based in Washington, DC, the National Business Aviation Association is the leading organization for companies that rely on general aviation aircraft to help make their businesses more efficient, productive and successful. The Association represents more than 10,000 companies and provides more than 100 products and services to the business aviation community, including the NBAA Business Aviation Convention & Exhibition, the world's largest civil aviation trade show

INTRODUCTION

The weather data collected and disseminated by the NOAA GOES plays a critical role in commercial and private aviation operations today (as well as in numerous other non-government and government contexts). The Joint Aviation Reply Commenters explain the commercial aviation uses of this data further in this reply, and underscore the requirement for real time or near-real time access. Any proposal that would impact the ability of aviation and other users to continue to receive that data as they do today, as well as the increased and enhanced data from the successor to GOES, GOES-R, must ensure that end users are not negatively affected. The Ligado proposals to use the 1675-1680 MHz band for terrestrial commercial mobile operations fails to do this on the current record.

The Joint Aviation Reply Commenters have specific concerns over the lack of detail on the proposed protection of the existing non-federal ground stations receiving NOAA GOES

products directly. The direct readout of data from the GOES satellites by non-federal users is a central and forward-looking feature of the GOES system promoting innovation in research and products used by aviation and others.⁴ Ligado proposes a content delivery network (“CDN”) system to replace direct readout by non-NOAA GOES receivers. This reflects a recognition by Ligado that its proposal to reallocate the 1675-1680 MHz will lead to harmful interference to direct readout users. But the CDN proposal is not sufficiently defined by Ligado to permit proper evaluation and assessment by the Commission and potentially affected direct users – including providers of weather products such as the Weather Company, Schneider, and Baron Services – and indirect users – such as aviation operators generally – of direct readout services. Many fundamental questions remain unanswered, making clear that the grant of the Ligado Petition for Rulemaking as it now stands would be premature and contrary to the public interest.

WEATHER DATA USAGE BY AVIATION OPERATORS

The aviation community relies heavily on accurate and timely weather data for safe and efficient aviation operations across all parts of the world, used by all airspace users, including

⁴ Regarding the rebroadcast capability on GOES-R, NOAA states that “GRB will enable direct broadcast users with their own receivers to receive full resolution, calibrated, near real-time direct broadcast data.” See National Oceanic and Atmospheric Administration, “GOES-R Data Access Mechanisms,” February 18, 2015, found at <https://www.wmo-sat.info/satellite-user-readiness/topic/data-access-and-use/data-access-mechanisms>. NOAA does not differentiate between federal and non-federal users in its mission. Indeed, NOAA has published a “User’s Guide for Building and Operating Environmental Satellite Receiving Stations” to support direct read out by non-federal users. See http://noaasis.noaa.gov/NOAASIS/pubs/Users_Guide-Building_Receive_Stations_March_2009.pdf. As of early 2009, NOAA noted that “Thousands of direct readout stations have been purchased or built to receive the direct readout transmissions from these satellites. Government and military agencies, private industries, and a variety of private individuals including ham radio operators, students and faculty are operating ground stations.” *Id.* at 6.

commercial airlines, business aviation, helicopter operations, and small General Aviation (“GA”) aircraft. The GOES-N/O/P Series weather satellite system, and its planned enhanced replacement, the GOES-R (collective referred to as the “GOES system” unless noted otherwise), are key to ensuring vital weather information is directly available in the North American Continent, over ocean areas, and in adjacent regions in a timely manner.

Weather-based events are the largest cause of air traffic delay in the U.S. airspace system, responsible for approximately 69% of commercial airline flight delays of greater than 15 minutes. Weather events both directly and indirectly caused nearly 170,000 hours of commercial aircraft delays in 2013 alone.⁵ Potentially dangerous weather is not an infrequent event in many parts of the US airspace, requiring constant monitoring and assessment for different aircraft types and flight routes.⁶ Thunderstorms or hurricanes for aircraft in flight are a major safety concern, and aircraft operators require constant updates to ensure such storms are not an immediate threat to an aircraft operating in their vicinity. Storms can form in a very short space of time, for example, in the Gulf of Mexico, where a large number of helicopter flights occur every single day (supporting the energy exploration sector), underscoring the need for timely and uninterrupted access to accurate weather data.⁷

⁵ FAQ: Weather Delay, Federal Aviation Administration, last updated July 31, 2015
<https://www.faa.gov/nextgen/programs/weather/faq/>

⁶ Potentially dangerous weather includes not only storms, lightning, volcanic ash, and other terrestrial effects but also space weather, such as increased radiation and the effects of solar flares.

