QUALCOMM Incorporated

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January 18, 2013

Ms. Marlene Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Petition for Rulemaking To Establish A Next Generation Air-Ground Service On A Secondary Licensed Basis In The 14.0 to 14.5 GHz Band -- RM-11640

Dear Ms. Dortch:

On January 16, 2013, Dean Brenner, Ahmad Jalali, Len Schiff, and the undersigned of QUALCOMM Incorporated ("Qualcomm") discussed the above-referenced Petition for Rulemaking with the following individuals from the FCC's International Bureau and Office of Engineering and Technology: James Ball, Brian Butler, Kathleen Collins, Mindel De La Torre, Howard Griboff, Geraldine Matise, Jamison Prime, Mark Settle, and Sci-Byung Yi.

Qualcomm presented the attached slides and encouraged the Commission to issue a *Notice of Proposed Rulemaking* proposing to establish the Next Generation Air-Ground service on a secondary licensed basis in the 14.0-14.5 GHz band.

Respectfully submitted,

John W. Kuzin

John W. Kuzin
Senior Director, Government Affairs – Regulatory

Att.

cc w/ Att.	Jim Ball	Julius Knapp
(via email)	Brian Butler	Geraldine Matise
	Kathleen Collins	Jamison Prime
	Mindel De La Torre	Mark Settle
	Howard Griboff	Sci-Byung K. Yi

Next Generation Air-Ground Communications Service RM-11640 – from Petition for Rulemaking to *NPRM*

January 16, 2013

Next Generation Air-Ground Service

- **Service equivalent to terrestrial broadband connectivity – Next Generation Air-Ground (Next-Gen AG) system will provide very high aggregate throughput (300 to 500 Gb/s over CONUS) and very high dedicated rate per plane (100 Mbps or more) with low latency by sharing the 14-14.5 GHz band on a non-interfering basis.**
- **Low-cost deployment – System will need only a few hundred terrestrial ground stations. Very competitive with satellite-based systems.**

Stay Connected
Growing need to stay connected for business and non-business users: email, social networking, etc.

High Speed Broadband
Fast connection: Internet browsing, content download, gaming and HD Video streaming.

Multimedia Content
Access to a unlimited variety of online content: TV shows, movies, games, educational content and social media.

Next-Gen Air-Ground Service

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A Next-Gen Air-Ground NPRM would advance key FCC policy initiatives

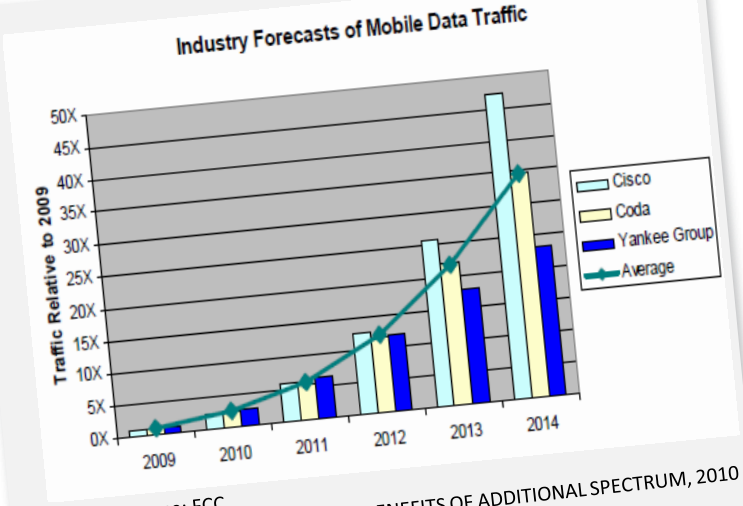
- **Successful spectrum sharing –** Qualcomm's extensive technical submittals show that the 14 GHz spectrum can be shared with primary operations without causing interference; authorizing the proposed Next-Gen AG service on a secondary basis will enable far more efficient use of under-utilized spectrum.

- **In-flight broadband connectivity –** Furthers FCC objective to enable increased support of mobile broadband devices on-board aircraft; Chairman Genachowski has formally asked the FAA Administrator to work towards allowing greater use of electronic devices on planes.

- **In-flight broadband service competition –** The FCC recently adopted rules for satellite-based aircraft communications systems in the 14 GHz band. The proposed terrestrial-based Next-Gen AG system will deliver a low cost, low latency service. The FCC should treat Qualcomm's proposal with regulatory parity as compared to satellite-based systems and let the free market decide which system or systems will succeed.

