Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Amendment of the Commission's Rules to Establish a Next-Generation Air-Ground Communications Service on a Secondary Licensed Basis in the 14.0 to 14.5 GHz Band	)	RM-11640

COMMENTS OF THE
NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies (hereinafter, CORF), hereby submits its Comments in response to the Commission's May 15, 2012, Public Notice (DA 12-767) in the above-captioned docket, regarding a Petition for Rulemaking filed by Qualcomm to establish an air-to-ground mobile service at 14.0 to 14.50 GHz (*Petition*).[1] In these Comments, CORF discusses the importance to the Radio Astronomy Service (RAS) of observations at 14.47 to 14.50 GHz. CORF recognizes the importance of sharing spectrum among different services where feasible, but notes that an aeronautical service transmitting down to Earth in this band could cause significant interference problems for RAS facilities. Qualcomm has properly proposed that operators of such a new aeronautical service be required to enter into coordination agreements to protect RAS facilities.

[1] The International Bureau revised the filing deadline for comments in its May 25, 2012, *Letter to Patricia Cooper*, DA 12-835.

However, as discussed below, such coordination will likely be considerably more challenging than coordination with the RAS by other commercial users of this band, such as operators of aeronautical mobile satellite services. Accordingly, careful consideration of and commitment to solutions will be essential if this new service is authorized.

I. Introduction: The Role of Radio Astronomy, and the Unique Vulnerability of Passive Services to Interference.

Because it represents the interests of the passive scientific users of the radio spectrum, including users of the RAS bands, CORF has a substantial interest in this proceeding. RAS observers perform extremely important yet vulnerable research.

As the Commission has long recognized, radio astronomy is a vitally important tool used by scientists to study our universe. It was through the use of radio astronomy that scientists discovered the first planets outside the solar system, circling a distant pulsar. It has also enabled the discovery of organic matter and prebiotic molecules outside our solar system, leading to new insights into the potential existence of life elsewhere in our galaxy. Measurements of radio spectral line emission have identified and characterized the birth sites of stars in our own galaxy, the processes by which stars slowly die, and the complex distribution and evolution of galaxies in the universe. Radio astronomy measurements have discovered the cosmic microwave background, (CMB), the radiation left over from the original big bang after it cooled to only 2.7 degrees above absolute zero. Later observations discovered the weak fluctuations in the CMB of only one-thousandth of a percent, generated in the early universe, which

later formed the stars and galaxies we know today. Radio observations uncovered the first evidence for the existence of a black hole in our galactic center, a phenomenon that may be crucial to galaxy formation. Observations of supernovas have allowed us to witness the distribution of heavy elements essential to the formation of planets like Earth, and of life itself.

However, the critical science undertaken by RAS observers cannot be performed without access to interference-free spectrum. Notably, the emissions that radio astronomers receive are extremely weak—a radio telescope receives less than 1 percent of one-billionth of one-billionth of a watt (10^{-20} W) from a typical cosmic object. Because radio astronomy receivers are designed to pick up such remarkably weak signals, radio observatories are particularly vulnerable to interference from in-band emissions, spurious and out-of-band emissions from licensed and unlicensed users of neighboring bands, and emissions that produce harmonic signals in the RAS bands. Even weak, distant in-band man-made emissions can preclude RAS use.

In sum, the important science conducted by radio astronomers cannot be performed without access to interference-free spectrum. Loss of such access constitutes a loss for the scientific and cultural heritage of all people, as well as a loss of the practical applications from the information learned and the technologies developed.

Specifically at issue in this proceeding is RAS observation at 14.47 to 14.50 GHz. In the United States, this band is used for a wide range of scientific investigations, including the study of star formation, active galaxies, and galaxy evolution. Within this allocation there are unique emission lines including the 14.488 GHz formaldehyde line

used to study the inner regions of our Milky Way Galaxy, as well as other galaxies.[2]

II. The Proposed Air to Ground Transmissions Would Require Challenging Coordination in Order to Protect Radio Astronomy Observations.

RAS observations at 14.47 to 14.50 GHz are protected pursuant to Footnotes US 203 and US 342. Footnote US 342 states that "... all practicable steps shall be taken to protect the radio astronomy service from harmful interference. Emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service." Consistent with the text of that Footnote, CORF asserts that air-to-ground (ATG) transmissions within the RAS band have the potential to be severely damaging to scientific investigations. This potential exists because radio antennas are very sensitive to radiation from the sky, since the main beam and higher inner sidelobes are pointed skyward.