⁷ Additionally, many airlines fly shorter routes across the Gulf of Mexico, rather than overland routes, and require the latest information about all aviation hazards to ensure safe operations in this airspace.

The ability to accurately monitor these events as they develop, gather enough data to project their course, and respond to them during flight operations not only allows aviation to ensure safe operations, but also to optimize routing of aircraft for maximum airspace efficiency. Rerouting around weather efficiently and only when required based on real-time data can reduce the economic impact on aviation operations and minimize delays for passengers and cargo. Monitoring hazardous weather in real time is especially important for long-haul aircraft which may have departed for a location before potentially significant weather developments emerge. Such monitoring, forecasting, planning, and response relies on access to substantial volumes of high quality and timely data. GOES-N/O/P provides that data today and GOES-R will provide that data in the future, bringing enhancements that will not only allow NOAA to generate better data products, but will also enable non-federal providers to improve and innovate in ways that further complement what NOAA offers.

FAA-approved aviation weather sources include NOAA, the National Weather Service (“NWS”), sources approved by NWS, and additional non-federal sources approved by the FAA Administrator. When complemented by other sources, a direct readout of NOAA weather data from the GOES system allows non-federal providers such as the Weather Company, Schneider, and Baron Services, to supplement the federally generated weather products with important additional products upon which airlines and aviation generally has come to rely. Both federal and non-federal weather products derived from the GOES data are essential to safe and efficient aviation operations.

The Commission asks in its Public Notice for details about the specific usage of non-federal users of NOAA data downlinked in the vicinity of 1675-1680 MHz. The extensive nature of the U.S. aviation industry, coupled with the absence of requirements for non-federal

users deploying direct readout earth stations to receive the GOES data to register such antennas, has made identification of the full aviation impact especially difficult given the size and multi-sector nature of the industry.⁸ However, enough is known at this time to permit comments to be made on current weather usage by aviation, including federal agency involvement, to demonstrate that the Ligado Petition should not be granted, at least in its current form.⁹

The FAA identifies three distinct types of weather information that is needed to conduct aircraft operations:¹⁰

- Observations
- Analyses
- Forecasts, to include in-flight weather advisories

These three types of information often must be collected from multiple sources. Historically, the Federal Government was the only source of weather data, with the responsibility assigned to the FAA and the NWS. However, due to the growing sophistication of aviation operations, and advances in gathering meteorological data and processing it, there are now three primary source categories for weather information – namely, a) the Federal Government, b) non-federal

⁸ The Joint Aviation Reply Commenters continue to solicit information from users, intending to supply the Commission with more details of commercial aviation usage as that information becomes available.

⁹ The Joint Aviation Reply Commenters would further note that such information is only being sought for US companies, and not from international airlines, who may also have their own systems for operations within the North American region.

¹⁰ Aviation Weather Services Advisory Circular AC 00-45G Change 2, Department of Commerce and Federal Aviation Administration, Section 1.3.3, p. 1-8, published October 2014 (“FAA Circular”).

Enhanced Weather Information Network (EWIN) providers, and c) commercial weather information partners.

An EWIN source may produce weather analysis and forecasts for aviation not available elsewhere based on Federal Government observations, such as the GOES system data received by direct broadcast. Commercial weather providers are a major source of weather products for the aviation community. In general, they produce proprietary weather products based on basic NWS products with formatting and layout modifications. Commercial providers may also produce forecasts, analyses and other proprietary weather products that substantially alter the information found in NWS-produced products.¹¹

Each of the three sources of aviation weather products or services rely to a substantial degree on the GOES data. To ensure the timely reception of the entire GOES data set under all conditions, reception of the direct broadcast at one or more of the producer sources using a satellite earth station is necessary.

TYPES OF WEATHER DATA PROVIDED BY THE GOES SYSTEM

Information is collected by the GOES system of satellites, and broadcast to and received by federal and non-federal earth stations for processing. “Satellite is perhaps the single most important source of weather data worldwide, particularly over data sparse regions such as countries without organized weather data collection and the oceans.”¹² This includes Alaska, Hawaii, and broad ocean areas and portions of many over-the-pole air routes. The weather

¹¹ An airline operator may require FAA approval to use such products in support of operations.

