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

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In the Matter of	)	
	)	
GE HEALTHCARE	)	ET Docket No. 08-59
	)	
Petition for Rulemaking	)	
	)	

To: The Commission

COMMENTS ON GE HEALTHCARE PROPOSAL

AEROSPACE and FLIGHT TEST RADIO
COORDINATING COUNCIL

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SUMMARY

Aerospace and Flight Test Radio Coordinating Council ("AFTRCC") opposes the proposal submitted by GE Healthcare ("GEH") for a secondary allocation in a band allocated for flight testing, namely 2360-2395 MHz.

The GEH proposal rests on fundamental errors regarding the nature of flight test telemetry and flight test operations. Among other things, GEH erroneously assumes that flight test receive antennas seldom operate at low-elevation angles where they would be especially vulnerable to interference from GEH's body sensor networks ("BSNs"). In point of fact, telemetry receive dishes routinely operate at elevations of 1.5 degrees or less. This has the effect of placing the main beam of the telemetry dish squarely in the line of fire from GEH's co-channel transmitters. When it is recognized that telemetry receive antennas are designed to be extraordinarily sensitive with gains ranging from 26 dBi to as high as 40 dBi, it should not be surprising that they are susceptible to the type of co-channel interference that BSNs would generate.

Adding to the problem is GEH's proposal to rely upon a frequency-hopping technology. According to GEH's vision, any BSN receiving interference would automatically hop to a "vacant channel." However, the technology offers no respite in those areas of the country where the entirety of the band 2360-2395 MHz is in use for flight test telemetry at any given time, e.g. the US Southwest where there is a concentration of major test ranges.

Moreover, frequency hopping makes interference to flight testing more likely -- not less. The reason is simple: BSNs will be located well within interference range of flight test receive antennas. If a BSN receives interference from an aircraft taking off for a test flight, it will be prompted to hop to a different channel, but the channel it hops to could be in active use for

tracking a distant test aircraft which the BSN, with its no gain antenna, would never hear. The result would be interference to the telemetry for that second aircraft. But there is more.

GEH has failed to take any account for the likelihood of aggregate effects. When it asserts the flight test telemetry would only receive interference if a BSN were a short distance away, its analysis is based on single-entry only. However, there can be absolutely no assurance that only one BSN would be in operation in any given metropolitan area. On the contrary, GEH's business case is built upon the hope that it could market many BSNs in any given area. Thus, GEH contemplates that BSNs would be "ubiquitous." It is impossible to predict -- much less control -- where they would be.

Field tests confirm that devices at the 1 mW level proposed by GEH cause interference to the telemetry stream as engineering analyses predict: Co-channel signals at that level cause <u>massive</u> <u>interference</u> to the point where the telemetry dish loses track of the test aircraft, and actually begins tracking the 1 mW signal source!

Any notion that an allocation would be acceptable because BSNs would be secondary to flight testing is illusory. There is no way of enforcing the obligation that goes with secondary status; namely, the obligation not to cause interference to primary services. Similarly, from the spectrum policy standpoint, the Commission has worked long and hard to confine medical telemetry devices to bands where it would not be subject to interference from other services. Precisely the opposite would occur if BSNs were placed in this flight test band.

The interference to flight testing would place at risk the lives of test pilots as well as persons on the ground. It would interrupt an essential lifeline in what is, and will remain, a high-risk endeavor. Interference will also injure the productivity of the nation's single most important export industry, aerospace.

For these, and the many other reasons articulated in the Comments attached, the GEH Proposal should be promptly dismissed or denied.[*]

[*] AFTRCC's membership includes the Companies shown on page iv.

Aerospace and Flight Test Radio Coordinating Council Members

Bell Helicopter A Textron Company

Boeing

Bombardier

Cessna A Textron Company

Honeywell

Gilfillan ITT Industries

L3 communications Integrated Systems

Lockheed Martin

Lockheed Martin Excellence Enterprise Information Systems

Northrop Grumman

ISA Integrated Systems and Aerostructures Sector

Raytheon

Electronic Sensors & Systems Sector

Rockwell Collins

Sikorsky A United Technologies Company

Agilent Technologies

Bechtel Nevada

Herley Lancaster

L3 communication Telemetry-West

L3 Telemetry East

L3 communications Communication Telemetry - East

Spectrum Certification Solutions Inc

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COMMENTS ON GE HEALTHCARE PROPOSAL

Aerospace and Flight Test Radio Coordinating Council ("AFTRCC"), by its counsel, hereby submits its Comments on the proposal by GE Healthcare ("GEH" or the "Petitioner") for a secondary allocation in the 2360-2400 MHz band. These Comments are submitted pursuant to Public Notice, DA 80-953, April 24, 2008. As shown below, GEH's proposed secondary service would cause harmful interference to important flight test operations currently allocated in the band. Therefore GEH's proposal is fundamentally flawed and should be dismissed without further consideration.

I.

INTRODUCTION

AFTRCC is an association of the nation's principal aerospace manufacturers. AFTRCC was founded in 1954 to serve as an advocate for the aerospace industry on matters affecting spectrum policy. Among its many accomplishments is AFTRCC's role in obtaining allocations of spectrum for flight test telemetry, including 2360-2390 MHz.

AFTRCC is also the recognized non-Federal Government coordinator for the shared, Government/Non-Government spectrum allocated for flight testing. AFTRCC works closely with Government Area Frequency Coordinators, who are responsible for Federal Government use of the spectrum, in an effort to ensure that interference-free flight test operations are protected, and flight safety maximized.

II.

BACKGROUND

GEH's proposal contemplates a secondary allocation for so-called body sensor networks (or "BSNs"), devices which would provide wireless links from individual sensors on a patient's body to a monitoring unit, in place of wire-based sensors. The monitoring unit would be either worn by the patient or located nearby for further transmittal upstream to medical personnel. According to the Petitioner, "BSNs must be capable of reliably conveying unprocessed life-critical monitoring data to devices that are responsible for processing and primary alarming. In these scenarios, if the link were lost, a serious event such as arrhythmia or hypoxia could go unalarmed."[1] Given the critical nature of the communications links, GEH stresses the importance of "extremely reliable" communications links with a predictable quality of service.[2]

BSN's would not be limited to hospitals. On the contrary, GEH contemplates that BSNs would be used on a mobile basis by patients outside the hospital setting (e.g. in "patient homes")[3] and "would become ubiquitous."[4] GEH further states that "due to the need to share with other

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[1] Comments of GE Healthcare filed October 31, 2006 in ET Docket No. 06-135 at 8; see also Reply Comments of GE Healthcare filed December 4, 2006 at 5.

[2] Comments at 7; see also Ex Parte Comments of GE Healthcare filed December 27, 2007, page 5 (referencing as an example monitoring a patient at home with "chronic heart failure") and at page 7 ("wireless quality of service ("QOS") will be a critical consideration for BSN design ...").

[3] Reply Comments filed December 4, 2006 in ET Docket No. 06-135, at 4.

[4] Comments at 11.

spectrum users, the Commission should allocate a sufficiently large quantity of spectrum such that the frequency agile and low power BSN devices will be able to avoid frequencies in use by other licensees ....”[5]

Initially, GEH estimated that five to ten megahertz of clear spectrum within the allocated band(s) would be required “*after* taking into account spectrum that may be in use by incumbent users at any point in time ....”[6] Within this spectrum requirement, GEH envisions the channels using approximately one megahertz each. However, in its recent Ex Parte Comments GEH increased the spectrum requirement to 40 MHz, “at least 20 megahertz [of which] will need to be available ... at any given time and location.”[7]

Likewise, GEH initially proposed a power limit of -10 dBm. Recently, however, it has increased the proposed power to 0 dBm (1 mW EIRP).[8]

GEH initially referenced several candidate bands including 420-450, 2300-2305, and 2395-2400 MHz, but now proposes to utilize only 2360-2400 MHz.[9] Within this band, 2360-2395 MHz is allocated for flight test telemetry (also known as aeronautical mobile telemetry, or “AMT”).

The Petitioner has presented information concerning the potential for interference between AMT, on the one hand, and BSN devices, on the other hand. GEH argues that there would be large separation distances between aeronautical mobile transmitters and BSNs, but that

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[5] Reply Comments at 6.

[6] *Id.* (emphasis in original).

[7] Ex Parte Comments at 8-9.

[8] *Compare* July 25, 2007 Ex Parte Notice at 15 *with* February 6, 2008 Ex Parte Notice at 18.

[9] *Compare* Reply Comments at 7-13 *with* February 6, 2008 Ex Parte Notice at 13.

a 10 km separation would be enough to protect the BSNs.[10] Conversely, GEH claims that a mere 218.2 meter separation is sufficient to protect flight test telemetry from BSNs.[11] GEH concludes that "BSN devices should be able to share with aeronautical operations…."[12]

The Petitioner premises compatibility on the notion that flight testing is conducted in "remote areas," and that telemetry receive antennas are pointed at high elevation angles, minimizing the chances for BSN transmissions into the main beam of the receive dish.[13] It further asserts that the protection levels set forth for flight test telemetry in International Telecommunication Union Recommendation M. 1459 are "overly conservative;" that flight testing receives fundamental and spurious emissions from other sources; and that BSN transmissions would not, therefore, represent harmful interference.

There are two fundamental problems with the GEH proposal, either one of which is sufficient to dismiss the notion of a secondary allocation for BSNs in the band 2360-2395 MHz. The first is the likelihood of harmful interference to life-critical BSNs from aeronautical telemetry. The second is the likelihood of interference from ubiquitous BSNs to extremely sensitive aeronautical telemetry receivers. Both of these stem from GEH's lack of understanding of the business of flight testing. In order to better appreciate the negative consequences of allowing BSNs in flight test spectrum, an overview may be helpful.

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[10] Reply Comments filed December 4, 2006 at 9 and Appendix A.

[11] Ex Parte Notice filed February 6, 2008 at 18.

[12] *Id*. at 9.

[13] December 4, 2006 Reply Comments at page 9 *quoting from Seventh Report and Order* in Docket Nos. 00-258 and 02-8, FCC 04-246, released October 21, 2004 at para. 47.

III.

FLIGHT TEST TELEMETRY: AN OVERVIEW

Flight testing is vital to the production of safe and efficient aircraft. So vital, that before an aircraft can be placed into commercial service, it must be certified as airworthy by the Federal Aviation Administration. See 14 C.F.R. Part 21. FAA airworthiness certificates are, in turn, based on exhaustive data compiled during flight testing.

From the days of the Wright brothers, advances in the science of manned flight have depended largely upon tests conducted under actual flight conditions. In the early days, data were essentially limited to the perceptions of the pilot and observers on the ground. Over time, as instrumentation and the use of wind tunnels developed, the types of data collected were expanded. Ultimately, on-board instrumentation such as photo-recorders, data recorders, and oscilloscopes provided information concerning the performance and condition of the aircraft far beyond that available previously.

However, reliance upon airborne recording equipment, and the methods generally used for the reduction and analysis of such data, presented a number of drawbacks. These problems included the inability of engineers to monitor the test while in progress; delays in processing, transporting and analyzing data; and the loss of data if the aircraft suffered a catastrophic failure -- data which might have revealed the cause. Radio telemetry helped solve all of these problems.

A flight test telemetry system generally consists of three main components: Airborne instrumentation and transmitting equipment; ground receiving and recording stations; and data reduction, analysis and monitoring equipment. Exhibit A includes a block diagram description of a typical flight test data reduction center and the flow of data.

As the development and testing of an aircraft progresses, detailed performance data must be accumulated from hundreds -- and in some cases thousands -- of points within the plane,

involving the power plant, the airframe, the control surfaces, the avionics, and virtually every other significant characteristic of the aircraft.

For example, pressure data provides information concerning airspeed, altitude, engine power, performance, airfoil and fuselage pressure, and loads on the wing structure.

Temperature data is collected for aircraft exhaust outlets, shrouds, fluids such as fuel, engine and hydraulic oil, engine thrust, outside air temperature, and the effect of heat upon structural components.

The forces that the pilot must exercise to control the aircraft, the forces on control surfaces, the stresses that take place on the surface of the structure, such as spar caps, landing gear, engine mounts, fuel flow rates and engine cooling ducts are all among the factors for which actual flight test data are required.

Measurements of aircraft maneuverability, its attitude in relation to the air stream (its "angle of attack") as an indication of the stability necessary to determine its structural integrity, the aircraft's capacity for acceleration and its structural strength and pliability under the resulting loads, must all be measured and carefully checked. This description of items involved in flight testing is simply illustrative; it is far from complete.

By means of telemetry, these data are transmitted to ground stations and thence, via relay facilities, to a point where the data can be analyzed by the engineers participating in the flight test evolution.

Complicating the flight test process are the number of variables which can impact scheduling. In order to prepare an aircraft for flight, the availability of a wealth of assets, technical and human, must be coordinated. Hundreds of manufacturer employees are typically involved in any one test. The aircraft or missile to be tested, of course, must be certified as ready

for flight. Ground tracking stations and other test equipment, such as range-finders, cameras, and theodolites, must be calibrated and ready. No less importantly, these and other range assets in limited supply must be scheduled for a given flight to ensure their availability. Chase planes, tanker aircraft, and telemetry relay aircraft must be ready and available. Search and rescue helicopters must be ready and available. Airspace clearances must be requested and obtained for a time slot when all of the above-referenced assets are available.

Finally, flying conditions must be satisfactory: In order to maximize pilot safety and facilitate video recording, test flights are normally limited to daylight hours and good weather. In the case of helicopters and certain other tests, flying conditions may be even more stringent: Such tests are often conducted during early daylight hours in order to take advantage of "quiet air" (reduced air turbulence) at this time of day.

Since flight test activities at a given facility must compete for the same limited assets and time slots, as well as for spectrum, with other manufacturers and facilities in the region, it becomes readily apparent why flight testing is so expensive: Many of thousands of dollars per flight in the case of a new aircraft, and more than this in the case of certain Government test programs.

A. Flight Test Telemetry and Safety

Perhaps the most important application of aeronautical telemetry involves what is known as "flutter" tests. Modern aircraft must be checked through their full speed and altitude ranges in order to determine whether there is any tendency toward rapid, violent and destructive vibration. Such vibrations, which may be induced by air loads acting on the wings or other parts of an aircraft, can build up with alarming suddenness. Once started, they are extremely difficult, and sometimes impossible, to stop. Unless detected early and stopped immediately, such vibrations

can cause an aircraft to disintegrate. The action is so rapid and violent that the aircraft may appear to “blow up” in mid-air.

Telemetry allows flight test engineers at ground control rooms to observe the response of critical components to excitation at short intervals of airspeed. It allows flight test personnel to advise the pilot if a serious condition is developing and also allows a prediction of the conditions that will result with an increase in speed. Aircraft manufacturers perform these tests in order to provide safe products pursuant to stringent requirements for such operations, mandated by the FAA. See 14 C.F.R. Section 21.35.

This type of testing is also applied to other critical safety items. One example is the pitch-roll coupling of high performance aircraft, e.g. maneuvers involving high-speed pullouts. These can involve conditions not easily predicted and/or recognized by a pilot. Telemetry allows flight test engineers to monitor critical sideslip angles, loads and other factors too numerous for the pilot to observe, and to advise the pilot of these conditions on a real-time basis.

Telemetry has saved many aircraft, pilots, and persons on the ground. One of the more notable examples involved the very first prototype of an advanced tactical aircraft in use today. The aircraft, worth hundreds of millions of dollars, was being flown from the manufacturing plant to Patuxent River Naval Air Station, where it was to undergo extended test and evaluation.

On the day of the flight, technicians at Patuxent established contact with the aircraft while at an altitude of 42,967 feet in the vicinity of Pittsburgh. Telemetry readouts immediately showed a serious problem: Temperature parameters in certain avionics equipment were dangerously out of limits. The pilot had no way of knowing this. Based on the real-time telemetry readings, engineers at Patuxent were able to warn the pilot and, together, the pilot and engineers were able to effect a series of corrective measures which ultimately saved the aircraft.

The use of telemetry also averted disaster during testing of a device intended to prevent a particular type of aircraft from slipping into an uncontrollable spin. The device in question, an aileron-rudder interconnect, was designed to improve aircraft stability so as to make a spin less likely.

