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WHITE PAPER

Hughes JUPITER Aeronautical Solution

As a pioneer in the field of satellite communications systems dating back over 35 years and over 10 years of history providing aeronautical broadband solutions for commercial, government and private aircraft, Hughes brings extensive experience in the field of satellite-based aeronautical broadband solutions. Hughes' first generation aeronautical broadband system is deployed on over 750 commercial aircraft operating around the world with airlines such as Southwest Airlines, Norwegian Air Shuttle, IcelandAir, and flydubai.

Hughes' latest generation aeronautical solution is based on its award-winning JUPITER System. Designed to extract maximum capacity and efficiency from High-Throughput Satellites (HTS), such as Echostar® XIX, the JUPITER System is comprised of a highly advanced, high-performance and spectrally efficient aeronautical terminal, a robust and dense gateway architecture, designed for "lights-out" operation, and an advanced central network management system. As the cornerstone for HughesNet® broadband satellite Internet service (with over more than 1 million active users in North America), JUPITER is the system of choice by HTS operators across the globe.

The Next-Generation of In-Flight Connectivity Performance

Hughes' JUPITER aeronautical solution is an integrated system of airborne and ground equipment and software that together delivers the next generation of broadband performance for commercial aircraft operating throughout the world. Both the ground and airborne hardware components of the system represent the state-of-the art in the industry in terms of processing power, packaging density, system capability and reliability. Likewise, the system software incorporates highly advanced and powerful mobility features, such as enhanced beam switching, adaptive coding and modulation and advanced Doppler correction, enabling rapid and uninterrupted switching from satellite to satellite as well as from beam to beam in spot beam environments. Designed to operate with both spot and wide beam satellites as well as both the Ka and Ku-bands, the JUPITER aeronautical solution has been designed from the ground up to deliver a level of performance and reliability that will serve the needs of the airlines and their passengers well into the next decade.

Highlights of the JUPITER aeronautical solution:

- **Capacity and spectral efficiency:** The JUPITER system employs wideband TDM outroute (download to aircraft) channel transmission based on the latest generation industry standard—Extension of Digital Video Broadcasting-Satellite-Second Generation (DVB-S2X). The system TDMA inroute channels (upload from aircraft) based on state-of-the-art coding and encapsulation. Both outroute and inroutes use Adaptive Coding and Modulation (ACM) to maintain superior efficiency and availability. In addition, the latest compression techniques are applied to minimize overhead and maximize user data throughput.
- **Dual Band Operation:** This system is designed to be fully compatible with all commercial Ka- and Ku-band satellite resources throughout the world, making it the ideal solution for airlines and their passengers to enjoy uninterrupted, high-performance connectivity for the entire gate-to-gate duration of every flight, regardless of where in the world the flight is operating.
- **Aero Terminal Performance and Capabilities:** The JUPITER Aero Terminal is a high-performance dual-band terminal capable of speeds in excess of 400 Mbps along with a host of advanced mobility and traffic handling features.
- **Beam and Satellite Switching Speed:** The JUPITER system incorporates powerful processing capability combined with advanced algorithms that enable extremely rapid switching between individual beams within a satellite and between satellites.
- **Application Performance:** The JUPITER system incorporates advanced Quality of Service (QoS) features that enable classification and prioritization of traffic to ensure that the various application types enjoy consistent and responsive performance.
- **Gateway Footprint:** JUPITER gateways incorporate wideband multicarrier modulators, wideband multicarrier demodulators, and high-performance multicore blade servers enabling very high rack density, minimizing floor space and power consumption. The gateway design incorporates full automatic redundancy for all traffic carrying components and is designed for remote lights-out operation from a remote network control center.

JUPITER Aero Solution Architecture

The JUPITER™ Aero Solution is designed to scale to support very high traffic volumes, both on a per aircraft basis and on a network-wide basis. It is also designed to span large geographic regions as well as across regions of coverage.

The solution is composed of the following key elements as shown in Figure 1.

- **Aero Terminal:** Dual Ka/Ku-band terminal supports throughput exceeding 400 Mbps and complies with DO 160 requirements.
- **Transport Gateway (TGW):** The system supports one or more TGW sites, the quantity and location of which are a function of specific geographic locations defined by the satellite coverage footprint and specific beam mapping. The TGW sites support the baseband satellite transmission and corresponding functional processing equipment that provide communications to one or more satellites. The baseband equipment connects to customer-supplied RF Terminal (RFT) via standard L-band IF interface. Gateway sites are connected to the Network Access Point (NAP) through a terrestrial backhaul network. Management path is established between the Network Management System (NMS) and TGW through this network.
- **Network Access Point (NAP):** The system supports one or more NAPs that provide a centralized point of presence (POP) for connection to the Internet. Multiple NAPs provide the capability to support multiple POPs that may be required to satisfy specific geopolitical considerations.
- **Network Management System (NMS):** The NMS system is the central point from which gateway baseband elements and Aero Modems are managed. The NMS may be installed at a gateway site or a centralized network operation center. The NMS is a collection of software components that perform the configuration, status, and performance monitoring of the gateway stations, Aero Modems, and ancillary equipment in cooperation with external business systems for terminal service configuration management and billing information.
- **Satellite Air Interface:** The air interface supports a TDM outroute channel (download to aircraft) that is based on the DVB-S2X standard and provides highly efficient wideband operation. The system also supports TDMA inroute channels (upload from aircraft) that is based on state-of-the-art coding and encapsulation, Doppler compensation, and spectral spreading. Both outroute and inroute channels utilize ACM to maintain the highest efficiency and availability.
- **Satellite:** The system is designed to operate on both Ku- and Ka-band satellites, both HTS and non-HTS.