¹² FAA Circular at 4.2.1, p. 4-16.

products relevant to aviation that are derived from GOES data (which in some cases may be combined with the output from terrestrial systems such as NEXRAD¹³) include the following:

- Areas of turbulent air
- Cloud coverage and heights
- Dust/smoke/volcanic ash location, concentration, and movement
- Flood and storm surge warnings advisories.
- Fog/visibility
- Icing
- Lightning location mapping
- Moisture content of the air
- Mountain obscuration
- Polar route radiation
- Temperature
- Thunderstorms
- Wind speed and direction

Select GOES-R baseline products of importance to aviation operations that will be added to the broadcast downlink in or adjacent to the 1675-1680 MHz band (once the first satellite is launched later this year) after minimal processing by NOAA (so-called Level 1b products) include:¹⁴

- Aerosol Detection (Including Smoke and Dust)
- Cloud Top Height, Pressure & Temperature
- Derived Motion Winds
- Hurricane Intensity Estimation
- Rainfall Rate
- Volcanic Ash: Detection and Height
- Space Weather: Geomagnetic Field
- Space Weather: Energetic Heavy Ions, Magnetospheric Electrons & Protons
- Space Weather: Solar Flux: X-ray Irradiance

¹³ Next-Generation Radar (NEXRAD) - a network of 160 high-resolution S-band Doppler weather radars operated by the NWS.

¹⁴ A complete list of baseline and derived products may be found at <http://www.goes-r.gov>.

These future GOES-R capabilities will make possible additional derivative products, such as better predictions of where turbulence is likely to arise, and an aircraft icing product that will identify areas with a high icing threat.¹⁵

The weather products identified above that are *currently* available are derived from data sent via the GOES-N/O/P Sensor Data Link (“SD”) on 1673.4-1678.6 MHz to NOAA ground stations at Wallops, VA, Greenbelt, MD, and Fairbanks, AK. Here, they are processed in real-time by NOAA before being immediately uploaded to the GOES-N/O/P for rebroadcast using the 2025.6-2029.8 MHz band. Upon reaching the GOES satellites, the data are broadcast using the GOES Variable (“GVAR”) format in the 1683.6-1687.8 MHz frequency band near to the band Ligado proposes to use.¹⁶ The direct relay via GOES enables reliable availability of the processed (Level 1b) GVAR data with the lowest latency.

In a similar manner, the GOES-R system will send a raw data feed (so-called Level 1 data) to several NOAA ground stations (in the 8160-8280 MHz downlink band) for basic processing (into Level 1b data), before uplinking the Level 1b data to the GOES-R satellite (in the 7211.15-7222.05 MHz band). GOES-R will then distribute the Level 1b data nationwide using the GOES Re-Broadcast (“GRB”) system (at the 1682.3-1690.9 MHz). Thus, not only will

¹⁵ See Aircraft Icing Threat, GOES-R, <http://www.goes-r.gov/products/opt2-aircraft-icing-threat.html> and Tropopause Folding and Turbulence Prediction, GOES-R, <http://www.goes-r.gov/products/opt2-trop-folding.html>

¹⁶ In addition, the Multi-Use Data Link (“MDL”) operates on 1681.478 MHz as an independent link on GOES-N/O/P and it is used by the Spacecraft Support Ground System (SSGS) to diagnose dynamic interactions among the instruments and the spacecraft. The MDL link, which is received at the Spacecraft Operations Control Center should be protected from potential interference caused by the proposed Ligado operations at 1675-1680 MHz. Ligado should also demonstrate that its operations will not contribute to the potential for interference to the Data Collection Platform Reports (“DCPR”) links operated on GOES-N/O/P around 1694 MHz.

the NOAA satellite downlinks in the 1683.6-1687.8 and 1682.3-1690.9 MHz bands be affected (directly) by the Ligado proposal, but the efficacy of the subsequent NOAA transmissions in the 2025.6-2029.8 MHz, 7211.15-7222.05 MHz, and 8160-8280 MHz band will be impacted indirectly.¹⁷

For both, GOES-N/O/P and GOES-R systems, the downlinked Level 1b products on GVAR and GRB, respectively, are received by the NOAA NWS centers listed below, as well as other federal and non-federal weather users.