During one of the device's early tests, telemetry readings showed a potentially fatal mistake: It had been miswired, such that its use would cause -- not prevent -- a spin. If the pilot had activated the device as planned, the aircraft would likely have crashed. Fortunately, telemetry observations alerted ground engineers to the problem, and they were able to warn the pilot, allowing him to return safely.

Given the dangers, communications that directly affect the lives of pilots, ground crew and observers occur quite often. At one test range it has been conservatively estimated that an in-flight emergency occurs about once every other month. Thus, aeronautical telemetry is a vital link in detecting problems early.

B. Flight Test Telemetry and Global Competitiveness

In today's intensely competitive global marketplace, flight test telemetry plays a significant supporting role in enhancing the competitiveness of the U.S. aerospace industry against foreign competition.

Delays of even one-hour in a flight test can cost $50,000 for labor alone. For certain programs, the cost of re-scheduling a single flight test can exceed $1 million. These are direct costs. Indirect costs become far more significant in terms of delayed delivery and time-to-market competitiveness: To put it in concrete terms, with interference-free telemetry it is estimated that the test program for one type of new aircraft could be completed in four months. Without interference-free telemetry, the same test program could require on the order of 12-18 months.

The global competitiveness of the aerospace industry is vital to the U.S. economy. Aerospace is the leading contributor to a positive balance of trade for the United States, and has been so for years. In 2007, for example, aerospace exports exceeded imports by more than $61 billion. The next nearest industry (oilseed and grain farming) was at $28.8 billion. During this same year, the aerospace sector employed 645,600 Americans.[14]

In short, the health and productivity of the aerospace industry is essential. The availability of interference-free telemetry spectrum plays a mission-critical role in maintaining that health and productivity.

C. Flight Test Telemetry and Spectrum Allocations

Flight testing is allocated two bands for telemetry, 2360-2395 MHz (S-band) and 1435-1525 MHz (L-band). While other bands are also allocated (e.g., 2.2 GHz in the case of Government testing), the S-band and the L-band are primarily used for testing of manned aircraft (as opposed to missiles and unmanned aircraft) for civil and military programs. Telemetry operations conducted in these bands have important safety-of-life implications.[15]

IV.

DISCUSSION

BSNs will cause interference to flight testing. Flight testing will cause interference to BSNs. The two are incompatible, and GEH's proposal should be denied, or dismissed.

[14] Source: Aerospace Industries Association.

[15] Additional spectrum was allocated for aeronautical telemetry by the 2007 World Radiocommunication Conference. However, the allocation was on a shared basis with a number of incumbent services, and is for non-safety-related applications only. *See, e.g.*, Res. COM 4/2 (WRC-07). The band 2390-2395 MHz is shared with amateurs who utilize the band for fast-scan television; there are only a very limited number of such facilities.

A. **Flight testing will cause interference to BSNs.**

With respect to interference from flight test telemetry to BSNs, there can be no assurance that aeronautical telemetry operations would be able to maintain a separation of 10 km as computed by GEH, much less the 17.8 km (or even as much as 71 km) separation -- depending on the assumptions about building/wall attenuation -- as computed in the Engineering Statement of Daniel G. Jablonski (Exhibit C). On the contrary, flight test centers are often co-located with aircraft manufacturing plants in or near major metropolitan areas. Examples of these include St. Louis, Wichita, Seattle, and Dallas-Ft. Worth.

Aircraft routinely transmit telemetry while on the ground during pre-flight calibration and check-out, on take-off, on transit to operating areas, on transit back to base, on landing approach, and upon taxi to the hangar. Runway performance, takeoff and landing tests can keep an aircraft in and near to an airport for days, and sometimes weeks. BSN users would be located in their homes and other non-hospital settings in proximity to these airports. In these and other areas, there is a material risk that patients with life-critical BSN devices would be located well within interference range of test aircraft.

To be sure, GEH seeks a secondary allocation, an allocation that theoretically carries with it no protection from harmful interference, and the obligation to avoid causing harmful interference to primary services. But the consequences of interference to medical telemetry from test aircraft are potentially fatal, as GEH itself indicates. Such interference would put the Commission in an untenable position.[16]

[16] Complicating the sharing scenario is the fact that the flight test community is actively pursuing techniques which look to make even more efficient use of the limited spectral resources available. Those techniques will enable operators to dynamically adjust the amount of spectrum devoted to any given test article during the mission so as to increase the spectrum available for another test article, e.g. one about to enter a critical maneuver. Such techniques will involve up-link transmissions from ground stations to aircraft and missiles at power levels of 100 watts and possibly much higher. Transmit power at such levels would likewise impact BSNs. The further development of this important primary service should not be constrained by a secondary allocation in this band.

Underscoring the problem is the Commission's long and difficult history with the regulation of "secondary" medical telemetry devices.

In order to achieve greater spectrum efficiency in the UHF band, the Commission determined in 1995 to allow high-power private land mobile radio ("PLMR") operation on channels which had been reserved for low power use and had long been used on a secondary basis for medical telemetry.[17] Despite the secondary status of medical telemetry, the Commission found itself forced to freeze the filing of high-power applications.[18]

Thereafter, in June 2000 the Commission established the Wireless Medical Telemetry Service ("WMTS").[19] It concurrently extended the PLMR freeze for another three years in order to allow more time for hospitals to migrate from 460-470 MHz to WMTS channels where they could operate free of harmful interference.[20] The Commission warned medical telemetry operators that:[21]

> Our goal in this proceeding is to not only provide spectrum where medical telemetry equipment can operate without interference, but also to encourage medical telemetry users to eventually migrate out of the current bands. Despite the fact that medical telemetry has no legal protection from interference in these bands, the fact remains that the Commission has had to take steps to protect medical telemetry from interference because it is used to protect safety of life. The steps the Commission has taken, such as the freeze in the 450-470 MHz band and the requirement for DTV stations to notify nearby health care facilities, affect other parties. We therefore encourage medical telemetry users to migrate out of the current frequency bands and into the new frequency bands.

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[17] *Report and Order* in PR Docket No. 92-235, 10 FCC Red 10076 (1995).

[18] *See* Public Notice, 10 FCC Red 9995 (WTB 1995).

[19] *Report and Order* in ET Docket No. 99-255, 15 FCC Red 11206 (2000).

[20] *Id.* at 11206 ("This action addresses consumer concerns that medical telemetry devices are increasingly at risk of harmful interference due to more extensive use of spectrum resources by other applications).

[21] *WMTS R&O*, 15 FCC Red at 11225 ¶ 57.

Despite this, three years later the American Hospital Association (as reported in the Commission's words) that there had been "virtually no migration of medical telemetry systems to the WMTS frequencies")[22] AHA asked that the freeze -- by then in its eighth year – be maintained and that medical telemetry operators be given yet another three years. Months of negotiations between and among the Commission, the Land Mobile Communications Council (representing the interests of PLMR licensees), the Food and Drug Administration, and hospital associations followed, finally resulting in a two-year extension to December 31, 2005. An essential element of the plan was a requirement that hospitals register their telemetry equipment, both that still in the 460-470 MHz band and that to be installed in the WMTS band.

In other words, ten years and countless man-hours have been devoted to the problem of simply clearing this one band of medical telemetry devices. During all this time, the public interest has been disserved by the inability to put the 460-470 MHz band to more efficient use as determined by the agency.

However, the difficulties have not been confined to 460-470 MHz. Some will recall the incident in 1998 when the Commission was forced to order the shut-down of WFAA (DT) in Dallas due to the interference it caused to cardiac telemetry at the Baylor University Medical Center and Methodist Dallas Medical Center. This prompted the Commission and the FDA to issue an unusual "Joint Statement ... Regarding Avoidance Of Interference Between Digital Television And Medical Telemetry Devices,"[23] and OET to issue a fact sheet on the same subject.[24]

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[22] Public Notice, July 9, 2004, at 2.

[23] http://www.fcc.gov/bureaus/engineering_technology/news_releases/1998/nret8003.html Ad ("fortunately no patients were significantly affected.")

[24] http://www.fcc.gov/oet/faqs/medical.html

Given the clear purpose for which GEH would market its device -- "life-critical" communications -- it is passing odd that GEH would seek an allocation which the Commission has spent years attempting to migrate medical telemetry away from. Perhaps it is a tacit recognition of the Commission's policy as articulated eight years ago in the WMTS *Report and Order:*

> We wish to underscore that we do not anticipate any further allocations for medical telemetry devices and expect manufacturers and the health care community to ensure that this spectrum is used efficiently to meet long-term needs.

Id. at para. 11; *accord* para. 46.

Regardless of its reasoning, the GEH proposal would have the Commission plunge back into the very morass the agency struggled to escape during DTV conversion and UHF re-farming with palpable risk to patient safety.

But the risk here is not limited to patients. As discussed in the next section, the risk is to aircrews as well.

B. <u>BSNs will cause interference to flight test telemetry.</u>

Preliminarily, it should be noted that telemetry transmitters are on board the test aircraft, and are typically ten watts output with a unidirectional antenna. Telemetry receivers, however, are on the ground and utilize parabolic, dish-type antennas, three to twelve feet in diameter. Telemetry antennas are very high gain, on the order of 26 to as much as 40 dBi. They are normally mounted on towers or plant rooftops 20 to 100 feet above the ground to facilitate a clear view of the horizon. See Exhibit B for typical such antennas.

Aircraft undergoing flight tests are frequently 150-200 miles away. This means the received signal is weak. Exacerbating the weakness is the problem of fading: As the aircraft is put through various maneuvers, the received signal fluctuates depending on the attitude of the

aircraft; in other words, the signal starts out weak (typically 30 dB above the telemetry receive system noise floor), and gets even weaker (on the order of 15 – 20 dB) on an intermittent basis during aircraft maneuvers due to various well-documented fading mechanisms. Because of the distances involved, even for aircraft at high altitudes, the elevation angle of the parabolic receive antennas is frequently one or two degrees or less, i.e. basically horizontal, given that the elevation angle is comparable to the antenna's half-power beamwidth.[25] In fact, during takeoffs and landings, the elevation angle of receive antennas is typically negative, due to their being located on buildings or towers. Standard AMT antennas are capable of negative elevations of 10 degrees. Exhibit C.[26]

In light of these factors, the Engineering Statement concludes that BSNs will cause interference to AMT antennas, and that the interference zone for a single BSN ranges from 19.6 up to 62 km, again depending again upon the assumptions about building attenuation, indoor/outdoor use, etc. -- a far cry from the 218.2 meters claimed by GEH[27] To put it another way, the main beam of telemetry receive antennas will be vulnerable to co-channel BSN emissions "whenever a BSN, even when located indoors, is within the visibility horizon of an AMT ground station receive antenna." Exhibit C at 3.[28]

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[25] A test aircraft at an altitude of 30,000 feet but a distance of 200 miles will, as a matter of geometry, be just above the horizon from the vantage point of the receive dish.

[26] Telemetry receive antennas are noise-limited, meaning that their ability to detect and utilize signals is limited only by the external noise sources and the noise generated within the amplifier itself. The total system noise temperature of a modern telemetry receiver and its low noise preamplifier is typically 250 Kelvin, well below the 9000 Kelvin of the proposed BSN receiver, which is designed for minimization of cost, rather than maximization of performance.

[27] February 6, 2008 Ex Parte Notice at 18.

[28] Interference to BSNs depends primarily on the distance between an AMT aircraft and the BSNs -- not on the distance between the BSN and the AMT ground station. On the other hand, the interference to an AMT ground receiver depends on the distance from the BSN to that ground receiver since it is the AMT receiver, not the aircraft, which is the interference victim. Since the distance from an AMT aircraft to a BSN is unrelated to the distance from a BSN to an AMT ground station, there will be situations where either the AMT ground station, or the BSNs, but not both, will experience interference.

As noted before, there is no way of enforcing BSN operation on a non-interference basis to AMT. Thus, BSN use of the same spectrum as flight testing would cause severe interference and disruption to flight test operations, and pilot safety.

1. GEH's argument to the contrary rests on erroneous assumptions.

GEH bases its argument that BSNs will not cause interference on the notion that flight testing occurs in remote areas and BSNs will not radiate into the main beam of telemetry antennas, i.e. that there is a "very low probability of low elevation, long range testing near urban areas where telemetry receive sites are most vulnerable to interference."[29] GEH is wrong.

First. While aerial maneuvers during actual testing are usually conducted over sparsely populated areas for the safety of persons on the ground, it is not the aircraft which is the potential interference victim here -- it is the parabolic dish antennas used to receive the telemetry radiated by the aircraft. As noted, these antennas are located on the premises of plants producing the aircraft, and these facilities are usually located in or near urban areas where many plant employees live.

For example, the Boeing plant in St. Louis shares runways with the St. Louis Municipal Airport at Lambert Field; Bombardier (maker of the Learjet), Cessna, Boeing, and Hawker Beechcraft, among other manufacturers, operate four telemetry sites at three different airports in and adjacent to Wichita, Kansas (two of them share runways with Wichita Mid-Continent Airport); in the Seattle-Puget Sound region, Boeing shares runways with the King County International Airport (Boeing Field), Seattle, WA, Everett & Snohomish County Airport – Paine Field, Everett, WA, and Renton Municipal Airport (Renton Field), Renton WA. Other manufacturers that use their own runways are nonetheless located in proximity to major urban

[29] February 6, 2008 Ex Parte at 21. *See also* Ex Parte Comments filed December 27, 2007 *quoting from Seventh Report and Order* in Docket Nos. 00-258 and 02-8, FCC 04-246, 19 FCC Rcd 21350 (2004) at para. 47.

areas, such as Lockheed Martin, whose facilities at Marietta, GA are near Atlanta; L-3 and Bell Helicopter whose facilities at Greenville and Ft. Worth, Texas, respectively, are near Dallas-Ft. Worth; and Northrop Grumman, whose Florida facility is near St. Augustine.

This is also true of certain military test facilities. Patuxent River Naval Air Test Center, for example, is only eight flight minutes from Washington, D.C. and twelve minutes from Baltimore. Eglin Air Force Base (which actually shares runways with the Okaloosa Regional Airport) is close by Pensacola and Ft. Walton Beach, FL.

There is nothing "remote" about these facilities, even if the aircraft they track fly over sparsely populated areas. See also Exhibit D, a map of certain flight test centers and their 200 mile operating radii.

Second. Testing with telemetry antennas at low elevation angles (e.g. plus or minus two degrees with respect to the horizontal) is commonplace both at long-range and close-in (e.g., during takeoffs and landings at the beginning and end of a test which, for safety reasons, are also monitored with real-time telemetry). As noted before, tests are not conducted close to population centers: They are conducted far away for safety reasons. Manufacturers go to the trouble and expense of building antenna structures and mounting receive antennas 20-100 feet above ground level precisely so that antennas can be depressed to the horizontal for tracking aircraft at low altitude and during long-range tests. It is also why telemetry equipment vendors design and build, and aircraft manufacturers buy, very expensive telemetry receive installations with antennas gains on the order of 26 to 40 dBi (with the trend toward 38 dBi). The attached Declaration of Lawrence T. Dufraimont, Director of Flight Test and Flight Operations for Learjet, Inc. verifies the fact that telemetry receive dishes are routinely operated at very low elevation angles. Exhibit E.

Furthermore, flight test operating areas are established by the Federal Aviation Administration, and the testing of aircraft is strictly limited to controlled airspace designated for the purpose. Manufacturers may not simply conduct test flights in any airspace of their choosing. The airspace designated for a particular test may be in a direct line over and far beyond populated areas near the manufacturing plant.

In any event, GEH expressly states that BSNs would be "ubiquitous."[30] They would not be used just in hospitals and doctors' offices, but rather in homes, in schools, at work, outdoors (walking the dog), etc. There is no way of predicting, much less controlling, where a BSN-equipped patient might or might not be: He or she could be located anywhere in the urban, suburban, or rural areas surrounding flight test facilities. Thus, BSNs will inevitably be located in the main beam of telemetry receive antennas.[31]

2. <u>GEH's contention-based protocol does not help -- it makes matters worse.</u>

GEH relies on a contention-based protocol as enabling its devices to avoid interference by hopping to an inactive channel. But there are two major problems with this method which actually make interference to flight testing, and even BSNs, more likely -- not less.

