QUALCOMM Incorporated

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September 14, 2012

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 September 12, 2012, Dean Brenner, Souheil Gallouzi, Ahmad Jalali, Srikant Jayaraman, Len Schiff, and the undersigned of QUALCOMM Incorporated ("Qualcomm") discussed the above-referenced Petition for Rulemaking with the following staff from the FCC's International Bureau and Office of Engineering and Technology: James Ball, Kathleen Collins, Howard Griboff, Ira Keltz, Jennifer Manner, Geraldine Matise, Robert Nelson, 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	Geraldine Matise
(via email)	Kathleen Collins	Robert Nelson
	Howard Griboff	Jamison Prime
	Ira Keltz	Mark Settle
	Jennifer Manner	Sci-Byung K. Yi

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Next-Gen AG System

September 12, 2012

Qualcomm Incorporated

Outline

- Next-Gen AG Multiple Access Highlights
- Interference from Next-Gen AG into incumbent services
  - From ground station to geo-arc
  - From aircraft to geo-arc
- Next-Gen AG error recovery techniques
- Interference from incumbent services to Next-Gen AG system
  - Interference from VSAT/ESV/VMSE to ground station
  - From VSATs to AG aircraft
  - Interference fro AMSS to AG ground station and aircraft

Next-Gen AG Multiple Access Highlights

- Uses TDD duplexing technique
  - Ratio of uplink to downlink time slot allocation is based on future traffic requirements
- LTE-TDD, appropriately modified to cope with large cell radii, and wider bandwidth
- Minimum uplink bandwidth allocation ~2MHz
  - Small planes may only need one allocation of 2 MHz
  - Will hop frequency allocation in different transmission attempts as in LTE to mitigate interference and fading
  - Aircraft will be assigned multiples of 2 MHz based on their uplink traffic requirements

Interference from AG Ground Station to GEO-Arc

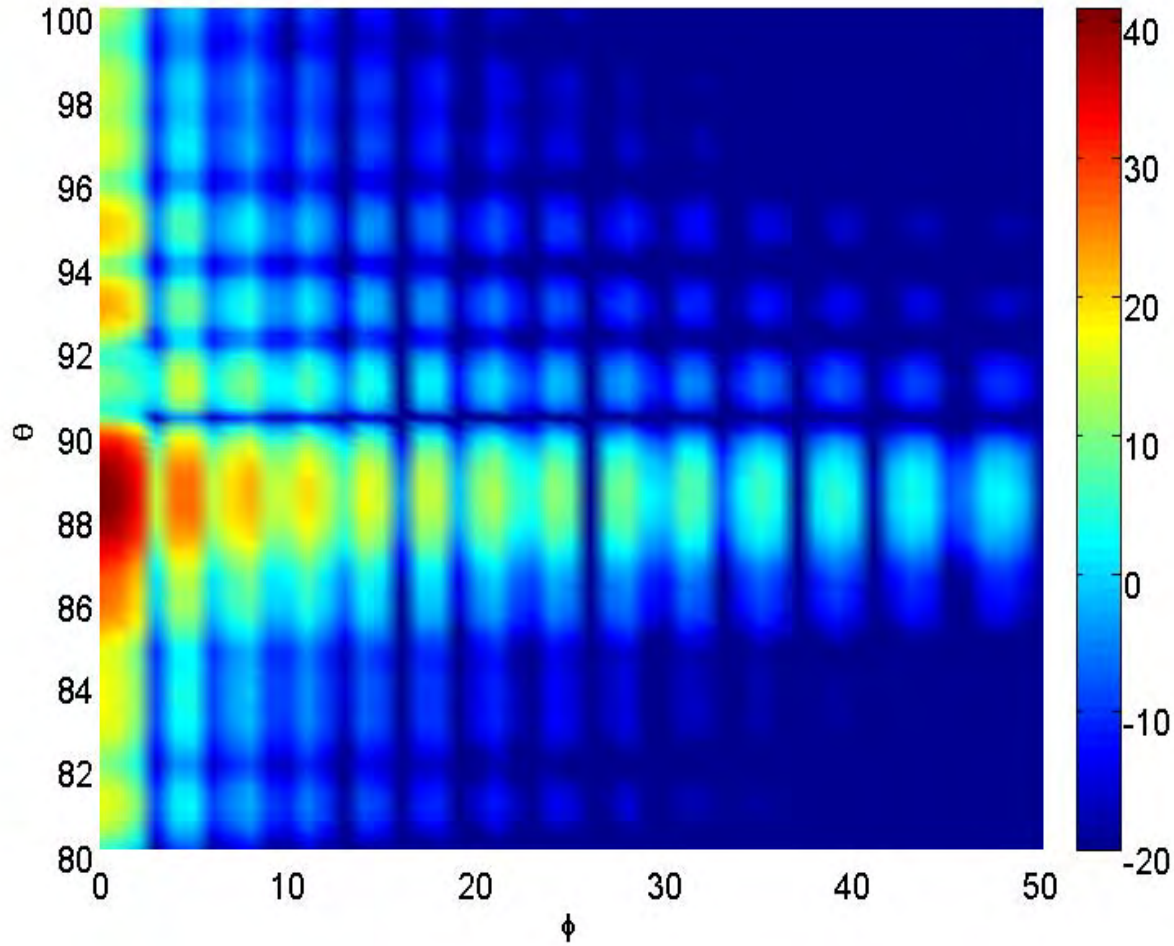
GS Peak EIRP per Beam	39.50	dBW
GS Antenna Backlobe	-37.00	dB
Number of Beam over CONUS (600)	27.78	dB
Atmospheric loss	0.00	dB
GEO Satellite Average G/T	2.00	dB/K
1/BW (BW=50 MHz)	-76.99	dB-HZ
1/Boltzmann	228.60	dB/K-Hz
Path Loss to GEO Arc (at 14 GHz)	-207.00	dB
Polarization Discrimination (GEO Satellite and BTS Antenna)	0.00	dB
I/N at Satellite Receiver	-23.11	dB
RoT	0.49	%