- NWS Aviation Weather Center (“AWC”).
- NWS Volcanic Ash Advisory Centers (Washington & Anchorage) (“VAAC”).
- NWS National Hurricane Center (“NHC”).
- NWS Storm Prediction Center (“SPC”).
- NWS Weather Prediction Center (“WPC”) and Ocean Prediction Center (“OPC”).
- NWS Space Weather Prediction Center (“SWPC”).
- Alaska Region NWS, including the Alaska Aviation Weather Unit
- Pacific Region NWS, including the Central Pacific Hurricane Center, Hawaii Aviation Products issued by the Pacific Region office in Honolulu

In the specific case of aviation, certain weather products used for flight movements and operations are specified by FAA regulations.¹⁸ These include reports and forecasts provided by the NWS, the FAA-approved phenomena reporting and forecast system, and the FAA-approved EWINS. These reports include a combination of weather satellite imagery and data, as well as observed and measured data at airports. This information increases pilots’, flight dispatchers’, and flight followers’ awareness of the meteorological situation, as well as improves decisions.

¹⁷ On GOES-R, the Data Collection Platform Reports (“DCPR”) links will be centered at 1683.3-1683.6 MHz and should be protected as well.

¹⁸ 14 CFR Parts 91,121,135.

For example, the GOES imaging products that are sent via GVAR/GRB are used by the NWS to construct weather mosaics.¹⁹ These mosaics are the key data source used by FAA to issue warnings during flight operations, including take offs and landings, such as Significant Meteorological Events (“SIGMETs”)²⁰ and Airmen’s Meteorological Information (“AIRMETs”).²¹ SIGMETs and AIRMETs are crucial weather resources pilots rely on to understand current or forecast Instrument Flight Rules turbulence or icing, and where there are significant surface winds. These products are critical to safety of flight and must remain available for all aviation users.

Prognostic charts (“PROG”) are also developed by the NWS forecasters directly from, among other things, GOES imagery mosaics.²² These charts are utilized by pilots, flight dispatchers, flight followers and others to understand where there are fronts and significant pressure gradients. Fronts and pressure gradients are important for pilots and these other users to understand as they can be indicators of severe weather. Pilots and flight dispatchers are tested on PROG charts by the FAA when getting their Airline Transport Pilot (“ATP”) certificates. This product is heavily relied upon by all aviation users.

¹⁹ These mosaics are composite images of weather phenomena overlaid on maps or navigational charts.

²⁰ SIGMETs are weather advisories that contains meteorological information concerning the safety of all aircraft.

²¹ Also known as weather advisories, AIRMETS are a description of weather phenomena that are occurring or may occur (forecast) along an air route that may affect aircraft safety. SIGMETs cover severe intensity while AIRMETS cover moderate intensity or less of turbulence and icing as well as sustained surface winds of 30 knots or more, and/or widespread restricted visibility.

²² An example of a PROG chart may be found at Aviation Weather Center, <https://www.aviationweather.gov/progchart/high?region=a>

Another critical product is volcanic ash information. Volcanic ash can be catastrophic to aircraft engines, causing them to stall or lose power suddenly in flight. Active volcanoes are located in the so-called Pacific Ring of Fire, which stretches around the Pacific Ocean, including, notably, Alaska and the western U.S. Aircraft routes overlay the entire Ring of Fire, making timely and consistent GOES system data critical to all flight operations in order to determine the extent, thickness and movement of volcanic ash in the atmosphere. The Alaska region covers one of the most volcanically active regions of the Ring of Fire, not to mention in the world, and Anchorage is the second busiest air cargo hub in the United States. Meteorologists monitoring volcanically active areas require the highest level imagery that is available in a real-time and reliable fashion to distinguish clouds from volcanic ash. This means for GOES satellite data in the GOES-R era they must receive GRB, which is the only source for the highest resolution over the ocean imager scans, at low latency and high reliability. Many commercial airlines and general aviation aircraft routinely fly in the areas impacted and need this product to understand whether they can complete that flight safely.

