Observation & Technology Analysis of New Generation Satellite Asiasat 7

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Abstract: ***A Satellite Communication for VSAT network-Band, and k-band on the study and design for digital satellite communication focus of this paper. Starting from the characterization of satellite propagation channel indifferent application environments (from broadcast to fixed terminals, to broadband mobile satellite access), we address payload architecture of VSAT network, C-band, K-band. Future C-band GNSS's including the Global Positioning System.***

Key words: AsiaSat, band Analysis, design, cellular network, VSAT.

1. Introduction

March 21, 1999 AsiaSat 3S, a Boeing 601HP satellite replaced AsiaSat 1 in May 1999, is now serving our global [1] clients at the orbital location of 105.5 degrees East. It delivers a great diversity of infotainment and thematic channels and mobilizes communications across the Asia-Pacific region with an extensive C-band footprint as well as fixed and steerable Ku-beams enabling greater flexibility in network connectivity. April 11, 2003 AsiaSat 4, a Boeing 601HP satellite, is positioned at 122 degrees East orbital location that offers excellent 'look angles' over Asia and Australasia. Its C-band footprint widely spreads over the Asia-Pacific region with two focused Ku-band beams for East Asia and Australasia, and a steerable Ku-beam enabling greater flexibility in network connectivity [1].

August 12, 2009 AsiaSat 5, a Space Systems/Loral 1300 series satellite, is equipped with 26 C-band and 14 Ku-band transponders, with a design life of 15 years. A replacement satellite for AsiaSat 2 at the orbital location of 100.5 degrees East, AsiaSat 5's C-band footprint covers more than 53 countries. AsiaSat 5 also offers two high-power fixed Ku-band beams over East Asia and South Asia.

2. Why Asiasat 7?

Asia Sat 7 is a new generation satellite designed to replace AsiaSat 3S at the orbital location of 105.5 degrees East. Based on the Space Systems/Loral 1300 platform, AsiaSat 7 will support a broad range of applications for the Asia-Pacific region, including television broadcast and VSAT networks. AsiaSat 7 will carry 28 C-band and 17 Ku-band transponders, And a Ka-band payload. Its region-wide high power C-band beam covers Asia, the Middle East, Australasia and Central Asia, with Ku-band beams serving East Asia, South Asia and a steerable Ku beam. AsiaSat 3S's one of AsiaSat's flagship satellites. The launch of AsiaSat 7, well ahead of the planned date for AsiaSat 3S's replacement, is a testament to AsiaSat's continued commitment to quality, reliability and uninterrupted services. AsiaSat 3S is expected to reach its end of life in 2014.

3. C-band Analysis

A detailed market and user receiver analysis has identified two baseline C-band services. A Service with Precision and Robustness (SPR-C), with global coverage, and a Public Regulated Service in C-band (PRS-C) with spot beam coverage over two selectable service areas. The SPR-C would provide users with additional robustness, protection, and precision for non-security-related critical infrastructures and applications for which vulnerability is a threat. In this regard, C-band offers the following advantages: no spectrum proliferation, smaller signal propagation effects from the ionosphere and unintentional interference, and higher jamming resistance compared to the L-band for same C/N0. As envisioned by the C-band service analysis, the SPR-C could support professional satellite navigation in situations where L-band signals are degraded and would provide additional value-added elements with the navigation message, such as clock and tropospheric correction data.

3.1 Satellite Constellation with C-Band

Navigation service requirements such as availability and position dilution of precision (PDOP) has a direct effect on the configuration of the satellite constellation. Consequently, a variety of constellations were analyzed in order to find the best solution. The C-band study conducted a trade-off analysis of a global and a regional SPR-C service. A regional SPR-C would provide continuous service over three selected industrial areas.

3.2 C-Band Transmit Power Requirement

For both C-band services, we calculated link budgets in order to determine the DC power required at the payload level. These will be described later in the end-to-end performance section Table 4 shows.