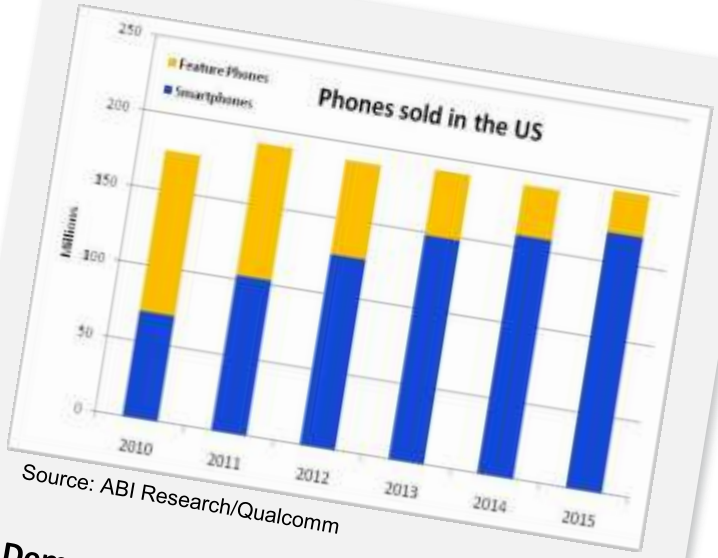
Mobile Broadband Market Growth

Demand for mobile broadband is continuing to surge



Source: FCC
MOBILE BROADBAND: THE BENEFITS OF ADDITIONAL SPECTRUM, 2010

Demand for bandwidth is rising
Mobile broadband data needs are ramping quickly and are expected to exceed desktop broadband data needs by 2014



Source: ABI Research/Qualcomm

Demand for Smart Devices is rising
In the US, Smartphone sales have surpassed those of feature phones (as well as PCs)

1 **FCC National Broadband Plan**
Recommends allocating 500 MHz of additional spectrum by 2020 and to make 300 MHz available by 2015.
FCC Technical Paper from 2010 estimates that mobile data demand will grow to between 25 to 50 times current levels within 5 years; this has been more than borne out through actual data usage levels.

2 **Growing number of broadband-enabled devices**
Already at 100% WiFi penetration for notebooks, netbooks, tablets, portable games consoles, etc. Growing demand for video & multimedia services. Video will be the major application that drives mobile traffic.

Next-Gen AG Interference Mitigation Techniques

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Ground Station Antenna Design and Pointing

1

- Ground Station (GS) antennas point to the north: limits interference to satellite systems well below required levels, as satellite uplink terminals point to the south
- GS antennas have high gain allowing low transmit power from aircraft
- GS antennas have isoflux characteristic in elevation angle to provide protection against potential interference into future NGSO uses

Aircraft Antenna Design

2

Aircraft uses directional receive antennas reducing transmit power requirement from the GS, which limits interference from GSs into GEO and NGSO satellites

Air Interface Technology Interference Mitigation Attributes

3

Multicarrier LTE modified appropriately for air to ground operation. LTE's frequency hopping and incremental redundancy (retransmission) techniques are ideal for the air to ground operational environment.

Conservative Assumptions in Rise over Thermal (RoT) Calculations into GEO-Arc (1 of 2)

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- **GS Antenna Backlobe:** The GS antenna prototype has at least 13 dB additional roll-off compared to the assumption used in the Petition.
- **Backlobe Definition:** Assumed antenna backlobe peak gain criterion vs allowing exceeding the limit occasionally.
- **Traffic Loading:** GSs were assumed to transmit at 100% duty cycle. At most GSs are loaded 75%, thus our analysis is conservative by 1.25 dB.
- **Traffic Uniformity:** GSs are assumed to be fully loaded. In actual operations, at least 50% of the beams would be idle due to non-uniformity of traffic across CONUS, thus our analysis is conservative by at least 3 dB.

Conservative Assumptions in Rise over Thermal (RoT) Calculations into GEO-Arc (2 of 2)

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- **Aircraft Antenna Roll-off:** The aircraft antenna simulations on a Hawker aircraft model shows at least 10 dB additional roll-off compared to the assumption in the Petition.
- **Antenna Polarization:** Assumed no polarization mismatch between Next-Gen AG and satellite antennas. There is at least 1 dB of mismatch averaged over all locations across the CONUS.
- **Atmospheric Loss:** Assumed 3 dB atmospheric loss from aircraft to the GS. Actually the loss is less for aircraft flying closer to the GS. Averaged over the cell area this is conservative by at least 1 dB.
- **RoT Limit:** RoT of 0.5% from GS into geo-arc, and 0.14% from aircraft, vs the 1% target. There is 3 dB margin for GS and 6 dB for aircraft for 1% RoT.