Aircraft in over-the-pole flights can expose passengers and crew to high levels of natural radiation not present to the same degree in other parts of the globe during space weather events. Warnings of such events from sensors on the GOES system must be disseminated with extremely low latency by federal agencies to airlines. Affected flights are then usually rerouted, in real-time, to a lower latitude where radiation levels are safe, requiring longer flight duration and more fuel consumption. Availability of better real-time information allows this to be done with increased efficiency without increasing the potential dangers for passenger and crew safety. This data is broadcast via the GOES system to federal centers where such warnings are issued.

LIGADO PROPOSAL FOR PROTECTION OF GOES GROUND STATIONS

Ligado proposes exclusion zones around NOAA sites within which Ligado base stations would be excluded.²³ The Joint Aviation Reply Commenters note several discrepancies in the Ligado proposals:

- Ligado proposes use of a 50% exceedance factor to calculate the necessary separation distances for the GOES-R system.²⁴ This conflicts with several internationally accepted standards. Both ITU-R SA.1160 and ITU-R SA.1163 state that the interference power can exceed the long-term threshold no more than 20% of the time.²⁵
- In Ligado’s proposal, GOES-N/O/P study, an omni-directional antenna system based on ITU-R F.1336 antenna pattern, was used in a single interferer analysis to ensure “worst

²³ See Comments of Ligado, dated June 21, 2016, at 8-9; Letter to Marlene S. Dortch, Secretary, Federal Communications Commission, from Gerard J. Waldron and Paul Swain, Covington & Burling, Counsel to New LightSquared, filed in RM-11681, dated December 16, 2015, received by the Commission on January 15, 2016 (“Ligado December 2015 *ex parte*”).

²⁴ See Potential for LightSquared Broadband Base Stations in the 1670-1680 MHz Band to Interfere with Select NOAA GOES-N/O/P Ground Locations, RESED 14-005, Consulting Report prepared by Alion Science and Technology for LightSquared, p. 90, April 2014 (“GOES-N/O/P Report”) *appended to* Letter to Marlene Dortch, Secretary, Federal Communications Commission from Jeff Carlisle, Executive Vice President for Regulatory Affairs and Public Policy, LightSquared, filed in RM-11681, dated April 14, 2016 (“Ligado April 2016 *letter*”).

²⁵ See Rec. ITU-R SA.1160-2: Interference Criteria for Data Dissemination and Direct Data Readout Systems in the Earth Exploration-Satellite and Meteorological-Satellite Services Using Satellites in the Geostationary Orbit (Question ITU-R 141/7), Table 1, found at <https://www.itu.int/rec/R-REC-SA.1160-2-199910-I/en>; Rec. ITU-R SA.1163-2: Interference Criteria for Service Links in Data Collection Systems in the Earth Exploration-Satellite and Meteorological-Satellite Services (Question ITU-R 142/7), table 1, found at https://www.itu.int/dms_pubrec/itu-r/rec/sa/R-REC-SA.1163-2-199910-I!!PDF-E.pdf

case results were obtained for the GOES Legacy analysis.”²⁶ However, for GOES-R, a sectorized antenna system was used in an aggregate study.²⁷ Ligado does not justify the differences in approaches in the two cases, and the Joint Aviation Reply Commenters are unaware of any justification for a disparate approach when considering the two GOES programs.

Given the lack of peer review in an appropriate form, combined with the points raised above, additional study similar to that of the AWS-3 auction process through the Commerce Spectrum Management Advisory committee ("CSMAC") would seem to be the only method of properly assessing what exclusion zones, if any, would be appropriate around sites receiving the NOAA GOES system downlink. Such a process could also account for other sites that may need protection, and are not covered by Ligado’s analysis. These methods should be developed through a multi-stakeholder system. The Joint Aviation Reply Commenters agree with the suggestion of SNR Wireless that a CSMAC process be used, more specifically, CSMAC-sponsored working groups, to determine protection criteria and coordination zones considerations similar to that used for the protection of meteorological spectrum downlinks in 1695-1710 MHz from potential interference by AWS-3 licensees.²⁸

²⁶ See Potential for LightSquared Broadband Base Stations in the 1670-1680 MHz Band to Interfere with Select NOAA GOES-R Ground Locations, RESED 14-004, Consulting Report prepared by Alion Science and Technology for LightSquared, pp. 31, 84, 109, February 2014 (“GOES-R Report”) *appended to* Ligado April 2016 letter.