<u>Problem No. 1</u>: In a major area of the country, the Southwest, concurrent operations in the S-band are conducted "wall-to-wall" by the multiple ranges located in that area, i.e. Edwards Air Force Base, China Lake, Point Mugu, Vanderberg, Nellis Air Force Base, and Ft. Irwin,

---

[30] Comments of GE Healthcare filed October 31, 2006 in ET Docket No. 06-135 at 11.

[31] GEH suggests that antenna polarization, for example, will attenuate the BSN signal before it reaches the telemetry dish. February 6, 2008 Ex Parte at 21. However, telemetry antennas receive in circular polarization; a non-polarized or linearly polarized interference signal is received with only a 3 dB reduction in signal strength. Furthermore, one cannot assume that main beam conjunction of an AMT ground station tracking antenna with a co-channel BSN is a low probability event. AMT antennas do not rotate with a predictable period, as do some radar antennas. They follow the aircraft, and antenna azimuth angles can vary rapidly, or slowly, during different time segments of the same test flight.

among others. In other words, there is a likelihood that BSNs worn by patients with heart problems, for example, would have no spectrum to hop to in the event they detected interference.

Problem No. 2: As noted before, aircraft regularly transmit telemetry in and near airports, and would radiate well within the interference range of BSNs, thus causing the devices to hop to a different channel. But that channel may be in use to track a distant, different aircraft which the BSN, with its omnidirectional, zero gain antenna, has no way of detecting. Thus, BSNs may cause interference to AMT ground stations when prompted to hop (and, even without prompting, when a BSN first begins operation on a frequency which already happens to be in use by a distant aircraft). In the numerous locations where aircraft manufacturers have ground receiving stations located near urban centers, the likelihood of such an event is high. When it does, the flight test telemetry data will be degraded, or lost entirely.

3. GEH fails to take account of aggregate effects.

GEH's analysis is single-entry only; it does not address the aggregate effect of multiple BSNs in the same area. When multiple co-frequency and adjacent frequency BSNs are co-located within the beam of an AMT ground station antenna, the effect of the interference on AMT operations will be greatly exacerbated. As the Engineering Statement observes, five (5) BSNs operating in the same facility in adjacent one (1) MHz channels will double the minimum separation distance from the facility to the affected AMT ground station. Exhibit C.

4. GEH's remaining arguments are likewise without merit.

GEH nonetheless argues that ITU-R Recommendation M.1459, which specifies protection standards for flight test telemetry, is "overly conservative."[32] GEH is in the medical telemetry business, and it is highly presumptuous to suggest that protection standards for flight

[32] February 6, 2008 Ex Parte at 21. A copy of Recommendation M. 1459 is attached as Exhibit F.

test telemetry are inappropriate. That aside, Recommendation M.1459 is based on accurate and validated system and noise floor measurements that were reviewed, analyzed, and debated over the course of several years in the Radiocommunication Sector of the International Telecommunication Union. Experts from over 30 nations and from a variety of interest groups analyzed and commented upon the various drafts. The Recommendation was ultimately approved by the Radiocommunication Assembly with delegates from scores of Administrations including the United States, in attendance, and it has been the recognized international standard for eight years.

But yet, GEH says, "multipath interference and electronic noise already limit low elevation, large range flights tests in urban areas."[33] However, multipath is already compensated for in the fade margin described, with considerable supporting detail, in Rec. M.1459. This takes into account the multipath rejection effects which drive the use of circular polarization for AMT, and is reflected in the protective interference levels incorporated in the Recommendation. And, as is confirmed on a daily basis worldwide during AMT system checkouts before flight, electronic noise is limited by the 250 Kelvin system noise temperature of the telemetry LNA/receiver combination.

Further, GEH's assertions ignore the fact that 2360-2390 MHz is a Restricted Band, off-limits to any and all fundamental emissions except those from flight test telemetry. See Rule 15.205. And spurious emissions are irrelevant inasmuch as GEH proposes co-channel operation.[34] Aided by sound spectrum management by the Commission (e.g. Rule 15.205),

[33] February 6, 2008 at 21-22.

[34] Aircraft manufacturers occasionally experience out-of-band interference. When it happens, they immediately seek to identify and eliminate the source. Furthermore, they take pains to police their own facilities to protect against potentially interfering devices being brought on their premises. Manufacturers have spent many thousands of dollars on spectrum monitoring equipment used for this purpose. When spurious emissions are an issue, it is generally at the band edges and affected manufacturers are then forced to limit operations to avoid the interference.

manufacturers thus far have had good success with use of the S-band for long-range/low elevation flight tests. They are anxious to keep it that way.

To show exactly what happens when a co-channel signal at the 1 mW level proposed by GEH is radiated in the vicinity of a flight test receive dish, Donald J. Hoehn, Radio Frequency/Telemetry Specialist with Learjet, conducted fields tests from its flight test center at Wichita. Those tests showed that a co-channel 1 mW signal inflicts massive interference: Data dropouts, followed by loss of bit synchronization, and loss of antenna auto-track. *See* Exhibit G.

Among other things, the test showed that the first drop-out occurred with the aircraft at 28 nautical miles from the AMT antenna, and that at only 31 nautical miles the telemetry receive station not only lost all data, but was captured by the interfering signal and began to track it -- rather than the aircraft ! When the signal generator was turned off, the AMT antenna pointed back to the aircraft.[35]

The tests also showed severe interference at a distance of 3.2 miles from the tracking antenna even in the presence of ground clutter (e.g. trees and buildings) between the signal source and the tracking antenna (no readings were taken beyond this point). Exhibit G. Based on his experience and findings, Mr. Hoehn concludes that a co-channel 1 mW signal like that

[35] Receive antennas track aircraft using the telemetry signal itself: As the aircraft flies its pattern, the antenna automatically trains left or right in sync with the aircraft. If the telemetry stream suffers interference, and there is a data drop-out, the antenna can lose its "lock" on the aircraft. The effect of even a short-term dropout in telemetry is significant. The parabolic dish must "re-find" the aircraft. Because of the very high gain (i.e. narrow beam) of the antenna, this is a difficult and time-consuming process. During this search, bit synchronization is lost, and what would in many systems be rapid and automatic signal reacquisition is, for flight test, a cold-start acquisition of the AMT signal. During this time, the test aircraft and its crew are at increased risk and the company faces the prospect of having to re-fly "test points," the costs of which, as seen before, are very substantial. Depending on the amount of data lost or corrupted, the Company may be required to re-fly the entire mission.

proposed by GEH "would cause destructive interference to our flight test operations at distances considerably greater than 3.2 miles." Exhibit G at 2.[36]

C. The Commission Has Repeatedly Recognized the Need to Protect Flight Test Telemetry From Interference.

The Commission has repeatedly recognized the safety implications to the aeronautical telemetry allocation. For example, in 1984 the Commission stated that flight test telemetry "involves the safety of life and property" and acted "to protect this safety service from harmful interference that could result in loss of life."[37]

In 1989, the Commission determined that the telemetry bands should be classified as Restricted and protected from fundamental emissions of unlicensed devices (such as effectively BSNs which would be licensed merely by Rule). In so doing the agency stressed that the telemetry band "involv[es] safety of life."[38]

In 1990, the Commission declined to reallocate flight test telemetry spectrum for broadcast auxiliary operations, even on a secondary basis, explaining:

> "In short, sharing of these frequencies with unlike services is difficult at best because schedules of telemetry flight tests are unpredictable and delays costly. Further, interference cannot be tolerated. For example, in the event of a crash the telemetry data may be the only means available to determine the cause of the crash. In this case, interference to the telemetry transmission could be disastrous."[39]

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[36] The vulnerability of telemetry receive antennas, whether S-band or L, to co-channel signals of 1 mW was confirmed by AFTRCC Member Cessna which conducted a similar test using L-band gear. See attached Declaration of Danny B. Hankins, Cessna Aircraft Company. Exhibit H.

[37] *In the Matter of Amendment of Part 2 of the Commission's Rules Regarding Implementation of the Final Acts of the World Administrative Radio Conference, Geneva*, 1979. FCC 84-306, released July 2, 1984, at 2.

[38] *In the Matter of Revision of Part 15 of the Rules Regarding the Operation of Radio Frequency Devices Without an Individual License*, 4 FCC Rcd 3493, 3502 (1989).

[39] *Amendment of the Frequency Allocation and Aviation Services Rules (Parts 2 and 87) to Provide Frequencies for Use by Commercial Space Launch Vehicles*, 5 FCC Rcd 493, 495 (1990).

The Commission likewise concluded that secondary use of flight test frequencies for air shows could result in significant harmful interference "impair[ing] the efficiency and safety of the flight test industry."[40]

Finally, the Commission has determined that

> "[F]light test, telemetry, and telecommand operations are vital to the U.S. aerospace industry to produce, deliver, and operate safe and efficient aircraft and space vehicles. Because the nature of the BSS (Sound) operations is 24 hour a day ... and the test and telemetry operations are in the proximity of many major metropolitan areas, we believe, as AFTRCC asserts, that the BSS (Sound) transmissions will cause interference to these operations and threaten safety of life and property. Consequently, we do not believe it is feasible to share aeronautical mobile telemetering frequencies with BSS (Sound) or terrestrial broadcasting systems." [41]

The Commission even went on to say that "We have previously determined that aeronautical flight test and telemetry operations should not share spectrum with unlicensed devices because of the threat to safety of life."[42]

Consistent with these determinations, the Commission should protect flight test telemetry as against GEH's proposal for an unknown and uncontrollable number of ubiquitous BSNs.

V.

CONCLUSION

GEH's proposed new secondary service would cause harmful interference to the incumbent primary service in this band. GEH's proposed new service would also receive harmful interference from that incumbent primary service. Sharing between flight testing and

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[40] *In the Matter of Petition to Amend Part 87 of the Commission's Rules to Allot VHF Aeronautical Frequencies for the Coordination of Air Show Events*, Order, DA 90-957, 5 FCC Rcd 4641, 4642 (1990).

[41] *Second Notice of Inquiry in GEN. Docket No. 89-554, In the Matter of An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum*, FCC 90-316, 5 FCC Rcd 6046, 6060, para. 101 (1990).

[42] *Id*. at 6061 para. 102.

BSNs is a bad idea which would jeopardize the safety of two communities at once. For these and the many other reasons set forth above, the AFTRCC urges that the Commission deny or dismiss the GEH proposal.

Respectfully submitted,

AEROSPACE and FLIGHT TEST RADIO COORDINATING COUNCIL

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505 9th Street, Suite 1000
Washington, D.C. 20004-2166
Telephone: 202-776-7800

Its Counsel

May 27, 2008

EXHIBIT A

BLOCK DIAGRAM

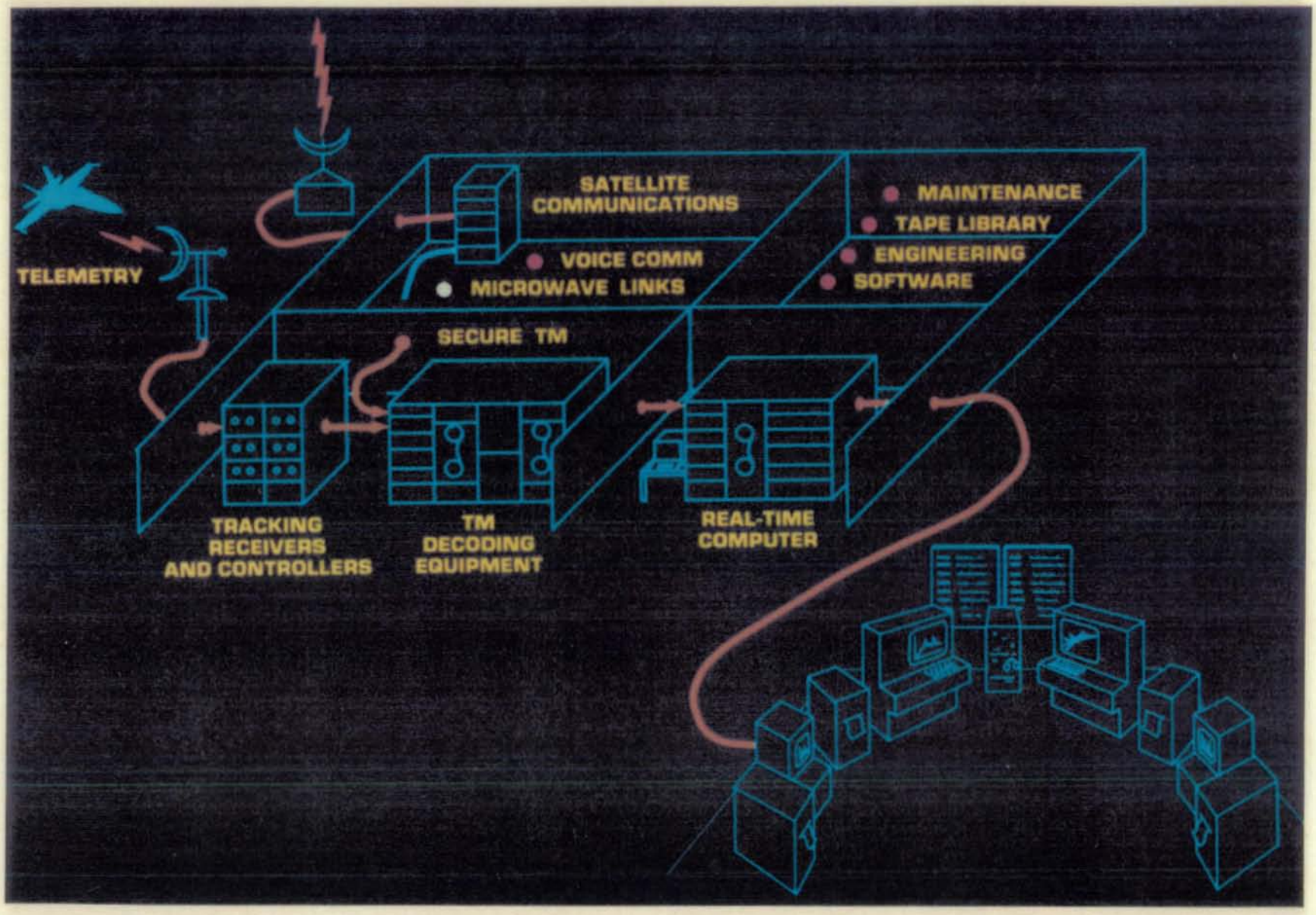
TELEMETRY
SATELLITE COMMUNICATIONS
VOICE COMM
MICROWAVE LINKS
MAINTENANCE
TAPE LIBRARY
ENGINEERING
SOFTWARE
SECURE TM
TRACKING RECEIVERS AND CONTROLLERS
TM DECODING EQUIPMENT
REAL-TIME COMPUTER

EXHIBIT B

VIASAT L- AND S-BAND RANGE TELEMETRY SYSTEMS

L- and S-band Range Telemetry Systems

L-Band, S-Band, Fixed and Mobile

For Decades ViaSat has been a leading supplier of high quality tracking antennas to the telemetry users of the world. Using our experience we have refined our products into simple, robust, and technically superior telemetry systems.

The Patented ESCAN tracking feed provides low sidelobes, high scanning rates, and superior multi-path resistance. We also produce conical scan and single channel monopulse tracking feeds to fit a wide range of requirements.

The series 13000 pedestal features patented bearing technology that combines long trouble free life with ease of service and maintenance. Pulse Width Modulated (PWM) servo power amplifiers are matched with brushless DC servo motors to assure long trouble free operation. These pedestals are in service around the world, some in extreme harsh environments providing daily service.

The heart of the control system is ViaSat's 3880 Antenna Control Unit (ACU). The 3880 is ViaSat's fourth generation ACU and provides unequalled performance for tracking systems. The 3880 provides for control, testing, and mission monitor (track files), far better than any previous control unit.

Telemetry Systems are available in fixed and mobile configurations as well as many size offerings (in addition to those listed here).