	Serving Concept	Required Tx Power
1	One global SPR-C: Two PRS-C spot beams (1,500 km) : Sum:	675 W 140 W 815 W
2	Two PRS-C spot beams (1.500 km):	140 W

Table 1: Required transmitter power for two different C-band service concepts

The required DC power at the payload antenna output in order to provide the concept that a global SPR-C global service plus two independent spot-beam PRS-C services each with a 1,500 kilometer service area and two independent spot-beams PRS-C services each with a 1,500 Kilometer services area.

3.3 C-Band Payload Design

The preferred payload architecture would accommodate the C-band payload on a spacecraft in combination with the current Galileo L-band payload. With this objective in mind, we will now cover the following points:

- General payload architectures to perform the beam forming for PRS-C
- RF front-end technologies, such as frequency up-conversion principles
- Possibilities of high-power amplification and effects on power budget and signal distortion
- Trade-off between antenna design and signal generator payload
- Interference with mission up-link receiver and preservation of ITU regulatory
- Power and mass budgets

The design of the most appropriate C-band signals will be described in the July/August issue of Inside GNSS. However, as the signal design is one driver for the payload design, we will briefly introduce it here. The constraints on the downlink C-band signal selection are the limited bandwidth (5010-5030 MHz), the requirements set at the ITU level for compatibility with radio astronomy (4990-5000 MHz), microwave landing system (5030-5150 MHz), and the Galileo mission uplink receiver (5000-5010 MHz) as illustrated in (Figure 1).

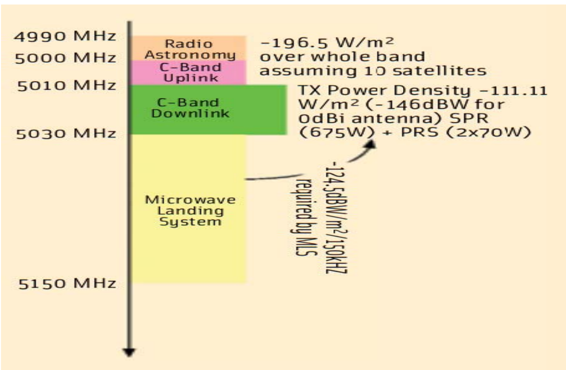

Figure 1: Frequency neighbors of the C-band downlink signal

The general objective of the signal and payload design was to trade off baseband signal design and compatibility with the aforementioned constraints. Out-of-band (OOB) emissions caused by inter modulation products introduced by the payload's high power amplifier (HAP) were taken into account in the trade-off. We performed simulations in order to display the effect of the payload HPAs on different signal types under these constraints.

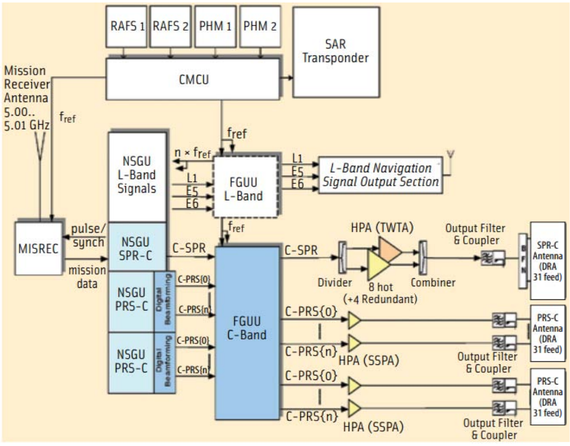

Figure 2: Combined L/C-band payload architect-use with digital beam-forming

Finally, Gaussian minimum shift keying (GMSK) has been chosen as the baseline signal for both C-band services. The proposed payload architecture consists of the existing Galileo architecture with enhancements to incorporate the C-band signal generation (Figure 2). This payload architecture would retain most of the existing design for the signal generation part while adding elements for the C-band solution: an enhanced navigation L- and C-band.