²⁷ See GOES-R Report at 102 (“*For modeling purposes, the analysis utilized the antenna values contained in ITU 1336 with three directional sectors (at 0, 120, and 240 degrees) that are typical of all LTE network*”) compared to GOES-N/O/P Report at 31 (“*the analysis utilized the antenna values...which were assumed to be omnidirectional instead of using the three directional sectors*”).

²⁸ See Comments of SNR Wireless, dated June 21, 2016, at 14. See also *Amendment of the Commission’s Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Report and Order, 29 FCC Rcd 4610

THE ABILITY OF DIRECT READ OUT BY NONGOVERNMENT USERS OF GOES DATA IS ESSENTIAL

As things currently stand, the Ligado proposal would permanently prevent non-NOAA users receiving GOES system data directly from the satellites at their own ground stations, rendering a key characteristic of the GOES system useless. For example, The Weather Company, Andover, MA and Schneider Electric, Minneapolis, MN both receive data directly from GOES, processing it before providing a significant amount of weather information to several US airlines. These companies are among many weather providers who support aviation users with meteorological products generated by data they receive directly from the GOES satellites and other NOAA/international weather sources. This is information that is not available directly from the products offered by the federal operators, but supplementary to it, and relied upon by many aviation interests. Even if these non-federal users were accounted for through protection zones in addition to federal ground stations, this would still result in an unacceptable compromise of the promise of the GOES system. Specifically, such a limited regulatory framework would effectively eliminate the creation of future reception sites and the ability of additional users to receive and process direct read out information to develop innovative new products. In short, freezing the status quo would preclude competition from

(2014) (“AWS-3 Order”); *Final Report: Working Group 1 – 1695-1710 MHz Meteorological-Satellite*, Commerce Spectrum Management Advisory Committee (Jan. 22, 2013), available at https://www.ntia.doc.gov/files/ntia/publications/wg_1_report.pdf (CSMAC Working Group 1 Report underlying protection zones adopted in the *AWS-3 Order*) Commenters do not, however, by making this suggestion, mean to endorse any of the technical results of the AWS-3 Working Group 1 process or the subsequent Commission rulemaking as methods that should be adapted specifically to the protection of meteorological downlinks from the proposed terrestrial commercial mobile operations in the 1675-1680 MHz band. The solutions may be very different. And, unlike the AWS-3 result, non-federal operations that support aviation and other critical non-federal operations must be protected, not just federal earth station sites.

potential new weather providers entering the market during the expected two-decade life of the GOES-R system.

Furthermore, in planning for the huge increase in meteorological data and enhanced weather products, such as lightning mapping, that will be generated and made possible, respectively, by new the GOES-R system and rebroadcast over the band of interest, several airlines are considering deployment of their own GOES-R receivers to collect the weather data directly that will be generated by the new system. Even with the extended timeline before GOES-R is ready for delivery of full operational data, such decisions will be made in the near future to derive the maximum benefit. If non-federal sites are not adequately protected, the Ligado proposal would eliminate this option and severely restrict the ability of aviation users to implement suitable receipt of weather information which is critical to flight safety and efficiency.

Additionally, based on the letter outreach that Ligado claims it engaged in and around June 2015 seeking information about and from existing GOES users, it appears doubtful that Ligado has yet to appreciate the full scope of how GOES data is used and by whom.²⁹ The Ligado Letter was not sent to any aviation groups, even though use of weather data is critical to flight safety and efficient aviation operations in the US and across the world.³⁰ Given the scores of comments in the current record which suggests heavy, widespread, varied, and multi-faceted uses, Joint Aviation Reply Commenters strongly support the establishment of a more

²⁹ See Letter contained in Appendix 1 and appended to Letter to Marlene S. Dortch, Secretary, Federal Communications Commission, from Gerard J. Waldron and Paul Swain, Covington & Burling, Counsel to LightSquared, filed in RM-11681, dated November 5, 2015, received by the Commission on January 15, 2016 (“Ligado November 2015 *ex parte*”). Appendix 1 is referred to herein as the “Ligado Letter.”

³⁰ See *Ligado November 2015 ex parte*, Appendix 2 (listing the entities to which Ligado attempted to send the Ligado Letter).

comprehensive multi-stakeholder approach to develop an understanding of GOES weather reception and usage which Ligado and others can jointly present to the Commission before moving forward with any proposals. This would provide a significantly more detailed assessment of losing the direct GOES broadcast links, and the safety, operational, and financial implications to hundreds or thousands of existing or potential end users.

