Implementation of Geostar's RDSS System

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ABSTRACT

The Geostar® system began its initial operations in 1988 and was the first domestic satellite system to provide regular service to mobile users within the United States. This paper provides an overview of Geostar's radiodetermination satellite system (RDSS) concept and its development by Geostar, with a focus on the current operational status of Geostar's interim RDSS system and services.

INTRODUCTION

Geostar was created in 1983 to develop RDSS. Mobile satellite systems (MSS) are designed to provide a communications link between a mobile user and base earth station. Such MSS links can be used to provide position reports based on position fixes determined from a separate radionavigation system. RDSS, on the other hand, integrates radionavigation, radiolocation and messaging within a single satellite system and transmission protocol.

Geostar received its RDSS license from the Federal Communications Commission in 1986[1]. Frequencies for RDSS were allocated throughout the world by the 1987 World Administrative Radio Conference for the Mobile Services[2].

Geostar is phasing the implementation of its RDSS satellite system. Before launching its own satellite relays, Geostar commercially provided a satellite-based position location and reporting system using the low-orbit Argos satellites in 1987. That phase of Geostar's service development provided an early demonstration of the benefits of a nationwide, satellite service to the long-haul trucking industry.

With the launch of its RDSS relay on board the GTE Spacenet III satellite in 1988, Geostar began its current phase of operations with a position reporting service. In 1989, a two-way messaging capability was introduced using conventional 4/6 GHz domestic satellite transponders for messaging to the mobile terminals.

CURRENT OPERATIONS

Geostar is currently providing over 65,000 position reports and messages each day to over 70 commercial and government customers. The current service provides users with a position reporting and two-way messaging capability. Presently, positions are determined using Loran-C. A detailed description of Geostar's initial system is provided in a paper presented by Robert D. Briskman at the AIAA 12th International Communications Satellite System Conference entitled, "Geostar Initial RDSS System."[3]

Mobile units transmit a burst containing position and status information, as well as an alphanumeric message of up to about a hundred characters, at 1618.25 MHz in the band allocated for RDSS. The transmission is a direct sequence, spread spectrum signal, with a duration of 20 to 80 milliseconds per transmission packet. This signal consists of 15.625 kilobit per second data, rate-1/2 encoded for forward error correction, spread by a direct sequence pseudo-random noise code operating at 8.000 megabits per second. The spread signal is BPSK modulated and occupies about 16 MHz of

bandwidth. The RDSS relay on board the host domestic fixed satellite retransmits these signals to Geostar's central earth station and operations center in Washington, D.C., using the conventional 11.7-12.2 GHz domestic satellite band.

A C-band (4/6 GHz) link using commercial fixed satellite transponders provides communications from Geostar central to the mobile terminals. This outbound link to the mobile terminals is a continuous signal, which is framed and contains message packets addressed to mobile users. This signal consists of 1200 bit per second data, rate-1/2 encoded for forward error correction, spread by a direct sequence pseudo-random noise code operating at 1.2288 megabits per second. The spread signal is BPSK modulated. Two such signals can be transmitted over the same transponder. Geostar is currently using an uplink earth station provided by GTE Spacenet to transmit this signal to the satellite, with landline connections between that earth station and Geostar's operations center in Washington, D.C.

Geostar recently extended its coverage capabilities with the addition to its system of RDSS relays on board the Gstar III satellite. That satellite carries an RDSS relay covering the continental United States as a backup to the RDSS relay on Spacenet III, as well as a second RDSS relay covering Mexico, Central America, the Caribbean and portions of South America. Figure 1 illustrates Geostar's current coverage capabilities.