Conservative Assumption in Interference from AG Ground Station to GEO-Arc Calculations

- -37 dB of backlobe rolloff into geo-arc was assumed in the petition
- The ground station prototype has at least 10 dB additional rolloff even with peak gain criterion
- GSs transmit at 100% duty cycle and maximum power. At most GSs are loaded 75%, i.e. analysis is conservative by 1.25 dB.
- All GSs are fully loaded uniformly in the analysis. In reality at least 50% of the beams would be idle, i.e. analysis is conservative by at least 3 dB.
- Assumed no polarization mismatch between AG and satellite antennas. There is at least 1 dB of mismatch averaged over all location across the CONUS.
- Assumed 3 dB atmospheric loss from aircraft to ground station. But the loss is less for aircraft closer to the GS. Averaged over the cell area this is conservative by at least 1 dB.

Ground Station 3 Dimensional Pattern Simulation

- Θ is elevation angle, Θ=0 is toward zenith
- Φ is azimuthal angle
- Backlobe rolloff is more than 50 dB



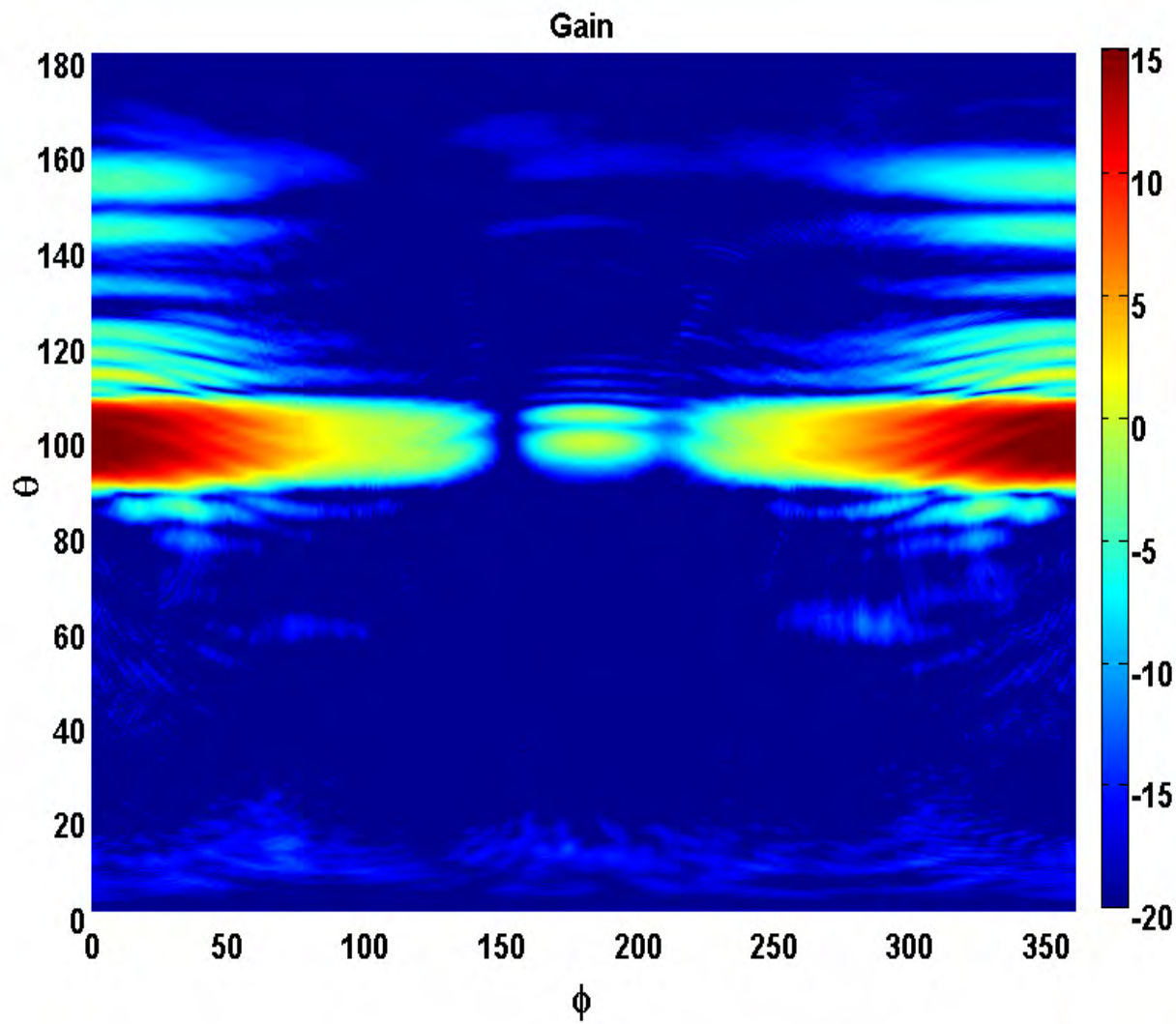
Interference from AG Aircraft to GEO-Arc

Plane EIRP per Beam	3.00	dBW
Plane Antenna Rolloff Toward GEO Arc	-20.00	dB
Number of Plance over CONUS (600)	27.78	dB
Atmospheric loss	0.00	dB
GEO Satellite Average G/T	2.00	dB/K
1/BW (BW=2 MHz)	-63.01	dB-HZ
1/Boltzmann	228.60	dB/K-Hz
Path Loss to GEO Arc (at 14 GHz)	-207.00	dB
Polarization Discrimination (GEO Satellite and BTS Antenna)	0.00	dB
I/N at Satellite Receiver	-28.63	dB
RoT	0.14	%

- Simulation on Hawker plane shows 10 dB additional rolloff

Aircraft 3 Dimensional Pattern Simulation on Hawker Plane

- Θ is elevation angle, Θ=0 is toward zenith
- Φ is azimuthal angle
- Antenna roll off of at least 30 dB toward geo-arc relative to peak gain. Had assumed 20 dB in petition.
- Expect 10 dB of margin