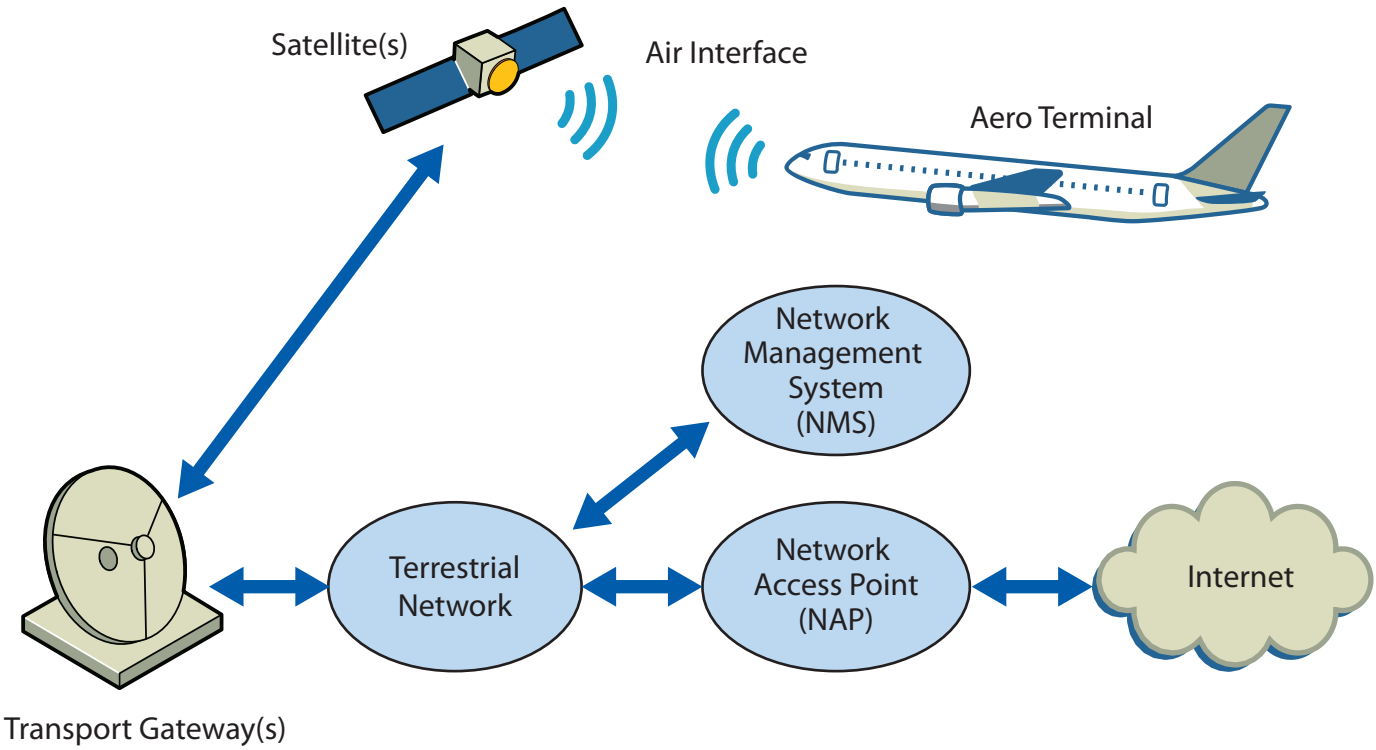

Figure 1. JUPITER Aero Solution Architecture

JUPITER Aero Terminal

The JUPITER Aero Terminal is comprised of two major components: a high performance, high-throughput satellite modem system (ModMan) and a compact, lightweight dual Ka and Ku-band antenna system. Together, these components enable delivery of over 400 Mbps to a single aircraft and are designed to operate with any commercial Ka or Ku- and satellite. Further, the system can dynamically switch from one type of satellite to the other (and from beam-to-beam within the footprint of a single spot beam satellite) with no interruption of service or manual intervention of any sort, thus ensuring passengers of a superior user experience and no loss of connectivity from gate-to-gate.

The terminal is based on ARINC 791 for both the in aircraft equipment (IAE) LRUs and out of aircraft equipment (OAE)—antenna, mounting adapter plate, and radome.

Figure 2 illustrates major components of the JUPITER Aero Terminal.