L- AND S-BAND RANGE TELEMETRY SYSTEMS AT-A-GLANCE

- A leading source for more than 40 years
- Highly multi-path resistant ESCAN feed
- High dynamics, high accuracy tracking pedestal
- Fourth generation touch screen antenna control unit
- Mobil e and fixed configurations
- Remote control

SPECIFICATIONS AND STANDARD ANTENNA SIZES

	1.8m	2.4m	3.0m	3.6m
Frequency [1]	1435 – 2300 MHz	1435 – 2300 MHz	1435 – 2300 MHz	1435 – 2300 MHz
Feed Type	ESCAN	ESCAN	ESCAN	ESCAN
Gain	28.5 dB @ 2300 MHz	31.0 dB @ 2300 MHz	33.0 dB @ 2300 MHz	35.0 dBi @ 2300 MHz
HPBW @ 2300 MHz	5.1° @ 2300 MHz	3.8° @ 2300 MHz	3.0° @ 2300 MHz	2.5° @ 2300 MHz
First Side Lobes	16 dB Below Peak	18 dB Below Peak	18 dB Below Peak	20 dB Below Peak
Polarization	LHC & RHC Sim	LHC & RHC Sim	LHC & RHC Sim	LHC & RHC Sim
Axial Ratio	2.0 dB Max at beam peak	2.0 dB Max at beam peak	2.0 dB Max at beam peak	2.0 dB Max at beam peak
Guaranteed G/T [2&3]	5.8 dB/K @ 2300 MHz	8.6 dB/K @ 2300 MHz	10.5 dB/K @ 2300 MHz	12.1 dB/K @ 2300 MHz

DYNAMICS

Velocity	30° sec
Acceleration	30° per sec^2
Azimuth Travel	+/- 375°
Elevation Travel	-10° to +110°

ENVIRONMENTAL

Temperature	-30° to +70° C
Rain	Up to 5 inches per hour
Ice	0.5 inch Radial
Wind	Operate in 45 MPH, Stow in 120 MPH
Voltage/Frequency	120/208 VAC 50/60 Hz

OPTIONS

- Separate data and tracking channels for improved performance
- Dual drive pedestal
- Slip-rings and rotary joint for continuous azimuth rotation
- Transmit versions available in all frequency bands
- Video camera
- Alignment telescope
- Acquisition antenna
- Dual or selectable polarizations
- Larger reflector sizes as specifications may require
- 1435 to 2400 MHz frequency range

NOTES

[1]Wider Frequency coverage available please consult Factory.
[2]G /T at 20° Elevation, 23° C, 7.5 gr/m^3 and under clear sky conditions.
[3]Separate Data and Tracking channels and other feed configurations with enhanced G/T performance are available as options.
[4]Above specifications are with one LNA and no Band Pass Filter.

White Sands Missle Range

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EXHIBIT C

DANIEL G. JABLONSKI ENGINEERING STATEMENT

ENGINEERING STATEMENT

Introduction

GE Healthcare ("GEH") suggests that proposed Body Sensor Network ("BSN") devices can share spectrum on a secondary basis with Aeronautical Mobile Telemetry ("AMT") systems in the band 2360 – 2395 MHz. The GEH conclusion is based on erroneous assumptions and flawed analyses. Using corrected analyses and accurate technical details of AMT operations, the GEH conclusion that AMT spectrum can be shared with BSN devices is shown to be invalid.

Interference to BSNs from AMT

The interference from an AMT aircraft that is measured at the receive antenna terminals of a BSN is given by

$$P_r = \frac{\alpha\beta P_t G_t \lambda^2 G_r}{(4\pi)^2 \cdot r^x} \qquad (1)$$

where

$$\lambda = c/f \qquad (2)$$

The parameter α is a scale factor that can be used to account for building wall attenuation, etc., and β accounts for bandwidth differences between the AMT and BSN systems. For free space propagation, the exponent of r is $x = 2$. Note that P_r has the dimensions of Watts.

Interference from AMT to a BSN network will occur when the signal from the flight test aircraft approaches in magnitude the -85 dBm sensitivity of the victim BSN receiver, which is assumed to have a receive antenna gain of 0 dBi.

For the specifications presented in GEH's most recent filing,[1] a 3 dB rise in the BSN noise floor will raise the bit error rate of a BSN from its putatively acceptable value of 10^{-4} by a factor of ten, to 10^{-3}, which is considered unacceptable by BSN operators. Thus, the interference received by a BSN from an AMT-equipped aircraft must be significantly less than the -85 dBm noise floor of the proposed BSN devices.

An additional consideration is that BSNs, despite their 1 MHz channel bandwidth, must be able to operate over 10 – 40 MHz of bandwidth. Thus, they are susceptible to noise floor rise due to out-of-channel (but not out-of-band) interference from AMT aircraft.

[1] Ex Parte Comments, filed 27 December 2007. Note the significant changes from the corresponding specifications in the the Reply Comments: EIPR levels for BSNs have increased from -10 dBm to 0 dBm, and the acceptable signal to noise ratio for the BSN has decreased from 10 dB to 0 dB with respect to the BSN noise floor of -85 dBm.

Combining these effects, an acceptable interference to noise ratio of -10 dB from AMT-equipped aircraft to a BSN is assumed.

A typical AMT-equipped aircraft transmits $P_t = 10\ Watts$ through an antenna with a transmit gain G_t of 2 dBi over a line-of-sight distance r to a BSN receiver. A transmit frequency f of 2377.5 MHz (i.e., at the center of the AMT band, and as assumed by GEH) and a BSN receiver antenna gain G_r of *0 dBi* for the BSN are assumed, as is a bandwidth of 5 MHz for the modulated AMT signal. For this air-to-ground transmission, the free space exponent is 2.

Assuming 12 dB of building attenuation, this yields an interference distance of 17.8 km between an AMT aircraft and a BSN located within a building. However, such attenuation cannot be assumed. An advertised feature of one major national chain of assisted living facilities is the presence of outdoor balconies on high floors. Likewise, patients may be located next to windows.

Thus, appropriate values for building/wall attenuation of 0 – 3 dB will often be appropriate, thus raising the interference distance to as high as 71 km. This is actually consistent with the GEH assumed value of 12 dB, which represents a mean value, when the rather large standard deviation of 6 dB is also taken into account.

<u>Interference to AMT Receive (Ground) Stations from BSNs</u>

ITU-R Recommendation M.1459 derives a threshold interference power flux density level of -180 dB Watts/m^2 in a bandwidth of 4 kHz that is appropriate to the present situation (i.e., AMT receive antenna elevation angles of 0 – 2 degrees). This pfd level reflects the high sensitivity of AMT receive systems, which use high gain parabolic dish tracking antennas and have a system noise temperature of 250K.

To compute the received power flux density (pfd) at the AMT receive antenna, the effective area $\lambda^2 G_r / 4\pi$ of the AMT receive antenna is deleted from equation (1) to yield a pfd (as opposed to an absolute power level) having dimensions of *Watts/m^2*. This reduced equation can then be used, as shown below, where $P_t G_t$ represents the power and gain of the BSN transmitter.

The value of β is also changed in order to scale the 1 MHz wide signal of the BSN transmitter to the 4 kHz reference bandwidth specified in Rec. M.1459. This gives:

$$pfd_r = \frac{\alpha \beta P_t G_t}{4\pi \cdot r^x} \qquad (3)$$

where for a single BSN, conversion from a 1 MHz bandwidth to a 4 kHz bandwidth, per Rec. M.1459, changes the value of β to .004 = -24 dB.

Under these conditions, it is appropriate to include ground propagation effects between a BSN transmitter and an AMT receiver by using the value of $x = 2.4$ for the exponent of r in equation 3.[2] Equation 3 becomes

$$pfd_r = \frac{\alpha\beta P_{BSN} G_{BSN}}{4\pi \cdot r^{2.4}} \quad (4)$$

For $G_{BSN} = 0\ dBi$ and $\beta = .004$, the following threshold distances for interference between a single BSN transmitter and an AMT ground station receive antenna are computed.

	α = 0 dB	α = 12 dB
$P_{BSN} = 1.0\ mW$	*62.1 km*	*19.6 km*

Note that if 5 BSNs are co-located in the same medical facility on adjacent 1 MHz channels within the 5 MHz receive bandwidth of an AMT ground station receiver, all of the distances in the table will increase by a factor of $5^{(1/2.4)} = 1.96$. Thus, the maximum expected distance for interference will increase to 124 km.

However, for an AMT receive antenna located 100 feet above the ground, in view of BSNs located on the top floor of a 10 story medical facility, the line-of-sight radio horizon is given by

$$d = \sqrt{2h_1 r_e} + \sqrt{2h_2 r_e} \quad (4)$$

where r_e is the radius of the earth, and h_1 and h_2 are the heights of the AMT antenna and BSN network.

Note that for an AMT ground station antenna located on a 100 foot tower and a BSN at ground level, the radio horizon is approximately 20 km. If the BSN is located on the top floor of a 10 story high medical facility, the line of site limit will be approximately 40 km, although variations in local terrain can affect both values.[3]

In any case, interference from BSNs to AMT ground stations should be expected to be a common occurrence whenever a BSN, even when located indoors, is within the visibility horizon of an AMT ground station receive antenna.

Conclusion

In conclusion, sharing between AMT and BSN systems is not feasible. To the contrary, the analysis indicates that there are serious issues concerning a "life-critical"

[2] This is identical to the value proposed in the GEH Ex Parte filing of 27 December 2008.
[3] For example, line of site microwave communications between Skyline Drive and Washington, D.C., a distance of 120 km, are possible. Similar geometric scenarios can be found at flight test ranges in the Southwestern United States.

technology sharing spectrum on a secondary basis where interference to and from the primary service is not only possible, but likely.[4]

I have read and am familiar with the attached Comments being filed this date. The statements made therein are true and correct to the best of my knowledge and belief including, but not limited to, the statements made concerning the performance characteristics of flight test telemetry equipment, flight test operations, and the interference that would result from intermixing BSNs with flight test telemetry.

Daniel G. Jablonski
May 27, 2008

[4] My qualifications to present this paper are set forth in the attachment.

Daniel G. Jablonski, Ph.D.

PROFESSIONAL EXPERIENCE

1991 - Present: Physicist and Electrical Engineer, the Johns Hopkins University Applied Physics Laboratory (JHU/APL), Laurel, MD

1986 - 1991: Research Staff Member, Supercomputing Research Center, Institute for Defense Analyses, Bowie, MD

1981 – 1986: Research Physicist, Naval Surface Warfare Center, White Oak, MD

FACULTY APPOINTMENTS

1999 - Present: Instructor, Engineering Programs for Professionals, Whiting School, Johns Hopkins University

1985 - Present: Adjunct Professor, Capitol College, Laurel, MD

EDUCATION

Ph.D., Physics, Cambridge University, 1982

M.S. Electrical engineering and Computer Science, Massachusetts Institute of Technology, 1977

B.S. Electrical Engineering, Massachusetts Institute of Technology, 1976

TECHNICAL INTERESTS

Communications, microwave engineering, spectrum management, and spacecraft mission design, navigation, and analyses.

RECENT PROFESSIONAL ACTIVITIES

Over ten years analytical, laboratory, and range experience with aeronautical mobile telemetry operations, including flight line and flight test experience with F/A-18 E/F, F/A-18 C/D, T-2, T-38, V-22, and other aircraft.

Member of the U.S. Delegation, 2003 and 2007 World Radio Conferences, Geneva, Switzerland

Principal Investigator, "Steerable Beam Antennas for Flight Test Telemetry," for the Department of Defense, 2006 – 2008

Project Manager, "X-Ray Navigation and Autonomous Position Verification (Xnav)", for the Defense Advanced Research Projects Agency, 2006

Principal Investigator, "X-ray Communications", for the Johns Hopkins University Applied Physics Laboratory, 2008

Project Manager, Deep Space Network Antenna Arraying Analysis, NASA, 2008.

RECENT PUBLICATIONS AND PATENTS

Author, numerous FCC filings, engineering statements, and Coordination Agreements.

Author, numerous ITU submssions.

Author, several reports and analyses on compatibility and adjacent band interference between GPS and other systems, including L-band AMT.

Co-author, ITU-R Technical Report M.2118, "Compatibility between proposed systems in the aeronautical mobile service and the existing fixed-satellite service in the 5 091 – 5 250 MHz band", November 2007.

"The Three-Axis Antenna," provisional patent application filed 2007.

Contributor, Encyclopedia of Material Science and Engineering.

Contributor, **Reference Data for Engineers**, 9th Ed.

Contributor, **The World Book**, 2009 Edition.

Inventor of numerous other patents, applications, and disclosures

Author, over 60 additional publications.

PROFESSIONAL ACTIVITIES
Senior Member, IEEE
Member, American Physical Society
Member of the Editorial Board, *IEEE Transactions on Microwave Theory and Techniques*
Licensed professional engineer, State of Maryland

EXHIBIT D

MAP OF CERTAIN TELEMETRY OPERATING AREAS

Rand McNally
COSMOPOLITAN SERIES
UNITED STATES
of AMERICA

EXHIBIT E

LAWRENCE T. DUFRAIMONT DECLARATION

BOMBARDIER
LEARJET

Learjet Inc.
P.O. Box 7707
Wichita, KS 67277-7707 United States
www.bombardier.com
TEL 316-946-2000
FAX 316-946-2163

DECLARATION

I, Lawrence T. Dufraimont, Director of Flight Test and Flight Operations, Learjet, Inc., hereby declare as follows:

Learjet Inc. is a wholly-owned subsidiary of Bombardier Inc. Learjet manufactures three models of business jet aircraft. Bombardier also manufactures 12 other models, including business, regional and amphibious aircraft. I am responsible for all Bombardier Aerospace flight-test activities. I have held this position for 4 years. As part of my duties, I am responsible for the facilities and personnel comprising our flight test operations, and for the successful execution of our flight test programs.

I have had an opportunity to review the attached Comments being filed with respect to the proposal by GE Healthcare. The statements made therein concerning flight testing and flight test operations are true and correct.

One of the points addressed in the Comments concerns the elevation angle at which telemetry receive antennas operate. It is commonplace in our business for us to track test aircraft at long-range from our plant. This is due in part to the need to conduct flight testing over sparsely-populated areas in accordance with restrictions imposed by the Federal Aviation Administration. At an altitude of 20,000 feet, for example, an aircraft will appear to be just above the horizon from the vantage point of the telemetry receive antenna when at a distance of 160 nautical miles.

In addition, Learjet routinely tracks aircraft at low elevation angles even when not at long range. An example is stall testing at medium and lower altitudes. The elevation angle of the antenna during such tests, as well as during take-off and landing, is very low.

Thus, it is routine for us to operate at elevation angles of 1.5° and below. This is one of the reasons why our tracking antennas are mounted on structures or roof-tops.

The primary purpose of flight-test telemetry is safety. The consequences of interference to the safety of flight-test telemetry are severe. As discussed in the Comments, flight test telemetry represents a real-time link with the pilot. It enables our engineers to continuously monitor the condition of the aircraft during what is a high-risk endeavor. In the event dangerous

conditions are detected, telemetry enables our engineers to warn the pilot to take corrective action.

Furthermore, with loss of data, we will be required to re-fly the maneuvers in question. In instances where the interference is longer-lasting, we would be required to re-fly the entire mission. The costs of such flights are very substantial, as much as $35K.

Executed under penalty of perjury this 27th day of May 2008.