LIGADO’S PROPOSED ALTERNATIVE DISTRIBUTION MODEL IS FLAWED

To advance its proposed terrestrial use of the 1675-1680 MHz and alleviate the concerns discussed above, Ligado proposes to substitute direct read-out from the NOAA satellites with a content delivery network (“CDN”).³¹ While Ligado’s proposal that the CDN would also be available to schools, libraries, and the general public is laudable, the proposal must first and foremost be assessed on its ability to fully mitigate the loss of a direct readout capability from the GOES system by those involved in the weather enterprise. Unfortunately, this proposal contains several serious flaws that need to be rectified or missing details that need to be filled in before any plan can progress, as noted in the comments of several parties, including Lockheed Martin Corporation, Science and Engineering Center of the University of Wisconsin, the Aerospace Industry Association (“AIA”), and the American Meteorological Society (“AMS”), among others.³² Joint Aviation Reply Commenters concur in those criticisms.

³¹ See Comments of Ligado at 9-17.

³² See, e.g., Comments of Lockheed Martin Corporation, dated June 21, 2016, at 2-3 (“we believe it is an incomplete solution to the problem as it is neither robust, nor does it offer a long-term viable solution for the entire weather enterprise. In fact, if the FCC were to act on the proposal as presented by Ligado, it would in effect be overturning the U.S. Government’s long-term commitment to free-and-open access of direct weather data”); Comments of the Space Science and Engineering Center at the University of Wisconsin-Madison, dated June 20, 2016, at 3, 4 (“Significant latencies are likely to be encountered . . . [and d]ata availability is likely be impacted . . .” by implementation of Ligado’s

As it stands, Ligado’s generic CDN proposal provides little specifics for the Commission or aviation users to be able to fully evaluate its suitability to satisfy a core function of aviation. The items discussed are a non-exhaustive list of the potential areas where weather users will need to review before being able to consider a system alternate to direct readout from the GOES system satellites. Ligado’s CDN system must be described and mapped out with an opportunity for public comment before its proposal can be seriously considered by the aviation industry and other users or the Commission.

Requirements of Critical Weather Users

On the surface, the Ligado CDN proposal might appear to offer certain potential benefits for flexible distribution to entities who are interested in weather data. However, the CDN as proposed does not address needs of end users relying on real-time weather data from the GOES system for critical decision making in a robust manner, especially for the safety of aircraft. GOES-R will generate over 31 Mbps of data continuously, 24/7/365, and as many as hundreds of users will require access simultaneously across a very wide geographic area. Joint Aviation Reply Commenters concur with the American Meteorological Society who expresses the concern that, based on the Ligado proposals for a CDN to date, “[t]he network infrastructure necessary to

proposed alternative; “recent events have proven that a cloud solution is not robust enough to eliminate significant outages”); and Comments of AIA, dated June 21, 2016, at 1-2 (any “alternative terrestrial solution to distribute GOES-R L1B and L2 data, in lieu of a GOES-R rebroadcast, poses a new cyber security risk and a lessened reliability compared to [the direct GOES-R broadcast];” increased latency form a complex terrestrial network would be inadequate to protect against “stringent, life-saving or property-protecting events associated with the GOES-R data that are time critical – such as the 3 second latency for space-weather data associated with the natural radiation environment at geo orbit”; “protects against a last mile failure for conventional terrestrial communications”). *See also* Comments of the American Meteorological Society (AMS), dated June 20, 2016, at 1-3.

provide suitable bandwidth to support all GRB data via a terrestrial network, plus other meteorological data that AMS members require, such as numerical weather prediction model output and Doppler radar imagery, may not be universally accessible or feasible to purchase.”³³

Apart from these holes in Ligado’s proposal, the Joint Aviation Reply Commenters question whether such a CDN capability exist today that could meet the strict requirement, e.g., extremely low latency for such large amounts of data now met by the direct broadcast. Further, ground network infrastructure is often susceptible to failure during severe weather, and GOES ground stations deployed by users other than NOAA, including the end users themselves who have deployed direct readout earth stations, allows for a robust method to receive that data. The time when a facility most needs NOAA weather data is during such severe weather events, when local network infrastructure that would support a CDN can be damaged.³⁴ Therefore, if the CDN suggestion is to be seriously considered – something impossible to do based on the current record – Ligado should provide significantly more details of its planned CDN, including system availability, latency, and how they will ensure dual redundancy of the system for critical sites that the current L-band system provides as well as accommodate new users who otherwise would

³³ See Comments of AMS at 1.