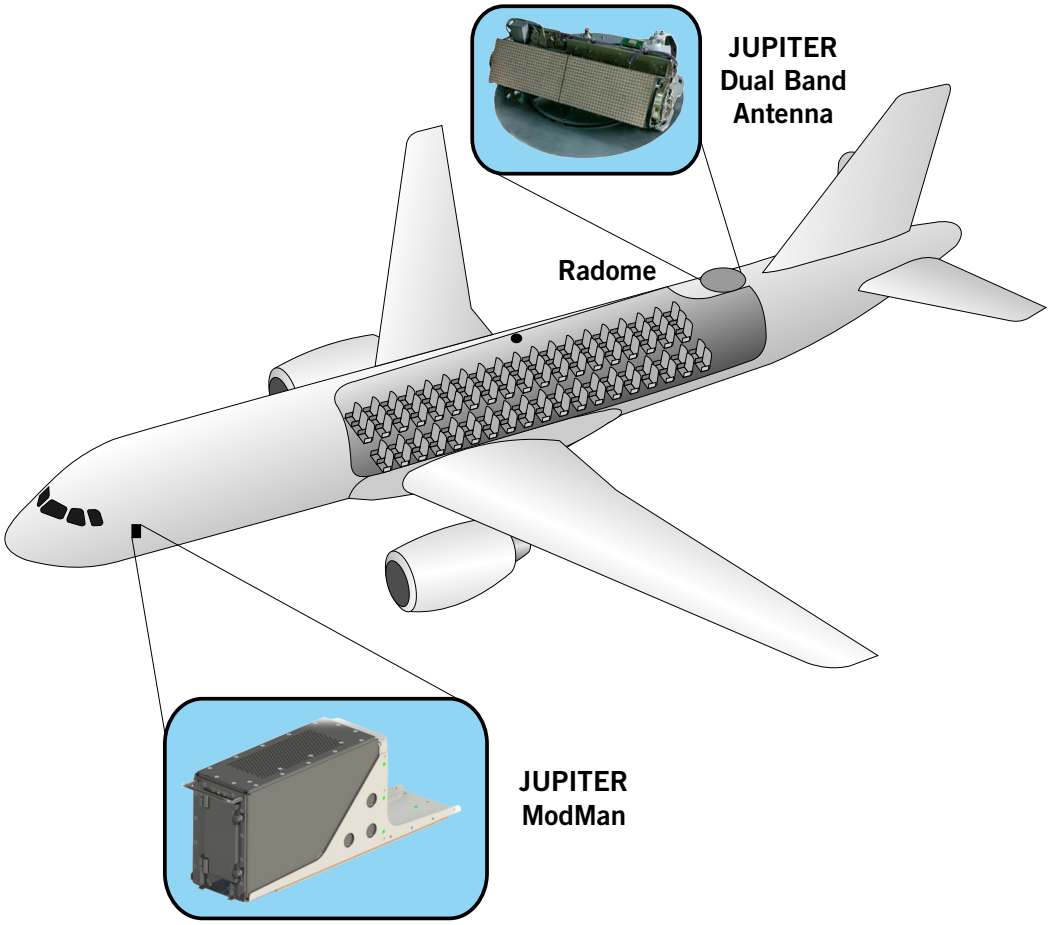

Figure 2. JUPITER Aero Terminal

ModMan

The ModMan combines the functionality of a high-performance airborne satellite communications modem and a full-featured airborne Server. The 4 MCU ARINC 600 Line Replaceable Unit (LRU) incorporates Hughes' latest and most advanced JUPITER HT Aero Modem plus an airborne server with functionality and features that go well beyond the requirements of ARINC 791. The server portion of the Modman may also be used to support a variety of customized applications such as on-board traffic management and shaping among others. The ModMan interfaces with the aircraft ARINC 429 Receive Only bus for navigation data. The ModMan is designed for installation in the aircraft electronics bay and ARINC 791 configurations. Finally, to facilitate use with the widest array of aero antennas, the ModMan utilizes a standard OpenAMIP interface between ModMan and the Antenna Control Unit.

Dual Band Antenna

Hughes' AERO antenna is a dual-band (Ka/Ku), low-profile, mechanically steered antenna that consists of a two axis (elevation and azimuth) stabilized positioner and two antenna apertures (Ka and Ku). The complete antenna system is composed of the fuselage-mounted antenna (apertures and positioner assembly) and separate Ka and Ku RF units (KRFUs) and an antenna control unit (KANDU) that are located inside the aircraft to minimize environmental impact. The Ka and Ku apertures are positioned back-to-back such that at any one time, one is pointing to the satellite and the other is inactive. The antenna swept volume is designed to fit within commercially available multi-band radomes.

For additional information on the JUPITER AERO Solution including specifications for the ModMan and Ka/Ku Antenna please see the companion data sheet: Hughes Dual-Band (Ka/Ku) In-Flight Connectivity System.

Proprietary Statement

Visit www.Hughes.com for more information about Hughes

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