Lawrence T. Dufraimont

EXHIBIT F

ITU-R RECOMMENDATION M.1459

RECOMMENDATION ITU-R M.1459*

PROTECTION CRITERIA FOR TELEMETRY SYSTEMS IN THE AERONAUTICAL MOBILE SERVICE AND MITIGATION TECHNIQUES TO FACILITATE SHARING WITH GEOSTATIONARY BROADCASTING-SATELLITE AND MOBILE-SATELLITE SERVICES IN THE FREQUENCY BANDS 1 452-1 525 MHz AND 2 310-2 360 MHz

(Question ITU-R 62/8)

(2000)

The ITU Radiocommunication Assembly,

considering

a) that in Region 2, frequency allocations to the aeronautical mobile service for telemetry have a primary status in the band 1 435-1 525 MHz and have priority over other mobile services under RR No. S5.343;

b) that WARC-92 adopted an additional allocation in the band 1 429-1 535 MHz, on a primary basis to the aeronautical mobile service for Belarus, the Russian Federation and Ukraine to be used exclusively for aeronautical telemetry subject to RR No. S5.342;

c) that in accordance with the decision by WRC-95, in the United States of America, telemetry stations in the aeronautical mobile service have a primary status in the 2 300-2 390 MHz band and have priority over other mobile services under RR No. S5.394;

d) that in Canada, telemetry stations in the aeronautical mobile service have a primary status in the 2 300-2 483.5 MHz band and have priority over other mobile services under RR No. S5.394;

e) that in France, frequency assignments to telemetry stations in the aeronautical mobile service have a primary status in the 2 310-2 360 MHz band and have priority over other mobile services under RR No. S5.395;

f) that in Europe future airborne telemetry equipment should tune primarily to the frequency range 2 300-2 400 MHz;

g) that the band 1 492-1 525 MHz has been allocated to the MSS (space-to-Earth) in Region 2 taking account of the provisions of RR Nos. S5.348 and S5.348A;

h) that WARC-92 allocated the band 1 452-1 492 MHz on a primary basis to the BSS (digital sound broadcasting (DSB)) (see Note 1) and the broadcasting service (DSB) subject to the provisions of RR Nos. S5.345 and S5.347;

j) that at WARC-92, an additional allocation in the United States of America, India and Mexico of the 2 310-2 360 MHz band to BSS (DSB) and the broadcasting service (DSB) was made on a primary basis under RR No. S5.393;

k) that in the band 1 452-1 525 MHz, WARC-92 adopted an alternative allocation on a primary basis for the fixed and mobile services in the United States of America in accordance with RR No. S5.344;

l) that in Japan in the band 1 492-1 525 MHz, a coordination threshold of –150 dB(W/m^2) in any 4 kHz band for all angles of arrival was adopted at WRC-95 for the protection of specialized land mobile services in accordance with RR No. S5.348A;

m) that coordination is required under RR No. S9.11A and Resolution 528 (WARC-92);

n) that Resolutions 528 (WARC-92) and 213 (Rev.WRC-95) invited the ITU-R to conduct the necessary studies prior to the next competent WRC;

o) that additional studies have been introduced in the ITU-R for determining the probability of interference to telemetry stations in the aeronautical mobile service which could lead to less stringent protection values, and that these studies are expected to continue;

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* This Recommendation should be brought to the attention of Radiocommunication Study Group 6.

p) that telemetry stations in the aeronautical mobile service have a wide range of characteristics and some may have less stringent protection criteria values than those contained in the *recommends*,

recommends

1 that the values needed for protection of the aeronautical mobile service for telemetry systems in the 1 452-1 525 MHz band shared with geostationary satellites in the BSS (DSB) or the MSS, should be determined by the following (see Note 4):

– for geostationary satellites visible to any aeronautical telemetry receiving station, the protection value corresponds to a pfd at the telemetry receiving station in any 4 kHz band for all methods of modulation:

–181.0	dB(W/m^2)	for	$0° \leq \alpha \leq 4°$
–193.0 + 20 log α	dB(W/m^2)	for	$4° < \alpha \leq 20°$
–213.3 + 35.6 log α	dB(W/m^2)	for	$20° < \alpha \leq 60°$
–150.0	dB(W/m^2)	for	$60° < \alpha \leq 90°$

where α is the angle of arrival (degrees above the horizontal plane);

2 that the values needed for protection of the aeronautical mobile service for telemetry systems in the 2 310-2 360 MHz band shared with the BSS (DSB) should be determined by the following (see Note 4):

– for geostationary satellites visible to any aeronautical telemetry receiving station, the protection value corresponds to a pfd at the telemetry receiving station in any 4 kHz band for all methods of modulation:

–180.0	dB(W/m^2)	for	$0° \leq \alpha \leq 2°$
–187.1 + 23.66 log α	dB(W/m^2)	for	$2° < \alpha \leq 11{,}5°$
–162	dB(W/m^2)	for	$11.5° < \alpha \leq 90°$

where α is the angle of arrival (degrees above the horizontal plane);

3 that the calculation methods and mitigation techniques given in Annexes 1 and 2 may be used, as applicable, for determining the probability of interference to telemetry systems in the aeronautical mobile service.

NOTE 1 – DSB refers to digital audio broadcasting as per RR Nos. S5.345 and S5.393.

NOTE 2 – The example calculation used to derive the protection values as set out in Annex 1 represent a worst-case scenario. Mitigation techniques given in Annex 2 may enhance sharing.

NOTE 3 – As safety of life aspects are to be considered with mobile aeronautical telemetry systems and efficient use of the spectrum allocated by WARC-92 to the BSS (sound) appears not to be possible, attention is drawn to studies being conducted under Question ITU-R 204/10 (see Recommendation ITU-R BO.1383).

NOTE 4 – Administrations are encouraged to submit information to ITU-R concerning performance and availability targets for the mobile aeronautical telemetry service with a view to developing an appropriate ITU-R Recommendation.

ANNEX 1

Calculation of pfd interference levels to aeronautical mobile telemetry systems from geostationary satellite emissions

1 Introduction

The analyses and results given in the following sections of this Annex are for the purpose of calculating interference to aeronautical mobile telemetry systems.

2 Development of values

The following development can be used in general, but the numerical values are for the 1 452-1 525 MHz band.

2.1 Telemetry system characteristics

General system characteristics are given in the CPM Report to WARC-92 and are as follows. Aeronautical telemetry and telecommand operations are used for flight testing of manned and unmanned aerospace vehicles. Vehicles are tested to their design limits, thus making safety of flight dependent on the reliability of information received on a real-time basis. When being tested to design limits, signal strength loss can exceed 30 dB due to nulls in the aircraft antenna pattern caused by aircraft attitude changes.

Required *C/N*:	9-15 dB
Transmitter power:	2-25 W
Modulation type:	PCM/FM
Transmission path length:	up to 320 km
Receiving system noise temperature:	200-500 K
Receiving antenna gain:	20-41 dB

Receive antenna first side-lobe levels for two antennas:

10 m (diameter):	20 dBi (antenna gain)
	2.4° (from centre)
2.44 m (diameter):	7-14 dBi (antenna gain)
	10° (from centre)

A number of antenna diameters are employed between the 20-41 dB limits. Left-hand and right-hand circular, as well as linear polarizations, are used.

Channel assignments are made in 1 MHz increments. Typical emissions are 1, 3 and 5 MHz in bandwidth with wider assignments made for video and other complex measurements.

The maximum air space for a telemetry receiving site is defined as a cylinder with a horizontal radius of 320 km around the site, with the lower bound determined by visibility and the upper bound determined by an altitude of 20 km. The minimum air space for a particular mission is defined as a vertical cylinder with a radius of 20 km within the maximum air space with the same lower and upper bounds as for the maximum air space.

Continuous RF tracking is employed using both monopulse and conical scan techniques.

Two antenna diameters are given a 2.44 m and a 10 m diameter. Figure 1 shows measured gain values for three 2.44 m antennas. Since these antennas track a moving vehicle so that the antenna gain toward a geostationary satellite is variable, there is a side lobe and backlobe gain which is exceeded or not exceeded 50% of the time. The following composite pattern is developed on this basis for antenna gains from 29 dB to 41.2 dB.

$$G(\theta) = 41.2 + 20\log\left(\frac{\sin 1.952\theta}{1.952\theta}\right) \quad \text{dBi} \quad \text{for} \quad 0° \le \theta \le 0.94° \qquad (1a)$$

$$G(\theta) = 35.1 - 20\log\theta \quad \text{dBi} \quad \text{for} \quad 0.94° < \theta \le 3.82° \qquad (1b)$$

$$G(\theta) = 29 + 20\log\left(\frac{\sin 0.479\theta}{0.479\theta}\right) \quad \text{dBi} \quad \text{for} \quad 3.82° < \theta \le 5.61° \qquad (1c)$$

$$G(\theta) = 27.27 - 18.75\log\theta \quad \text{dBi} \quad \text{for} \quad 5.61° < \theta \le 12.16° \qquad (1d)$$

$$G(\theta) = 34.05 - 25\log\theta \quad \text{dBi} \quad \text{for} \quad 12.16° < \theta \le 48° \qquad (1e)$$

$$G(\theta) = -8 \quad \text{dBi} \quad \text{for} \quad 48° < \theta \le 180° \qquad (1f)$$

The values of 1.952 and 0.479 associated with angle θ are in radians.

The telemetry transmitting antennas are mounted on airborne vehicles and, ideally, would be isotropic radiators to cover all possible radiation angles toward the telemetry receiving station. However, in practice, multiple reflections and blockage from the airborne vehicles cause large variations in the gain pattern. Multiple reflections generally result in a Raleigh fading distribution, and measured gain functions have shown that this is approximately the case as shown in Fig. 2. Using Fig. 2 for a near-worst case, including propagation effects, the probability (portion of time), P_1, that a given gain, G_1, is not exceeded can be expressed as:

$$P_1\,(G \leq G_1) = (1 - e^{-3.46\,G_1})^{1.25} \text{ (numerical)} \qquad (2)$$

Distributions corresponding to an exponent of $(-5G_1)$ are observed.

The received *C/N* and carrier power, *C*, at output of the telemetry receiving antenna are proportional to this function.

FIGURE 1

Measured data on 2.44 m diameter antennas

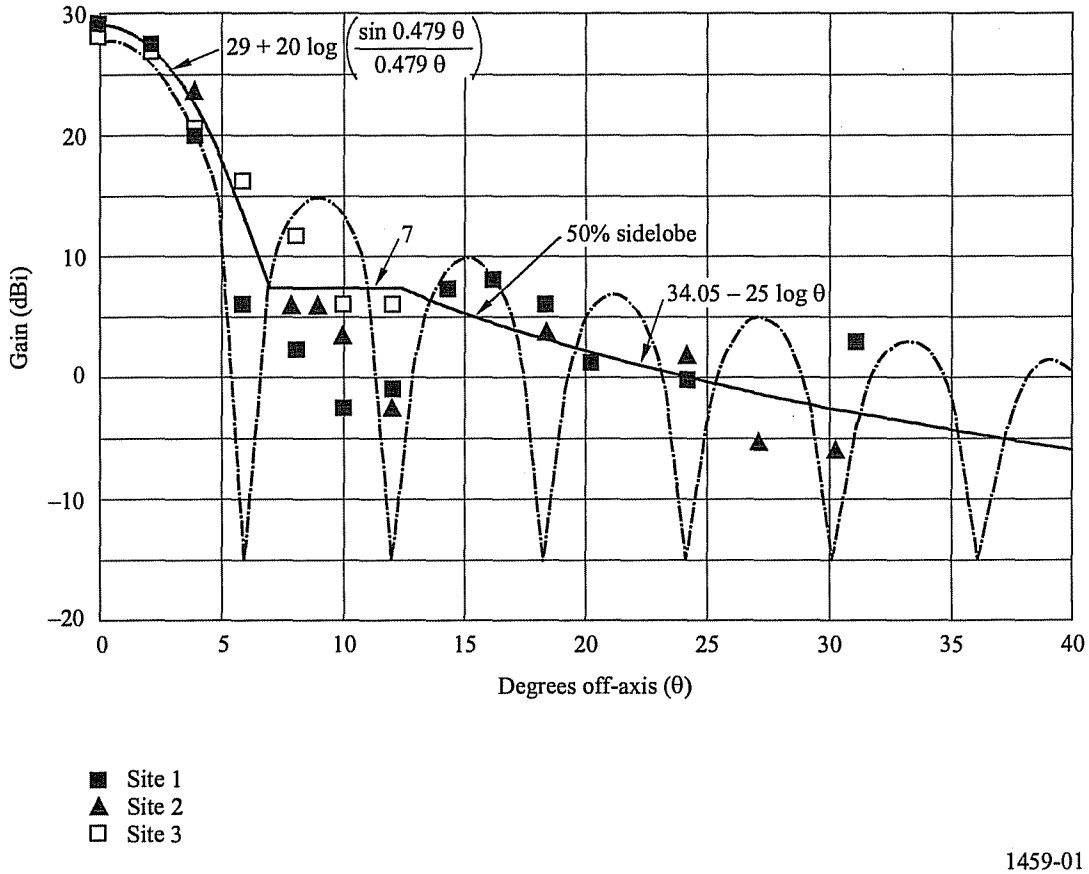
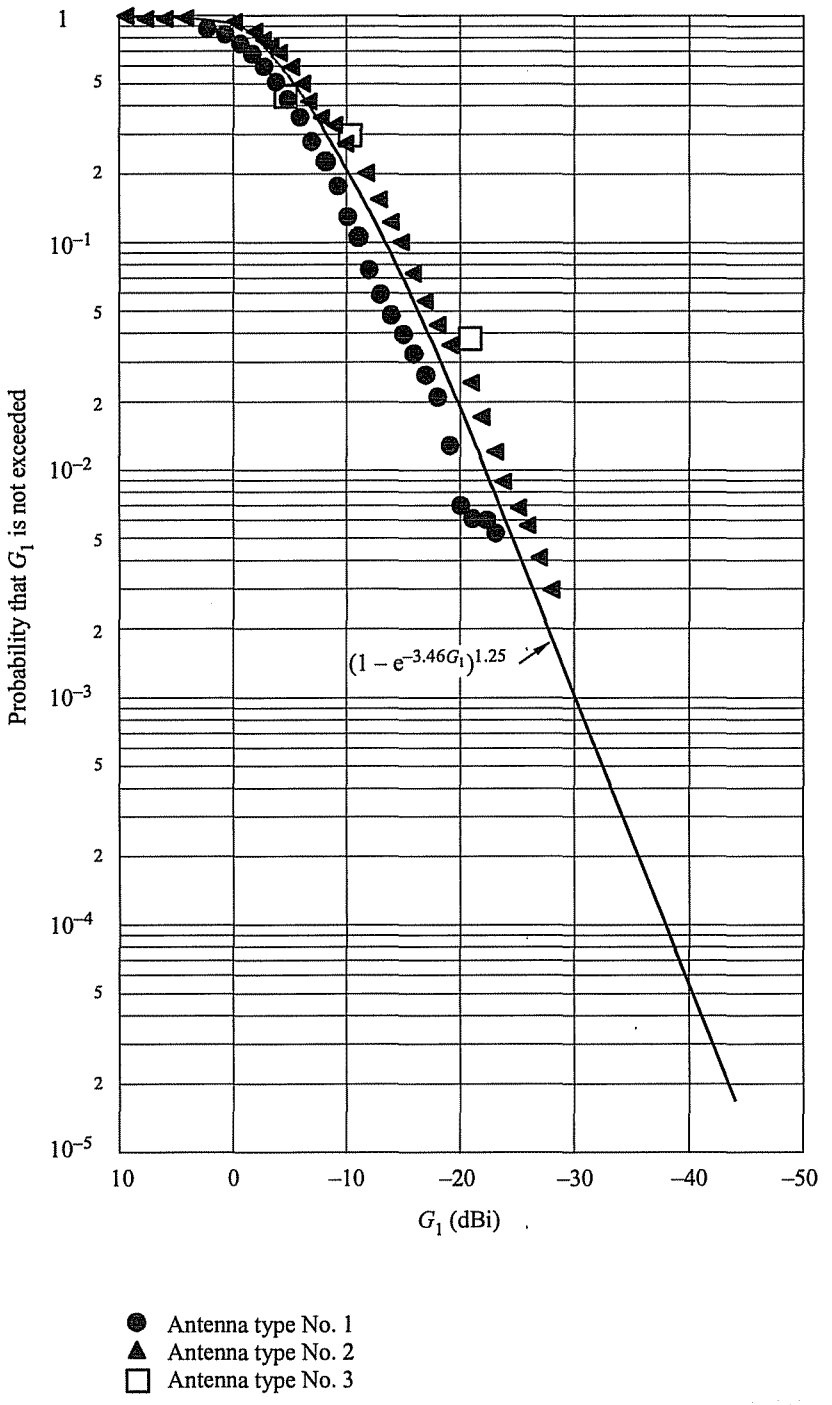