³⁴ AMS notes that rapid availability of GOES-R data is most critical when conditions are evolving rapidly, and that the track record terrestrial delivery network of the Japan Meteorological Agency (“JMA”), as a predecessor to what Ligado proposes, has proven to be very poor. See Comments of AMS at 2. Commenters note further that, as a general matter, any CDN proposal as a replacement for direct read out will introduce additional points of failure, making the continuous, reliable distribution of data more vulnerable. Accord Comments of AIA at 1; Comments of AMS at 2 (“By their nature, terrestrial networks have multiple points of failure based on the number of nodes the data transits.”) The elimination of such points of failure was one of the reasons for the direct readout capability for non-federal users in the first place. See e.g. National Oceanic and Atmospheric Administration, Budget Estimates Fiscal Year 2015, Congressional Submission at 767.

benefit from access to a direct read out capability. Further, the Joint Aviation Reply Commenters concur with Lockheed Martin that, should Ligado subsequently provide sufficient detail so as to enable proper assessment of the impacts on the totality of the weather data collection and forecasting, that NOAA should provide such an analysis.³⁵ But interested parties, such as the members of the aviation industry, should also be given the opportunity to comment and offer concerns and suggestions for possible improvement.

Remote Receiving Sites

The proposal also does not address more remote sites requiring NOAA GOES satellite data. Without knowing all the sites involved in direct readout activities, there is no basis to conclude that all such sites can be reached by terrestrial infrastructure or in a cost effective manner. The comments of the Geographic Information Network of Alaska indicate that terrestrial communications within and to Alaska fail regularly, even without severe weather events.³⁶ This makes reception of the satellite broadcast essential for Alaska and other remote receiving sites. There are serious challenges created by, effectively, the need for a high-speed nationwide network reaching not only heavily developed but remote areas with limited infrastructure options. Ligado does not even begin to explain how these needs will be met wherever they are needed, nor who would need to pay for the required infrastructure and service delivery.

³⁵ See Comments of Lockheed Martin at 3.

³⁶ See Comments of Geographic Information Network of Alaska, University of Alaska Fairbanks, dated June 20, 2016, at 1-2 (citing cable cuts as well as major disaster events).

Financial Stability of a CDN System

In proposing a CDN model, Ligado offers to support the [as-yet-undefined] system for a 10-year period, before users would need to begin self-financing. However, no estimates of financial sustainability or costs have been provided by Ligado in this proposal. Therefore, users of this system would be taking on an unknown financial as well as administrative burden without even a minimal business case, rather than the free public data source currently being provided by NOAA through direct GOES system downlinks. Given the unknown number of users who may use such an unscoped system, its economic feasibility is uncertain for the users Ligado intends would “benefit” from it, let alone users who must rely on the system for safety and operations such as aviation.

CONCLUSION

As discussed herein, weather data from the GOES system is a key enabler for aviation safety and operational efficiency, let alone the other benefits it brings to other industries, state and local governments, and the people at large. There is no substitute for the accurate and timely receipt of GOES system data. Ligado’s proposal to reallocate 1675-1680 MHz would threaten that receipt, and thereby endanger the flying public and adversely impact efficiency of aviation operations. Because the proposed reallocation would fundamentally impact the weather enterprise as it pertains to aviation and other industries which rely on GOES system data and the related products to conduct operations, a comprehensive assessment of the interference risks and detailed planning of any mitigation measures is required. This is not sufficiently present in the Ligado Petition for Rulemaking or in its other filings in this proceeding. Rather, the comments in response to the Commission’s Public Notice make clear that the proposal and solutions (such

as the suggestion for a CDN to replace the GOES direct readout capability) require further investigation before the Commission could make a decision to act favorable on Ligado's Petition and initiate a rulemaking. The Commission should shelve the Petition unless and until the details of any proposed solutions are more clearly laid out in response to the criticisms of users in this record and further public comment can be offered on such solutions.

Respectfully submitted,

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