There is at least 20 dB of margin while achieving RoT < 1%.

Comparison of Qualcomm and SIA RoT Assumptions and Conclusions

- SIA and Qualcomm RoT analysis methodologies are consistent
- The difference is in two assumptions
  - RoT target assumption: 1% by Qualcomm; and 0.33% by SIA.
  - G/T of satellite assumption: 2 dB by Qualcomm; and 6 dB by SIA.
- Appropriate RoT and G/T levels should be developed through the rule making process
- Nevertheless, the proposed Next-Gen AG system has adequate margin (more than 20 dB) to accommodate SIA's proposed assumptions

Why VSATs Cause Negligible Interference to Next-Gen AG Ground Stations

- **Low Density of VSATs Near GS:** Assuming 600,000 VSAT across CONUS, 200 hexagonal GS sites covering CONUS, and uniform distribution of VSATs, there would be on average less than 10 VSATs within 10 km of a GS site.
- **Narrow Azimuthal Beamwidth of GS Antenna:** Beamwidth of GS antenna is ~2.8^{o} and the antenna rolls off significantly beyond 10 degrees from boresight. Need consider only VSATs within +/-10 degrees of GS site. Then, less than 10% of the above 10 VSATs, *i.e.,* less than 1 VSAT, would be visible to the GS antenna.
- **Narrow GS Antenna Beamwidth in Elevation:** GS antenna boresight is pointed ~1.5^{o} above horizon and its gain drops off at least 20 dB looking below horizon.
- **Low Duty Cycle & Narrow Bandwidth of VSATs**
- **High Probability of Obstruction Between VSAT and GS Beyond 1 km**
- **Next-Gen AG Technology:** Next-Gen AG air interface (multicarrier LTE) uses frequency hopping and retransmission through Incremental Redundancy (IR) techniques that will smooth out any interfered tones.

Impact of VSATs to ground station is at worst a very small capacity loss.

Interference from VSAT into Aircraft

- Qualcomm's analysis of negligible interference from VSATs to aircraft was based on maximum allowable VSAT EIRP based on satellite transponder saturation power
- SIA/Telecomm Strategies paper assumed 600,000 VSATs and that all VSATs transmit at maximum allowable EIRP of 56 dBW
- But for a satellite transponder saturation power level of ~ -93dBm/m^2
  - 600,000 VSATs, maximum allowable EIRP of 56 dBW for all VSATs, and 25% activity for all VSATs assumed by the Telecomm Strategies paper results in 12 dB over saturation of all VSAT satellite transponders. Considering that a typical transponder supporting multiple carriers is configured for 6 dB of input backoff, that transponder would be overloaded by 18 dB. Hence, the cumulative EIRP from VSAT is much smaller as analysed in the Petition.
  - Satellites with saturation power above -93dBm/m^2 would introduce slightly higher interference but it would still be negligible to Next-Gen AG system
- This is the discrepancy between Telecomm Strategies paper and the conclusion in the Qualcomm Petition

Interference from ESV/VMES into Ground Station and AMSS/ESAA into Aircraft

- **ESV/VMES**
  - ESV/VMES must come very close to the GS to cause excessive interference
  - Even if an ESV/VMES terminal comes close to the GS (or somehow has a line of sight to the GS) and the GS beam points in the direction of the ESV, some of the tones used by Next-Gen AG link may be lost, but frequency hopping and IR will compensate, resulting in (at worst) slightly lower throughput.
  - At worst, the capacity of the GS will be reduced by the fraction of the bandwidth used by ESV
- **AMSS (now ESAA) to Aircraft**
  - In response to SIA, Qualcomm considered a number of scenarios of position and altitude of ESAA and Next-Gen AG equipped aircraft
  - Calculations showed that interference to Next-Gen AG was mitigated in all realistic cases due to high roll off of Next-Gen AG antenna toward ESAA aircraft and/or the required flying distance between the two aircraft
  - In rare cases where interference occurs, it will be of very short duration and only slightly reduces capacity.