Next-Gen AG Error Recovery Techniques

- 3G standards such as EV-DO and HSPA use Incremental Redundancy (IR) for error recovery
- IR encodes the user information and divided the encoded symbols into multiple pieces
- The receiver attempts to decode the packet after receiving the first transmission
- If the packet is not decodable, additional redundancy bits are transmitted. Receiver combines the first transmission and second transmission to decode the packet.
- Additional transmissions continue until the packet is successfully decoded
- LTE also changes the frequency assignment (hopping) in different transmissions
- IR combined with frequency hopping are powerful techniques in mitigating interference and deep fades
- If any frequency segment is interfered with, the effect is to retransmit additional redundancy in other frequency allocations and with a slight reduction in throughput but no disruption of service

Interference from VSAT into Ground Station

- Consider 600,000 VSAT terminals
- Assuming uniform distribution of VSAT, there are 3,000 VSATs in each of the 200 hexagonal sites covering CONUS
- Number of VSATs within 20 km of the ground station at the corner of hexagon is ~42
- Since the ground station beam had beamwidth of 2.8° azimuthally and falls off rapidly, then need to consider VSATs within say 10° from beam boresight, i.e. number of VSATs becomes ~(20/120)*42 ~ 7
- But these 7 VSATs are not transmitting simultaneously, duty cycle of VSATs is low
- The GS vertical beamwidth is also ~1.5° and is pointed at about 1.5° above horizon and drops off rapidly below horizon
- VSATs transmit powers are typically far less than the maximum allowable
- Most of these 7 VSATs will likely suffer blockage at large distances & low angles
- The probability of more than one VSAT transmitting and having a free space propagation toward ground station is small
- The impact of VSATs to ground station is at most a very small (<1%) reduction in capacity

Interference from VSAT into Aircraft

- Consider 600,000 VSAT terminals
- Satellite transponder saturation power level configured to support many VSATs is ~-93 dBm/m^2
- The number of VSATs, maximum allowable EIRP of 56 dBW for all VSATs, and 25% activity for all VSATs assumed by Telecomm Strategies report results in 12 dB over saturation of satellite transponder. Considering that for a transponder supporting multiple carriers needs at least 6 dB of backoff, then the transponder would be overloaded by 18 dB.
- This is the discrepancy between Telecomm Strategies paper and the conclusion in Qualcomm Petition

Interference from AMSS into Aircraft

- Telecomm Strategies assumed distance between planes of 3,000 feet and 0 dB gain from AG antenna toward AMSS transmitter
- Both these assumptions are highly pessimistic
- Planes flying at same altitude must be at least 5 NM apart. Even with the assumption of 0 dB AG antenna gain toward the AMSS transmitter the C/(I+N) is ~6.2dB at the AG receiver well above that required for the highest provisioned data rate.
- Two planes 3,000 feet apart must be at different altitudes. For this geometry, the look angle from AG antenna to AMSS transmitter is 45 degrees. At 45 degrees, the gain of the AG antenna is less than -20 dB resulting in a C/(I+N) of better than 6.2 dB at the AG receiver.

Interference from AMSS into AG Ground Station

- Telecomm Strategies assumed 0 dB AMSS antenna gain toward the AG ground station antenna at 300 km. This is pessimistic because the AMSS antenna is mounted on the top of the aircraft and the ground station is below horizon with respect to the AMSS terminal.
- Since the AG beam is quite narrow (2.8°) the AMSS aircraft needs to be within 7 km of the AG aircraft at 300 km radius to even be in AG's beam. The probability of two planes with this proximity is very low.
- Even if the AMSS terminal caused interference to the ground station, the interference would be to the uplink of a plane that is flying close to the AMSS aircraft, and the impacted bandwidth is very small ~3 MHz, and the capacity impact on the affected AG aircraft uplink is very small