Coordination between the proposed ATG service and the RAS would be challenging, given the high velocity and large numbers of aircraft potentially making use of ATG communications, and the dynamic use of the spectrum by radio observatories that can (and often do) switch between bands in seconds. Qualcomm's *Petition* recognizes that the RAS should be protected in a manner consistent with the requirements of Footnotes US 203 and US 342, and it suggests that Qualcomm expects an ATG operator to enter into a coordination agreement with the National Science Foundation to facilitate such protection (*Petition* at footnote 43). Specifically, Qualcomm suggests that an ATG operator would enter into a coordination agreement

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[2] This line is recognized by the ITU as one of the radio frequency lines of greatest importance to radio astronomy. *See,* ITU-R RA.314-10, at Table 1.

similar to that entered into by the Row 44 provider of aeronautical mobile satellite service (*Petition* at Appendix A, footnote 53).

However, coordination with an ATG service would likely be more challenging than coordination with an aeronautical mobile satellite service. First, unlike the case with AMSS, the ATG 14-GHz transmissions would be downlinks, not uplinks. The opportunity for direct interference over a larger distance, in fact the entire line of sight, is accordingly much greater. This issue is made even more complex by the number of U.S. RAS facilities that observe in this band. These facilities include the entire Very Large Array (VLA), the 10 antennas of the Very Long Baseline Array (VLBA), the Green Bank Telescope (GBT), the 40-meter telescope at the Owens Valley Radio Observatory (OVRO), and the Owens Valley Solar Array.[3] CORF notes that, in addition, the Ku-band of NASA's Tracking and Data Relay Satellite System (TDRSS) uses the frequency band 13.4 to 14.05 GHz to return data from satellites in geosynchronous orbits to the White Sands Complex in New Mexico.

Any effective coordination would require establishing exclusion zones around RAS facilities to avoid interference. As the Commission has recognized in an analogous situation, ITU Recommendation ITU-R M.1643 states that aircraft Earth stations should cease transmission in the 14.47 to 14.5 GHz band and meet PFD limits in the 14.0 to 14.47 GHz band when within the line of sight of radio astronomy facilities

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[3] The OVRO 40-m telescope is used to monitor the variability of active galactic nuclei, and thus its observations are time critical in the sense that if an observation is lost because of radio frequency interference, repeating the observation does not recapture all of the lost data.

observing in the 14.47 to 14.5 GHz band.[4] The principle underlying this line of sight requirement would be even more critical and applicable in the case of ATG downlinks. Such exclusion zones would necessitate care in the placement of the ATG ground stations, as well as procedures to avoid illumination of RAS facilities by aircraft.

Significant consideration must also be paid to out-of-band emission (OOBE) limits for ATG operations. As is noted above, because RAS equipment sensitivity is extremely high, only very low levels of spurious emission or OOBE from neighboring bands (e.g., 14.0 to 14.47 GHz) can be tolerated. Protection of the RAS from transmitters operating in adjacent bands is discussed in ITU Recommendation ITU-R RA.517-4, which references detrimental interference levels listed in Annex 1 of ITU Recommendation ITU-R RA.769-2.

III. Conclusion.

CORF recognizes the importance of sharing spectrum among different services when feasible, but notes that an ATG service transmitting in the 14.0 to 14.5 GHz band could cause significant interference problems for RAS facilities. Careful consideration of and commitment to solutions, including coordination agreements and exclusion zones,

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[4] *See, Order,* In the Matter of Panasonic Avionics Corporation; Application for Authority to Operate Up to 50 Technically Identical Aeronautical Mobile-Satellite Service Aircraft Earth Stations in the 14.0-14.4 GHz and 11.7-12.2 GHz Frequency Bands, 26 FCC Rcd 12557, 12568 (Int'l. Bur. 2011), *citing* ITU Recommendation ITU-R M.1643, Annex 1, Part B [that *Order*'s reference to Part B appears to be a typo; the correct citation appears to be Part C]. The limits agreed to in the coordination agreement between Panasonic and the National Science Foundation, which were included as a condition in the operator's FCC authorization, require that aggregate PFD be limited to -221 dBW/m^2/Hz at the National Radio Astronomy Observatories and -189 dBW/m^2/Hz at other specified radio astronomy sites in the United States. *Id.*

will be essential if this new service is authorized.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

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July 16, 2012

Appendix

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