FIGURE 2

Airborne telemetry transmitting antenna gains, G_1



1459-02

2.2 Interference from geostationary satellites

2.2.1 Time-gain function of interference

If it is assumed that the telemetry antenna may be pointed at any point on its hemisphere of visibility, the cumulative probability, P_2, that a satellite at geostationary altitude is within a radius of θ, as viewed from the telemetry receiving station, is:

$$P_2 = (1 - \cos\theta) \qquad \text{for} \quad 0 \le \theta \le \pi/2 \tag{3}$$

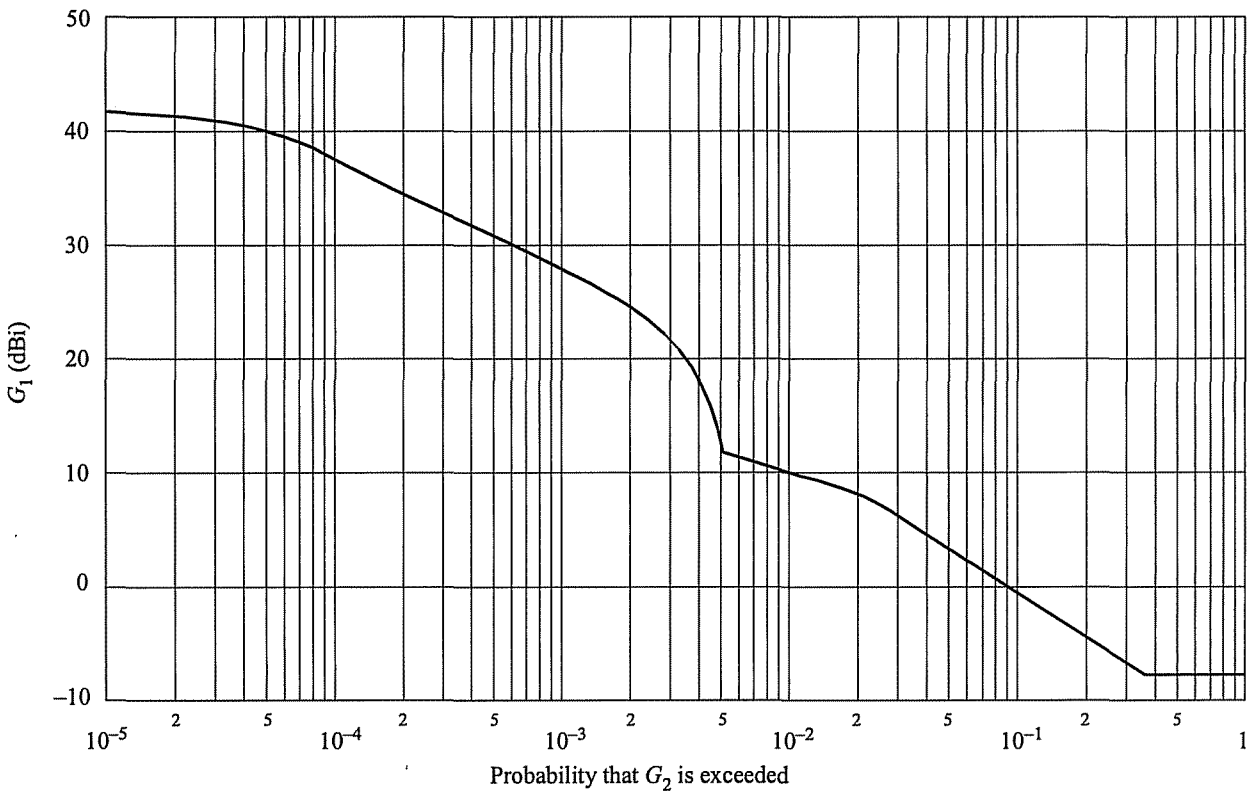
The θ in equation (1) is the same as in equation (3). Thus, by combining equations (1) with (3), functions can be developed which relate the probability (portion of time) that the telemetry receiving antenna gain, G, toward the satellite is equal to or greater than a given value, G_2, as shown in Fig. 3.

The received I/N and the interference power, I, are proportional to the functions shown in Fig. 3.

In the case of geostationary satellite, the angle-of-arrival of interference at a telemetry receiving station is fixed. The only randomness involved is the telemetry receiving antenna pointing variations. Testing of airborne vehicles is often restricted to areas over water or uninhabited land in order to preclude danger to life or property in case of catastrophic failure of the vehicle being tested, thereby limiting the azimuth angles for these tests. There are also minimum limits on the azimuth and elevation pointing angle variations of the telemetry receiving antenna that are defined by the minimum air space in § 2.1.

FIGURE 3

Telemetry receiving antenna gain probability, G_2



1459-03

2.2.2 *C/I* analysis

Since equation (2) is proportional to C and the functions in Fig. 3 are proportional to I, the probability of C/I can be determined and is proportional to:

$$P((C/I) \geq (C/I)_c) \propto \left[(P_1(G' \leq G_1))/(P_2(G'' \leq G_2))\right] \tag{4}$$

where $(C/I)_c$ is a chosen value.

The square brackets indicate the joint, cumulative probability function. The C and I functions are independent since they result from independent sources. The indicated integrations were performed for various limited ranges of P_2 which, in turn, corresponds to limited steradian areas, S, when the satellite is within the minimum airspace defined in § 2.1. These integrations may be expressed as:

$$P_3(\Delta G \geq G_2/G_1) = \left[(P_2(G'' \geq G_2))/(P_1(G' \leq G_1))\right] \tag{5}$$

The (C/I) in equation (4) is normally expressed in relation to (C/N), and since loss of availability is the prime concern, it is expressed in relation to the threshold $(C/N)_T$ as follows:

$$(C/I) \geq (C/N)_T (P_4/P_3) \tag{6}$$

where

P_4: probability associated with $(C/N)_T$ and is set equal to $P(\Delta G)$

P_3: probability associated with (C/I).

The ratio (P_4/P_3) is analogous and numerically equal to (I/N) criteria. The allowable non-availability, P, is based on $C/(N+I)$ so that $P(\Delta G) = P - P_3$ which results in:

$$P(\Delta G) = P/(I/N + 1) \tag{7}$$

It is now necessary to relate ΔG to pfd. First, a pfd is determined when the telemetry antenna is directed toward the satellite:

$$pfd \leq \frac{k\,T\,B(I/N)}{(\lambda^2/4\pi)\,G_0} \qquad \text{W/(m}^2 \cdot B) \tag{8}$$

where:

k: Boltzmann's constant

T: noise temperature (K)

B: bandwidth (Hz)

$G_0 = 13\,183$ (41.2 dB).

This pfd is associated with a $(\Delta G)_m$ at a $P(\Delta G)$. At G_0, only C is variable and thus, C/I is given by equation (2). The $(\Delta G)_m$ function is closely approximated by:

$$(\Delta G)_m = 45\,000/P(\Delta G)^{1.25} \tag{9}$$

The pfd from equation (8) can be increased by $(\Delta G)_m/(\Delta G)$. Thus:

$$pfd \leq \frac{k\,T\,B(I/N)}{G_0\,(\lambda^2/4\pi)} \times \frac{(\Delta G)_m}{(\Delta G)} \qquad P(\Delta G)_m = P(\Delta G) \qquad \text{W/(m}^2 \cdot B) \tag{10}$$

2.2.3 Impact on telemetry link design

Analyses show that the value of P, the telemetry link non-availability, does not significantly affect the pfd values. The pfd values are primarily determined by the value of (I/N). The impact on the telemetry link measured in terms of the decrease in usable range, R, for a given P, as a function of (I/N) can be determined from equation (7), since $R^2 \propto 1/(N+\mathrm{I})$ for a fixed transmitter power. The decreased usable range as a function of (I/N) is shown in Fig. 4. The impact on telemetry link design becomes severe for (I/N) values greater than one (0 dB) because the link must be designed to overcome interference rather than internal noise. The maximum practical value is considered to be approximately 0.5 (–3 dB) with smaller values desired.

2.2.4 Interference allowances

Based on the factors given in § 2.2.3, the following aggregate allowances appear appropriate for this case. The total noise is the sum of internal noise, N_I, plus interference from satellites, I_S, plus interference from terrestrial sources, I_T. The aggregate permissible interference from satellites and terrestrial sources are:

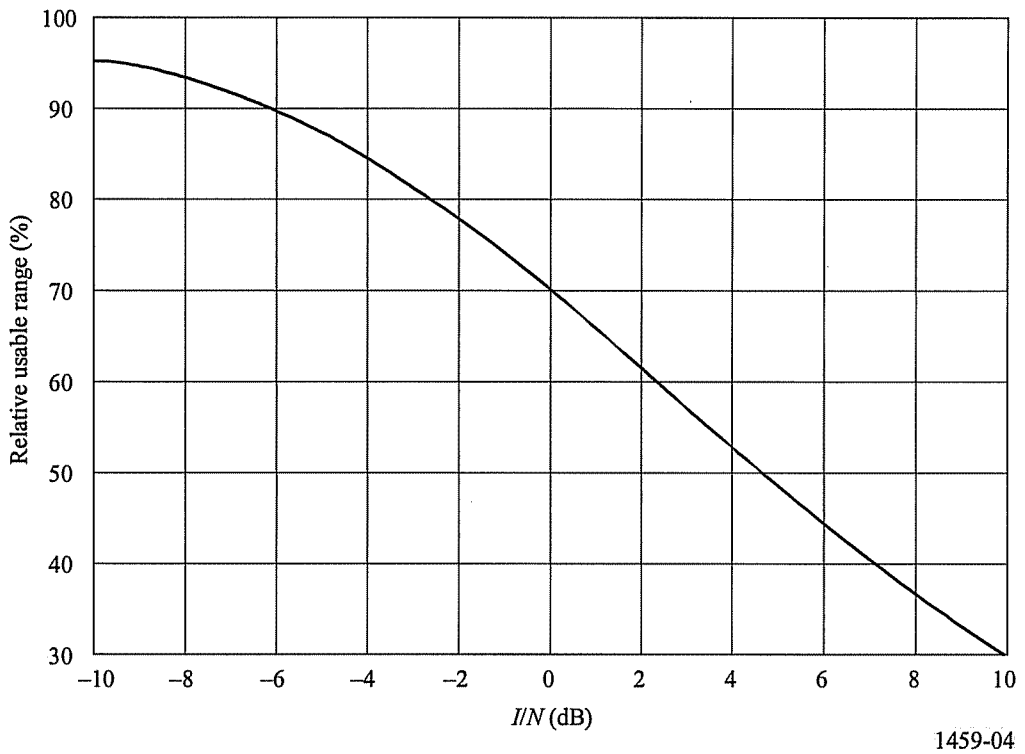
$$I_S = 0.25\,(N_I + I_S + I_T) \tag{11}$$

$$I_T = 0.10\,(N_I + I_S + I_T) \tag{12}$$

From this, the aggregate allowable I/N from satellites is 0.3846 or –4.15 dB, and from terrestrial sources is 0.1538 or –8.13 dB. Since pfd is not particularly sensitive to P, a mid-range value of P of 0.005 is selected for numerical evaluation which results in a $P(\Delta G)$ of 0.003611 from equation (7).

FIGURE 4

Decrease in usable range versus *I/N*



2.2.5 Minimum *S* versus angle of arrival, α

The minimum value of *S* can be determined from the minimum radius of a circle in which aircraft testing is normally accomplished (see Fig. 5). *S* as a function of α is determined as follows. The elevation angle of arrival is:

$$\alpha = \tan^{-1}\left(\frac{h}{d} - \frac{d}{2r}\right) \qquad \text{rad} \tag{13}$$

The incremental angle of arrival, Δα, along the telemetry antenna pointing azimuth is:

$$\Delta\alpha = \tan^{-1}\left(\frac{h}{d-a} - \frac{d-a}{2r}\right) - \tan^{-1}\left(\frac{h}{d+a} - \frac{d+a}{2r}\right) \qquad \text{for } d \geq a \qquad \text{rad} \tag{14a}$$

$$\Delta\alpha = \tan^{-1}\left(\frac{d+a}{h}\right) - \tan^{-1}\left(\frac{d-a}{h}\right) \qquad \text{for } d < a \qquad \text{rad} \tag{14b}$$

The angle tangent to the azimuth, β, is:

$$\beta = 2\tan^{-1}\left(\frac{a\cos\alpha}{d}\right) \qquad \text{rad} \tag{15}$$

From which *S* is:

$$S = \pi/4\,(\beta)\,(\Delta\alpha) \qquad \text{steradians} \tag{16}$$

where:

h: aircraft altitude = 20 km

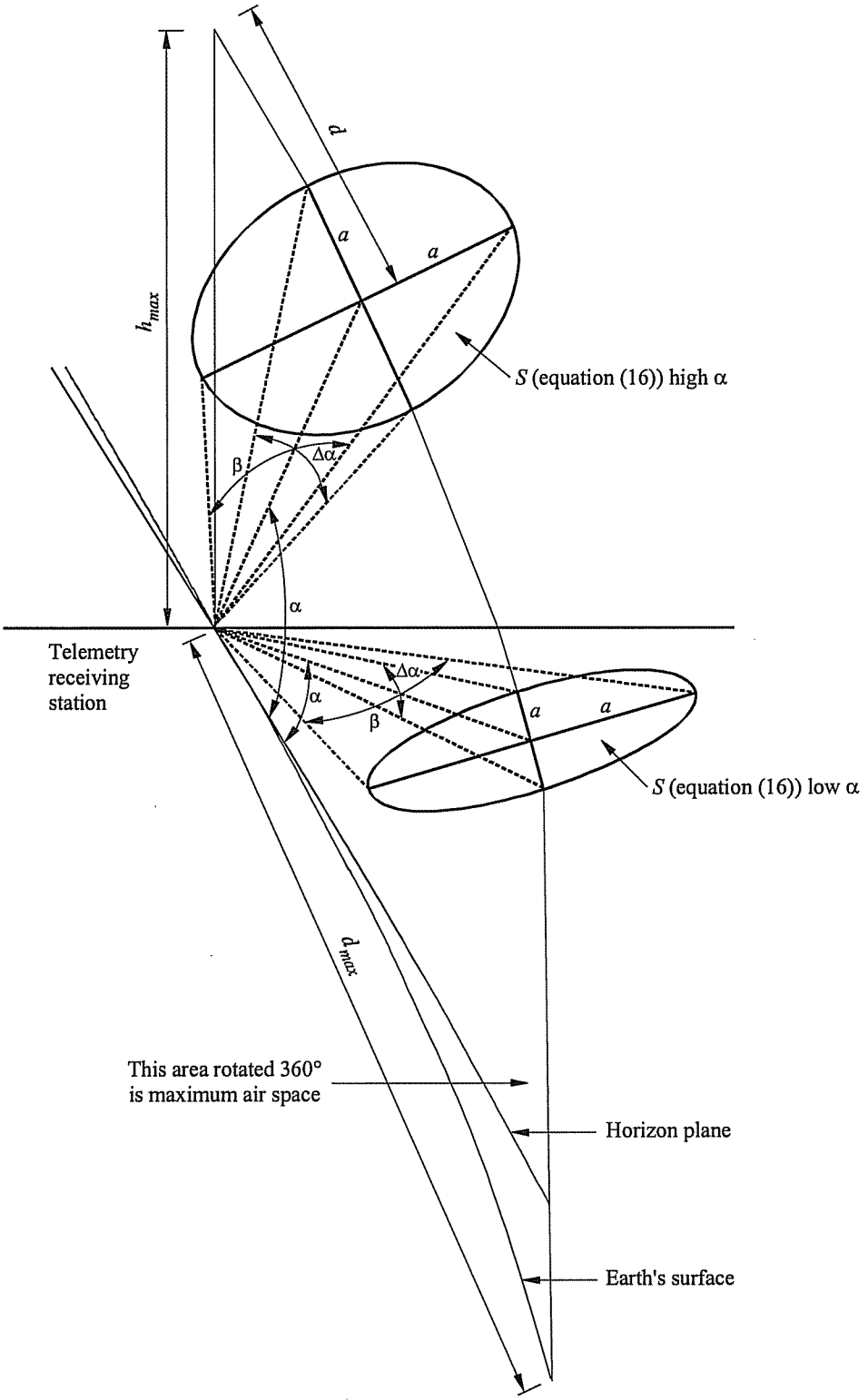
d: surface distance to aircraft = 320 km (maximum)

r: radius of the Earth = 6 378 km

a: minimum radius of flight patterns = 20 km.