3.4 Spacecraft Accommodation

The C-band/L-band payload architecture design has been taken as an input for the space segment in order to analyze the accommodation on the spacecraft and launcher. The accommodation analysis was performed for the two C-band service concepts displayed in Table 4 using Architecture 1 because it also covers the slightly relaxed power and mass requirements of Architecture 2.

4. K-band Analysis

K band is a portion of the radio spectrum in the microwave range of frequencies ranging between 18 and 27 GHz. K band between 18 and 26.5 GHz is absorbed easily by water vapor (H_2O resonance peak at 22.24 GHz, 1.35 cm). The IEEE K band is conventionally divided into two sub-bands. The Ka band (Pronounced: "Kay-Ay Band") covers the frequencies of 26.5–40 GHz. The Ka band is part of the K band of the microwave band of the electromagnetic spectrum. This symbol refers to "K-above" in other words, the band directly above the K-band. The 30/20 GHz band is used in communications satellites, uplink in either the 27.5 GHz and 31 GHz bands [2] and high-resolution, close-range targeting radars aboard military airplanes. Some frequencies in this radio band are used for vehicle speed detection by law enforcement. Kepler Mission uses this frequency range to downlink the scientific data collected by the space telescope. The designation Ka-band is from Kurz above, which stems from the German word kurz meaning short in satellite communications, the Ka band allows higher bandwidth communication, and is going to be used in the upcoming Iridium Next satellite series, for instance. The Ku and the C bands, however, it is far more susceptible to signal attenuation under rainy conditions [3]. Ku band is primarily used for satellite communications, most notably for fixed and broadcast services, and for specific applications such as NASA's Tracking Data Relay Satellite used for both space shuttle [4] and ISS communications. Ku band satellites are also used for backhauls and particularly for satellite from remote locations back to a television network's studio for editing and broadcasting. The band is split into multiple segments that vary by geographical region by the International Telecommunication Union (ITU). Some frequencies in this radio band are used for vehicle speed detection by law enforcement, especially in Europe [5].

5. VSAT

Present VSAT networks use geostationary satellites, which are satellites orbiting in the equatorial plane of the earth at an altitude above the earth surface of 35 786km.

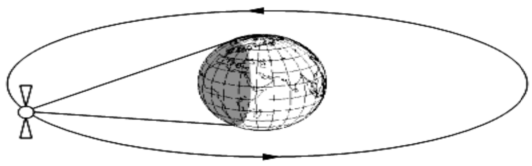

Figure 3: Geostationary Satellite

VSATs are connected by radio frequency(RF) links via a satellite, with a so-called uplink from the station tothe satellite and a so-called downlink from the satellite to the sta-tion (Figure 3)[6]. The overall link from station to station, sometimescalled hop, consists of an uplink and a downlink. A radio frequencylink is a modulated carrier conveying information.

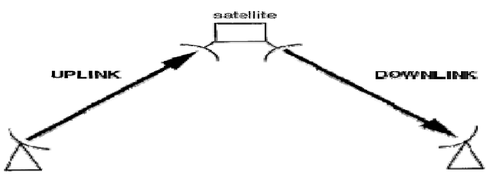

Figure 4: definition of uplink and downlink

As all VSATs are visible from the satellite, carriers can be relayed by the satellite from any VSAT to any other VSAT in the network, the solution then is to install in the network a station larger than a VSAT, called the hub. The hub stations has a larger antenna size than that of a VSAT, say 4 m to 11 m, resulting in a higher gain than that of a typical VSAT antenna, and is equipped with a more powerful transmitter. As a result of its improved capability, the hub station is able to receive adequately all carriers transmitted by the VSATs, and to convey the desired information to all VSATs by means of its own transmitted carriers. The architecture of the network becomes star-shaped. The links from the hub to the VSAT are named outbound links. Those from the VSAT to the hub are named [7] inbound links. Both inbound and outbound links there are two types of star-shaped VSAT network. Two way networks (Figure 5), where VSATs can transmit and receive. Such networks support interactive traffic.

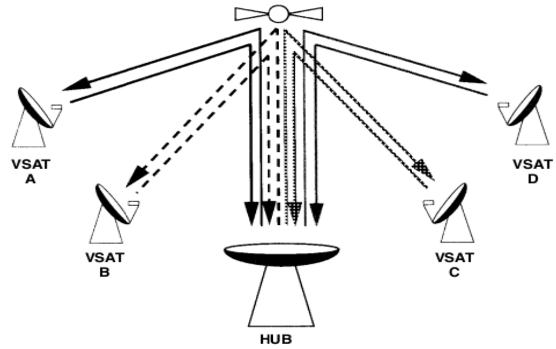

Figure 5: Two-way VSAT Network

A one-way network (Figure 6), where the hub transmits carrier's to receive-only VSATs. This configuration supports broadcasting.

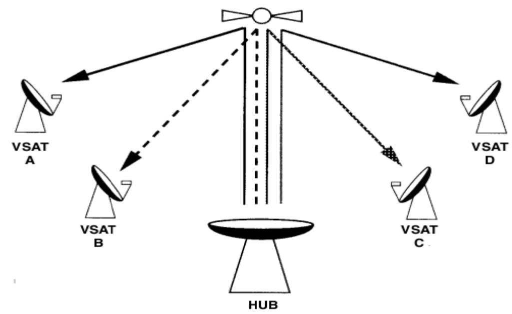

Figure 6: One –way VSAT network

5.1 Relay functions of satellite for VSAT network

The satellite roughly consists of a platform and a payload [8]. The platform consists of all subsystems that allow the payload to function properly, namely:

1. The mechanical structure which supports all equipment in the satellite;
2. The electric power supply, consisting of the solar panels and the batteries used as supply during eclipses of the sun by the earth and the moon.
3. The attitude and orbit control, with sensors and actuators.
4. The propulsion subsystem.
5. The onboard TTC equipment.

6. Cellular Network

Various schemes have been devised to allow satellites to increase the bandwidth available to ground based cellular networks. Every cell in a cellular network divides up a fixed range of channels which consist of either frequencies, as in the case of FDMA systems, or time slots, as in the case of TDMA. Since a particular cell can only operate within those channels allocated to it, overloading can occur [9]. By using satellites which operate at a frequency outside those of the cell, we can provide extra satellite channels on demand to an overloaded cell. These extra channels can just as easily be, once free, used by any other overloaded cell in the network, and are not bound by bandwidth restrictions like those used by the cell. In other words, a satellite that provides service for a network of cells can allow its own bandwidth to be used by any cell that needs it without being bound by terrestrial bandwidth and location restrictions [10]. In a word, cooperative communications can be seen as a means of achieving spatial diversity without the need of using multiple antennas at either the transmitter or the receiver [11].

7. Satellites for Data

Latency (propagation delay): Due to the high altitudes of satellite orbits, the time required for a transmission to navigate a satellite link (more than 2/10ths of a second from earth station to earth station) could cause a variety of problems on a high speed terrestrial network that is waiting for the packets.

Poor Bandwidth: Due to radio spectrum limitations, there is a fixed amount of bandwidth allocable to satellite transmission.

Noise: Radio signals strength is in proportion to the square of the distance traveled. Due to the distance between ground station and satellite, the signal ultimately gets very weak.

8. Conclusions

Satellite communication is the advanced technology now and it will be future. In this paper focused the C-band and K-band architecture and how does work it is to the earth. AsiaSat-7 carries 28 C-band and 17 Ku-band transponders that the advantage of AsiaSat-7. It can perform as high speed data process on bad weather condition. AsiaSat-7 will support a broad range of applications including TV broadcast and VSAT networks across the region and there C-band navigation system will be upgraded. We need to wait till the AsiaSat-7 launch.

9. Future work

In order to show the benefits of a future C-band navigation in addition to the L-band system used by GNSSs, including the Global Positioning System and Galileo, the C-band analysis included an architecture study that considered likely technology developments through 2020.

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