FIGURE 5

Geometry for *S* computations for geostationary satellites



β (equation (15))
Δα (equation (14))
α (equation (13))

1459-05

2.2.6 pfd versus angle of arrival

– pfd escalation due to S

The permissible pfd increases with S which increases with angle of arrival, α. The pfd as a function of S can be calculated using equation (16), in conjunction with the ΔG versus S functions developed in § 2.2.5, for a $P(\Delta G) = 0.003611$ which, in turn, is used in equation (10). The minimum S is 0.001262 steradians.

– pfd escalation due to excess margin

There will be some distance, d_0, between the telemetry receiving station and the airborne vehicle at which the desired availability is generally exceeded. Thus, excess margin is available which could be used to increase the allowable pfd. The value of d_0 can be determined by:

$$d_0 = \left\{ \frac{P\, G_a\, G_0}{1\,758\, k\, T\, B\, M\, f^2 (C/N)_T} \right\}^{0.5} \quad \text{km} \tag{17}$$

where:

P: aircraft power (W) = 4

G_a: aircraft median antenna gain = 0.2

G_0: telemetry receiving antenna gain = 800

M: availability margin required = 300

f: frequency (MHz) = 1 500

k: Boltzmann's constant

T: noise temperature (K) = 250

B: bandwidth (Hz) = 3×10^6

$(C/N)_T$: threshold value = 32.

The nominal values for each parameter as listed above are considered to be the most appropriate for determining d_0. The solution of equation (17) with these values result in a d_0 of 40 km.

The angle of arrival, α, is determined by the distance, d and the aircraft height, h and is:

$$\alpha = \arcsin (h/d) \tag{18}$$

From equation (18), α as a function of d, for values of d between d_0 and h can be determined. The excess margin, M_e, which can be used to increase the pfd is:

$$M_e = (d_0/d)^2 \tag{19}$$

The maximum value of h is assumed to be 20 km. Using these values M_e as a function of α is computed. A nearly exact formulation of this function can be expressed as a pfd escalation factor, pfd_e, as follows:

$$pfd_e = 1 \quad \text{for} \quad 0° \leq \alpha \leq 30° \tag{20a}$$

$$pfd_e = 1 + 0.066\,(\alpha - 30) \quad \text{for} \quad 30° < \alpha \leq 62.5° \tag{20b}$$

$$pfd_e = 4 \sin^2 \alpha \quad \text{for} \quad 62.5° < \alpha \leq 90° \tag{20c}$$

2.2.7 Multiple entries

When the value of S is very small, sidelobe and back lobe interference levels from similar satellites in the GSO will be insignificant as compared to the main lobe level. As S increases, the sidelobe and back lobe contributions become statistically significant and are accounted for on a per-satellite basis in § 2.2.1. Therefore, multiple entries are primarily related to the number of geostationary satellites within the limited steradian coverage of the telemetry antenna, S.

First, it is assumed that an area, S', is circular and that its diameter, δ, is aligned with the GSO, and second, it is assumed that there are N satellites equally spaced by an angle, Δ, each producing equal pfds at the telemetry antenna.

When δ is equal to Δ, two entries are possible but the probability is near 0. When δ is equal to 2Δ, the probability of two entries is near 1, while probability of three entries is near 0, and so forth. Thus, for a probability of about 0.5:

$$\delta = (N - 0.5)\,\Delta \qquad \delta \text{ and } \Delta\text{, degrees} \tag{21}$$

The area S' is:

$$S' = (\pi/4)\,\delta^2 \qquad \text{steradians} \qquad \delta\text{, rad} \tag{22}$$

From this model, N is closely approximated by:

$$N = 70(S')^{0.5}/\Delta \qquad \text{for} \quad \Delta^2/4\,900 \le S' \le 1.938 \tag{23}$$

Since $N \ge 1$, $S' \ge \Delta^2/4\,900$, and since the "maximum" minimum value of S from § 2.2.5 is 1.938, N in equation (23) is limited to this range. Thus, N is limited to the range; $1 \le N \le ((90/\Delta) + 0.5)$.

The single entry escalation, pfd_{es}, is related to the aggregate pfd_{ea} by:

$$pfd_{es} = pfd_{ea}/N \tag{24}$$

2.3 Single entry pfd values

From the preceding analyses, values of single entry pfds may be developed. The pfd single entry values developed in the following sections are applicable for aeronautical mobile telemetry systems. Telemetry systems parameter values are as follows:

T: receiving station noise temperature = 250 K

B: referenced bandwidth = 4 kHz

λ: wavelength = 0.2 m

I/N: interference/noise = 0.3846

$P(\Delta G)$: probability of differential gain = 0.003611.

Using these values in conjunction with the ΔG versus S function, the excess margin and multiple entry factor for a Δ of 45°, results in the function shown in Fig. 6. As also shown in Fig. 6, the pfd versus angle of arrival is closely approximated by:

$$pfd \le -181.0 \qquad \text{dB(W/(m}^2 \cdot \text{4 kHz))} \qquad \text{for} \quad 0° \le \alpha \le 4° \tag{25a}$$

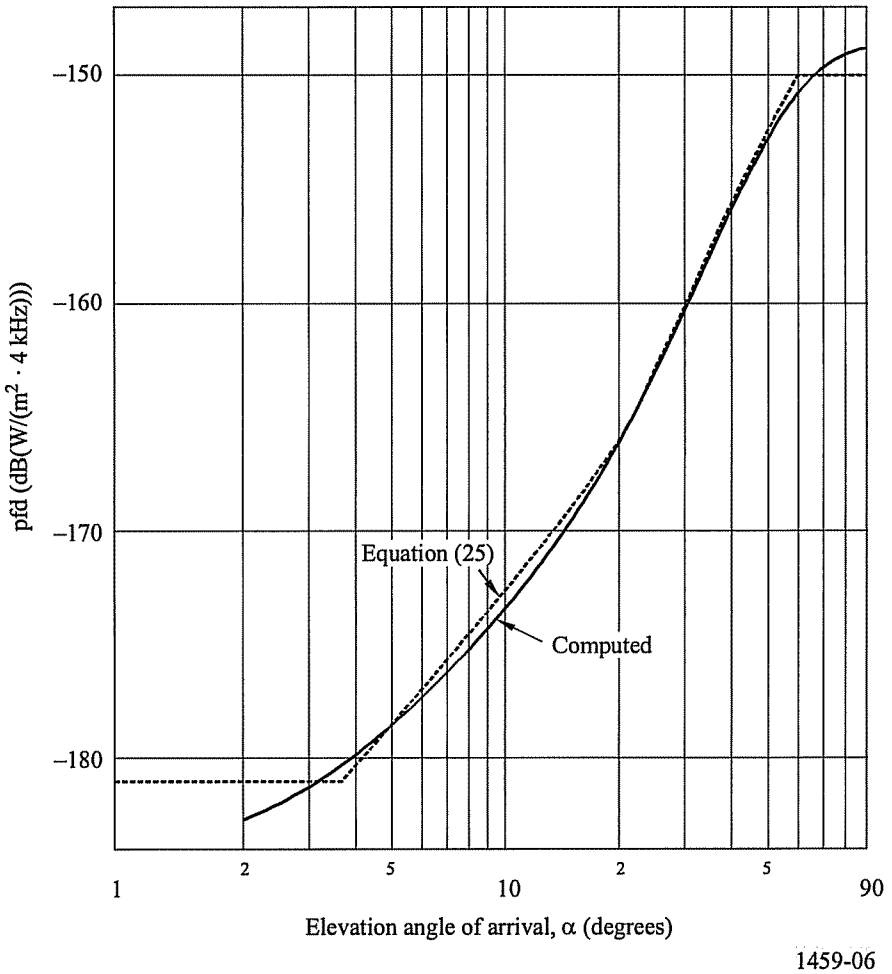
$$pfd \le -193.0 + 20 \log \alpha \qquad \text{dB(W/(m}^2 \cdot \text{4 kHz))} \qquad \text{for} \quad 4° < \alpha \le 20° \tag{25b}$$

$$pfd \le -213.3 + 35.6 \log \alpha \qquad \text{dB(W/(m}^2 \cdot \text{4 kHz))} \qquad \text{for} \quad 20° < \alpha \le 60° \tag{25c}$$

$$pfd \le -150 \qquad \text{dB(W/(m}^2 \cdot \text{4 kHz))} \qquad \text{for} \quad 60° < \alpha \le 90° \tag{25d}$$

FIGURE 6

Single entry thresholds for aeronautical telemetry receiving stations due to interference from geostationary satellites



ANNEX 2

Mitigation techniques

1 Mitigation techniques for telemetry systems in the aeronautical mobile service

The following mitigation techniques should be reviewed and used to the extent practical towards achieving successful sharing with the BSS (sound).

1.1 Frequency avoidance

If possible avoid the use of those portions of the affected frequency bands. In the case of isolated telemetry sites (no overlapping air space with any other site) with a light testing schedule, it may be possible to avoid use of portions of the bands allocated to BSS (sound). In the case where many site coverage overlaps occur and simultaneous testing occurs, frequency avoidance may not be possible.

1.2 Polarization discrimination

In situations where it is possible for telemetry systems in the aeronautical mobile service to use opposite polarizations than those employed by BSS (sound) systems then some polarization discrimination may be achievable during the worst-case interference scenario when the BSS (sound) transmit and the telemetry receive antenna boresights are in near alignment.

1.3 Modulation and bandwidth considerations

There are several types of modulations and bandwidths used in telemetry systems in the aeronautical mobile service with a general trend towards becoming all digital. Use of digital modulation will facilitate the use of FEC coding techniques that would provide a higher degree of immunity or coding gain against BSS (sound) interference. Also from the standpoint of the interfering BSS (sound) signal being digital, will exhibit noise-like interference into the telemetry signal.

pfds are currently specified in a 4 kHz bandwidth at these frequencies. When the interfered-with signal is analogue or digital, limiting the interference levels in such a narrow bandwidth may lead to overly protective criteria. The use of more appropriate averaging bandwidths for particular sharing situations can more accurately represent protection requirements. For this case a 400 kHz averaging bandwidth can be used.

1.4 Telemetry airborne transmit antenna diversity

An important parameter in telemetry systems in the aeronautical mobile service is the signal availability. Manoeuvres of the airborne test vehicle can result in severe fading of the telemetry receive signal which typically follows a Rayleigh distribution. In some cases it is feasible to employ multiple transmit antennas along the body of the test vehicle to provide transmitter antenna diversity which could result in significant reduction of signal fading.

1.5 Telemetry site diversity

Some telemetry test ranges in the aeronautical mobile service employ two or more receive antennas. If these antennas can be arranged to provide site/space diversity a significant reduction in Rayleigh signal fading would be achieved. Also properly spaced receive antennas may result in avoidance of boresight-to-boresight interference scenarios and boresight-to-sun scenarios further improving telemetry signal availability and improving sharing. Combining frequency and site diversity would further reduce the fading margins.

1.6 Aeronautical telemetry test range geometry

In most interfering situations boresight-to-boresight scenarios will result in worst-case interference. If the previously described countermeasures are not viable or sufficient, a flight path for the test vehicles may be selected so as to avoid the most critical azimuths corresponding to near boresight conjunction and the avoidance of lower elevation angles. The particular arrangement and degree of success achievable will depend on the mutual spatial position of the test range telemetry receive antenna and BSS (sound) interfering transmitter.

Perhaps the single most effective mitigation technique from the aeronautical mobile telemetry standpoint would be to avoid telemetry antenna main lobe conjunctions with geostationary satellites. This case has been analysed for the 1 452-1 525 MHz band and it is estimated that about 20 dB of additional protection could be achieved at very low angles of arrival to about 5 dB at near zenith. The extent to which this technique can be employed depends on the geometry of the test ranges and the flight patterns which are not known at this time.

1.7 Aeronautical telemetry receiver interference cancelling techniques

Active suppression of interference is regularly used in dual polarization FSS and fixed service radio systems and on many occasions where specific difficult sharing scenarios occur. Significant interference suppression may be achieved depending on the fading dynamics. Such techniques could be a means of ameliorating particular interference situations that occur.

1.8 General sharing assessment

Even under the most favourable geometric conditions with mitigation techniques, it is extremely unlikely that a successful sharing could be achieved under co-coverage, co-frequency conditions, considering that the required pfd for the BSS (sound) service is of up to –122 dB(W/(m^2 · 4 kHz)).

However, under favourable geometric conditions and where BSS (sound) satellite antenna discrimination to the telemetry receiving antennas in the order of 30 dB can be achieved, there is a reasonable expectation of successful sharing for low-power systems, i.e. in the order of –138 dB(W/(m^2 · 4 kHz)). However, this value is not typical for BSS (sound) systems.

2 Mitigation techniques to facilitate sharing with BSS (DSB) systems

2.1 BSS (sound) systems

It is normally presumed that new systems in the planning and early implementation stages have more flexibility in choosing operating parameters that will facilitate sharing with existing services. The following lists some possible mitigation techniques that could be considered applicable to the BSS (sound) service to alleviate sharing. Also the results of different ITU-R studies agree with the views stated below on the feasibility and applicability of these mitigation techniques.

2.2 Orbit location

The selection of orbital locations that minimizes exposure and spill-over into critical mobile aeronautical telemetry (MAT) sites is a possible mitigation technique. The ITU-R considers that it would be very difficult to select orbital locations to minimize exposure to the affected services. The BSS (sound) expects to offer a worldwide service, and the countries who use MAT systems are spaced around the world so that it is impossible not to illuminate one or more of them. Furthermore, in many instances there are constraints on the choice of orbital locations available to provide a viable BSS (sound) service. Therefore, the ITU-R does not believe that significant advantage can be gained from this technique.

2.3 Modulation and implementation

This involves the employment of efficient modulation and channel coding schemes, and utilization of path diversity techniques that minimize pfd requirements in achieving the desired level of system performance and availability.

The comments of the ITU-R on this mitigation technique is that it has been diligent in its search for efficient modulation and channel coding schemes. Indeed, the work discussed in ITU-R in recent years has been innovative and significant in its ability to enable spectrum efficient systems to be considered. It is not likely that any further improvements will lead to major reductions in the necessary pfds, and hence improvements in the sharing scenario.

2.4 Spectrum spreading

Employing spread spectrum techniques reduces the pfd by the inverse of the spread ratio (spread bandwidth/unspread bandwidth) and increases the interference immunity by the spread ratio.

The ITU-R considers that spectrum spreading as a method of ameliorating sharing implies that there is sufficient spectrum allocated to the service to be able to spread the energy of the interfering signal over a larger bandwidth to provide a corresponding reduction in the pfd per unit of bandwidth, in this case per 4 kHz. Furthermore, in order to maximize this advantage, each interfering BSS (sound) service would need to utilize exclusive spectrum (i.e. no overlapping of the spread spectrum channels). Considering the relatively narrow-band of spectrum allocated to BSS (sound) by WARC-92, and further considering that this spectrum is shared with the broadcasting service (sound), spectrum spreading would not be a feasible mitigation technique to achieve sharing. This is illustrated by way of the following example:

The order of improvement in pfds to enable sharing appears to be greater than 30 dB. To achieve even 20 dB using spread spectrum techniques would, using normal pseudo-noise spreading systems, require a spreading gain of about 100,

and hence use a spreading factor of 100. Given that the BSS band at 1.5 GHz is 40 MHz wide and we expect will, in time, be fully utilized, this would lead to a spectrum requirement for the BSS operation of 4 GHz if spread spectrum techniques were to be adopted.

2.5 Receiver performance

Maximization of the receiver figure of-merit, *G/T*, by employing low noise front ends and maximum gain antennas consistent with costs and the type of service being offered is a possible mitigation technique.

The ITU-R considers that RF device technology has now improved to the point that the low noise front end is not the limiting factor in setting the receiver noise budget. Typical receiver noise figures being considered range from 1-3 dB. As other sources of noise at the receiver, such as radiation from the ground, sky and surrounding objects, input filter losses, etc., contribute a significant portion of the overall receiver noise budget, we would therefore be suffering diminishing returns in considering reduction in receiver noise figure as a significant mitigation technique. Improving the gain of the antenna is feasible, and has been adopted in our attempts to realize cost-effective solutions. However, there is a limit to the amount that we can go in this direction when we consider that we are attempting to provide a service to mobile and portable receivers, and to offer a system which can be implemented at a price which can be afforded by all. Therefore, it would be difficult to achieve significant improvements in sharing by any possible improvements in the receiver *G/T*.

2.6 Satellite transmit antenna and coverage area

This mitigation technique consists of minimizing the satellite beam spill-over to the extent practical by utilizing beam shaping to conform as closely as practical to the intended service area.

The ITU-R considers that all proposals for BSS (sound) satellites pay careful attention to antenna engineering. The size of the antenna, and the need to minimize spill-over for efficient use of the BSS (sound) spectrum for our own purposes mean that beam shaping is already fully optimized. Also, while beam shaping will lead to more rapid roll-off of the close-in sidelobe levels (e.g. first sidelobe) thus facilitating sharing with services near the edge of the coverage area, such techniques do not improve the levels of the higher order sidelobes and hence will not improve sharing for systems located further from the edge of the coverage area which will tend to also correspond to lower elevation angles where the minimum pfd levels are required.

2.7 Highly-inclined elliptical orbit (HEO) BSS (sound) systems

For HEO systems, selection of orbital constellations that maximizes the elevation angles to affected MAT sites and making available Ephemeris (spatial and time information on the orbits) data to MAT operators are possible mitigation techniques.

The ITU-R considers that, given the large number of countries using fixed systems and the incomplete information about the location of these systems, it is not likely that any major improvement can be gained for HEO systems, other than those already achieved for the benefit of the broadcast service.

2.8 Frequency avoidance

This consists of selecting that part of the spectrum allotted to BSS (sound) least utilized by MAT systems when possible.

The ITU-R considers that this mitigation technique, while not representing in the true sense sharing, appears to be the only one which can be realistically exploited. The ITU-R realizes that, in the case of MATS, some of the band occupied by the MAT systems are safety of life systems. It would appear reasonable that, if at all possible, these elements of the MAT service occupy that part of the spectrum not occupied by BSS. It would make reasonable sense to require protection of this part of the service at the proposed levels.

The overall conclusions of the ITU-R on the above mitigation techniques to be applied to the BSS (sound) is that, except for the frequency avoidance technique, the sum of the improvements expected from the application of these mitigation techniques will not be nearly sufficient to ensure that successful sharing can be achieved. That being the case, the ITU-R considers that any improvements in sharing that may be achieved by the application of these and any other mitigation techniques would need to ensure that all administrations would have the capability of implementing the BSS (sound) service in the appropriate band allocated by WARC-92 and without the need for major constraints being placed on the level of service that can be provided.

3 Practical measures to permit inter-service sharing

When interference calculations are being made, worst-case scenarios are likely to be used, which could tend to lead to the conclusion that co-frequency or co-channel sharing by different services cannot occur. General technical parameters are used to establish appropriate sharing criteria. Those parameters may not reflect the actual proposed usage by administrations.

Where an administration wishes to establish a new system and appropriate sharing criteria have not been finalized, the measures outlined below should be considered to ensure that harmful interference is not caused to the existing service or to the proposed new service.

3.1 The affected administrations should identify specific areas, or installations, where such interference is likely to occur. It may then be possible to take specific action to adequately protect such areas or installations.

3.2 Initially, geographical separation will be a consideration, but as adjacent border areas will be most affected, this option may be limited.

3.3 When specific installations or sites have been identified as being affected, practical methods such as interference cancellers, special screening, and adaptive antenna systems may be implemented (see Recommendation ITU-R SM.856).

3.4 Modifications to existing channelling arrangements for systems in the fixed service may also need to be considered, provided this approach is consistent with economic advantage.

3.5 In the longer term, moves to the use of improved transmission techniques, such as spread spectrum (see Recommendation ITU-R SM.1055), coding techniques, automatic power control, and energy dispersal, may further facilitate inter-service sharing.

EXHIBIT G

DONALD J. HOEHN DECLARATION

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DECLARATION

I, Donald J. Hoehn, hereby declare as follows:

I hold the position of Radio Frequency/Telemetry Specialist, Learjet Inc., a subsidiary of Bombardier Inc. I am responsible for the operation of our Company's telemetry equipment. I have held my position for ten years and have been a practicing electrical engineering technologist for 18 years. At Wichita, we manufacture and flight-test all models of Learjet business jet aircraft, and conduct flight testing for all aircraft models manufactured by Bombardier Aerospace, such as the CRJ Series Regional jet utilized by many airlines.

I have read and am familiar with the attached Comments being filed this date. The statements made therein are true and correct to the best of my knowledge and belief.

In connection with the GE Healthcare proposal, I supervised the conduct of a test of the effects of a 1 mW undesired co-channel signal on the performance of our telemetry system. That test was conducted according to a detailed test plan. The objectives of that plan were to determine whether a signal at the power level proposed by GE Healthcare would cause interference to the Learjet telemetry system and, if so, to characterize the effects of that interference.

For example, we wanted to determine whether the undesired signal would degrade data integrity, whether the interference would interfere with our ability to track the aircraft, and the maximum range at which the data and tracking remained reliable in the presence of the undesired signal.

The results of our test are set forth in the spreadsheet attached hereto. Key findings are as follows:

- At 28.4 nautical miles, the first telemetry drop-outs were detected.

- At 31.4 nautical miles, all telemetry was lost and the antenna lost track of the aircraft and locked onto the interference source.

- With the interference source turned off, no drop-outs were detected out to a distance of 150 nautical miles.

This test was conducted with the interfering source located at distance of 0.7 miles from our receive site. Our tracking antenna is mounted on a tower at a height of 65 feet above ground level so as to provide a better view of the horizon.

We also tested the effects of the 1 mW signal at other distances from the tracking antenna. With the omni-directional antenna mounted to the TM Van roof and the CW output level set to 1 mW EIRP, the van was positioned at various distances from the tracking antenna. The following measurements were made and recorded using a spectrum analyzer connected to one of the two RF feeds of the tracking antenna system:

- 0.2 statute miles; -67 dBm
- 0.7 statute miles; -61 dBm
- 1.2 statute miles; -71 dBm
- 2.2 statute miles; -67 dBm
- 3.2 statute miles; -68 dBm

It should be noted that nearby buildings and trees, in combination with downtilt of the tracking dish, placed significant ground clutter between the main beam of the tracking antenna and the test source antenna when located at the 0.2mile waypoint. The van driver also noted a drop in terrain due to a creek bed just prior to reaching the 1.2mile waypoint. As the elevation pointing angle of the antenna was raised more in-line to that of a normal test flight, clutter was still present between the van and the tracking antenna, but was less of a factor. In fact, we observed that as the van moved further away from the aeronautical telemetry antenna, the effects became even more pronounced. While traveling between the 2.2 and 3.2 mile waypoints, for example, the signal level at the tracking antenna not only approached the level measured at 0.7miles, but actually appeared to exceeded the level by as much as 2-3 dBm for several brief periods of time.

Time did not permit us to check additional locations, but based on these tests, and 10 years of flight-test telemetry experience, it is my professional opinion that the presence of co-channel devices at the power levels proposed by GE Healthcare would cause destructive interference to our flight test operations at distances considerably greater than 3.2 miles.

Executed under penalty of perjury this 27th day of May, 2008.

D. Hoehn

Donald J. Hoehn

Bombardier-Learjet

S-band Telemetry Interference Test May 22, 2008

Test Condition	Interference Signal[1]	AC TM Signal[4]	AC Range from Tracking Antenna in Nautical Miles (NM)	Aircraft Altitude (ft)	Antenna Tracking	Comments
Noise Floor Sweep	OFF	OFF	NA	NA	Manual	Sweep was performed 10 minutes prior to flight. No visible interference signals displayed on spectrum analyzer
Interference Signal Sweep	ON	OFF	NA	NA	Manual/Auto	Max signal strength with antenna pointed at 266 degrees azimuth and 0.44 degrees elevation. Antenna tracking locks to signal
AC TM Check	OFF	ON	0.1	GL	Manual	Clean waveform and solid tracking antenna lock. Clean PCM demod displayed on oscilloscope.
AC Takeoff	ON	ON	0.1 to 5	GL to 3200	Auto / Az	Tracking antenna remained locked on target, resulting in a clean take-off at 15:07.
Waypoint 10 NM	ON / FM Mod[2]	ON	10	3600	Auto / Az / El	At 15:12:41 data is good & antenna is tracking test aircraft
Waypoint 20 NM	ON / FM Mod[2]	ON	20	3900		At 15:14:59 data is good & antenna is tracking test aircraft
Interference Detected - First data loss occurs	ON / FM Mod[2]	ON	28.4	4200	Auto / Az / El	First sign of interference & data loss. Data lost from 15:16:45 to 15:16:56. Data re-acquired at 15:16:57
Waypoint 30 NM	ON / FM Mod[2]	ON	30	4300	Auto / Az / El	good.
Interference Detected - No data - Antenna Tracking	ON / FM Mod[2]	ON	31.4	4400	Auto / Az / El	At 15:17:20 data is lost and tracking antenna is now tracking/pointing at the interference signal. Aircraft tracking does not recover and all telemetry data is lost.
Interference Source turned Off	OFF	ON	35.8	4690	Auto / Az / El	At 15:18:16 the interference source is turned off. The tracking antenna recovers to track test aircraft and telemetry data is re-acquired.
Interference Verification	OFF/CW[3]/FM Mod[2]/OFF	ON	38-40	4700-5000	Auto / Az / El	At 15:18:44 the interference source is cycled at 3 second intervals from OFF to ON-CW to ON-FM-Mod and OFF again. When ON all telemetry was lost and the antenna lost track of the aircraft and locked onto the interference source. When the interference source is turned OFF at 15:19:09 the tracking antenna recovers to track the aircraft and no telemetry data drop-outs are detected.
Waypoints 40 NM thru 150 NM	OFF/CW[3]/FM Mod[2]/OFF	ON	40-150	5000-20,038	Auto / Az / El	Shortly after the test aircraft reaches each waypoint, the interference source is turned ON and sequenced between CW & FM Mod and turned off again. When turned ON all telemetry data is lost and the antenna lost track of the aircraft and locked onto the interference source. When the interference source is turned OFF the tracking antenna recovers to track the aircraft and no telemetry data drop-outs are detected.

Waypoints 150 - 200 NM	NA	NA	NA	NA	NA	Test was aborted after 150 NM due to approaching severe thunderstorm and aircraft returned to ICT.

[1] **Interference Source:** Signal generator, coax cable and omni-directional antenna calibrated for an output of 1mW EIRP. Omni-directional antenna located on the roof of the Learjet Telemetry Van, at a 266 degree radial and 0.8 statute miles away from the tracking antenna.

[2] **FM Modulation:** Center Frequency 2375.5 MHz, Modulation Frequency 1 kHz, FM Modulation Deviation 50 kHz

[3] **Continuous Wave:** Unmodulated Carrier, Center Frequency 2375.5 MHz

[4] **Aircraft Transmitter:** 10 W EIRP; 2 dBi Omni-directional antenna mounted just forward of the wing, centered on the bottom of the fuselage; Carrier Frequency 2375.5 MHz, 750 kbps data rate, w/ sideband audio modulated 1.4 MHz from the carrier frequency.

Tracking Antenna: EMP 8 ft. Reflector, Dual-Feed - Conical Scan Converter, mounted on a roof-top platform 65 ft AGL, PC Based ACU, EL/AZ Positioner

Telemetry Receivers / Combiner: Microdyne 700-MR / 1620-PC

EXHIBIT H

DANNY B. HANKINS DECLARATION

DECLARATION

I, Danny B. Hankins, hereby declare as follows:

I am the Senior Engineer for Spectrum Management Services at Cessna Aircraft Company, a division of Textron Inc. I am responsible for the telemetry facilities utilized for Cessna's flight test operations at its Wichita manufacturing plant where we design, test and manufacture various models of Citation business jets and other models of aircraft. I developed a detailed test plan to evaluate the effects of a co-channel, 1 mW undesired signal on Cessna's flight test systems. The results of Cessna's testing are reflected in the attached spreadsheet. Among other things, it was determined that the interference caused data drop-outs from the aircraft at a distance of 30 nautical miles from the airport; at 45 nautical miles, the telemetry stream was entirely lost; and at 57 nautical miles, our telemetry antenna lost track of the aircraft and was locked onto the interference source, which was located 0.7 miles away.

I am familiar with the results of similar tests conducted by Learjet which is also based at Wichita. While the Cessna telemetry equipment was operating in L-band instead of the S-band utilized by Learjet, the results obtained are nonetheless consistent; namely, that a 1 mW co-channel signal causes destructive interference to the very sensitive flight test telemetry receivers.

I have read and am familiar with the attached Comments being filed this date. The statements made therein are true and correct to the best of my knowledge and belief.

Executed under penalty of perjury this 23rd day of May, 2008.

Danny B. Hankins

Danny B. Hankins

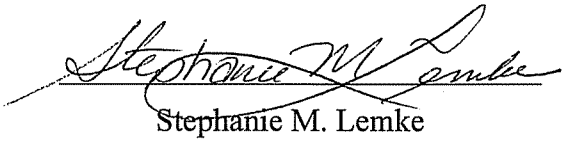
Telemetry Interference Test					
Test Condition	**Interference Signal**	**AC TM Signal**	**AC Distance Miles Nautical/Statute**	**Antenna Tracking**	**Comments**
Noise Floor Sweep 1	OFF	OFF	NA	Manual	Sweep was performed after the flight as the sweep prior to flight was not completed due to aircraft ready to go. Only signal visible is above 1525 MHz in adjacent band, near 1528 MHz
Signal Sweep 1	ON	OFF	NA	Manual	Max signal strength at 215 degrees.
AC TM Check	OFF	ON	0.1	Manual	Clean waveform and solid lock. Video eye on oscilloscope is good.
AC Takeoff	OFF	ON	0.1 / 0.1 to 20 / 23	Auto	
Tracking Distance	ON/OFF/Sweeping	ON	20 / 23 estimated	Auto	Tracking beginning to show instability indicated on the ACU crosshairs when the signal is sweeping through the TM.
Interference Detection - first dropouts occur	ON/OFF/Sweeping	ON	30 / 34.5	Auto	AC is at 223 degrees, about 8 degrees off line with the signal. Occurred as correction instructions were given to the pilot to correct heading to come into line with the signal. Distance by pilot was later so actual distance at first dropout less than recorded value in chart.
Interference Detection - No data passes	ON/OFF/Sweeping	ON	45 / 51.8	Auto	Distance value is what pilot called in several minutes after data stopped passing. Data stopped at closer range than recorded.
Tracking Distance	ON/OFF/Sweeping	ON	57 / 65.6	Auto	Azimuth Error Readout on ACU reads 2.9 degrees when signal turned off first time and 5.4 the second time when aircraft was further from the signal azimuth.
TM Max Distance	OFF	ON	174 / 200	Auto	No dropouts all the way out when the interference signal was off. TM turned off at 200 statute miles as that is the max distance on our license.

CERTIFICATE OF SERVICE

I, Stephanie M. Lemke, hereby certify that I have caused the attached Comments on GE Healthcare Proposal to be deposited in the U.S. Mail, first-class postage prepaid, this 27th day of May 2008, addressed as follows:

Ari Q. Fitzgerald
Hogan & Hartson LLP
555 Thirteenth Street, NW
Washington, DC 20004

Counsel for GE Healthcare



Stephanie M. Lemke