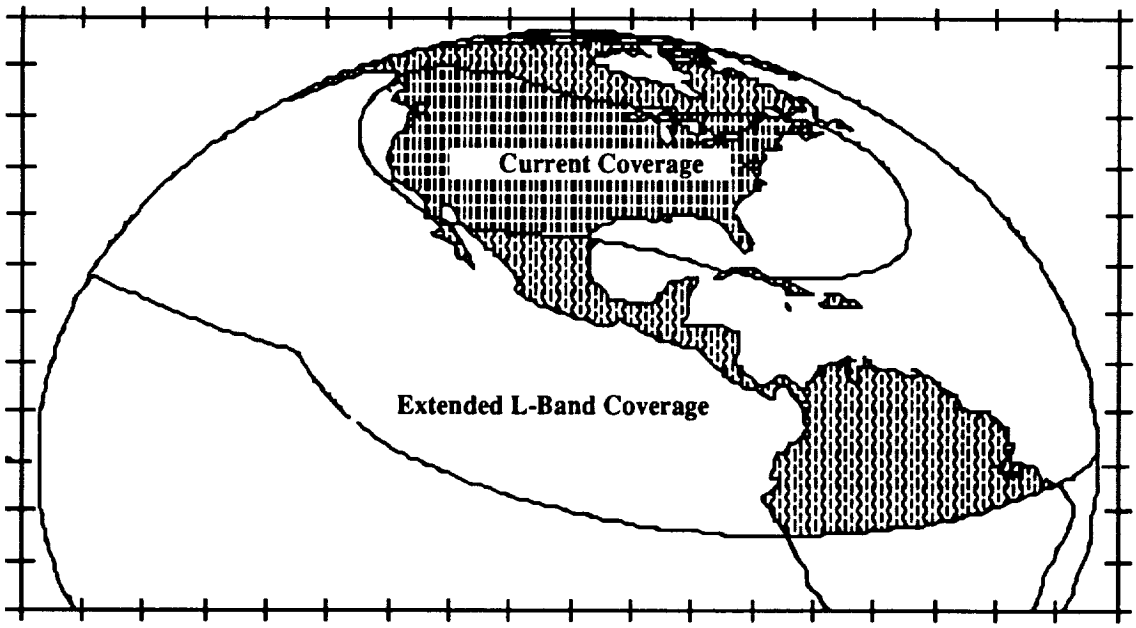

Figure 1. Geostar System Coverage

The launch of Gstar III in September 1988 was anomalous, in that it was left in an initial 16 by 36 thousand kilometer, 16-hour orbit after the firing of its apogee kick motor. However, by means of a long and complicated set of maneuvers, the on board thrusters were used to successfully boost the satellite into geosynchronous orbit. It became operational in October 1989, and is expected to have four or more years of operating lifetime.

Mobile user equipment is being provided by Sony (*2-Wayfarer*™) and Hughes Network Systems (*SkyRider*™). The mobile terminal consists of a small, omnidirectional antenna unit mounted on the outside of the vehicle, a receiver/transmitter and mobile data terminal

installed inside the vehicle, and a keyboard/display unit mounted near the driver. For the Sony unit, the external transmit/receive antenna unit is 3.5 inches high and weighs 2.9 kilograms, with the internal electronics unit occupying approximately 825 cubic inches (11.7" by 7.1" by 9.9") and weighing 9.6 kilograms. A small external Loran-C whip antenna is also mounted on the vehicle. The keyboard/display unit is backlit, displays four 40-character lines, and can be programmed with various menus and preformatted message layouts. The keyboard/display is approximately 11" by 5.9" by 1.4" and weighs 1 kilogram. The Sony unit also includes a sensor port and an RS-232C port to interface with other ancillary equipment. The Hughes mobile terminal is similar in size, weight and configuration, and provides the same capabilities as the Sony unit.

Geostar's current system is being used for a wide variety of applications to all types of vehicles, including trucks, trains, aircraft and boats. Software is available for displaying position and status information and for two-way communications using personal computers. For large fleets, software has also been developed to interface Geostar's service directly with mainframe or minicomputers at the subscriber's headquarters. Real-time interfaces between Geostar and its customers utilize SNA LU 6.2 and Communications Manager protocols, and Geostar's operations center can be interconnected with the subscriber's headquarters through leased lines, the IBM Information Network or the Telenet™ point-to-point service. Geostar will also support the X.25 packet switched protocol, and VSATs can also be used to connect a subscriber's headquarters with Geostar's operations center. Geostar supports Electronic Data Interchange, and RDSS user terminals can be interfaced directly with refrigeration, trailer and security devices for automatic transmission of alarms.

RDSS SYSTEM DESIGN

Geostar is licensed by the Federal Communications Commission to construct, launch and operate three dedicated RDSS satellites by 1993. These satellites will be built by GE-Astro and launched on the space shuttle. They will provide service to users in both the S-band (specifically, 2483.5-2500 MHz) for satellite-to-mobile terminal transmissions, and the currently used L-band RDSS frequencies (1610-1626.5 MHz) for mobile terminal-to-satellite transmissions[4]. Position determination will be accomplished automatically by ranging through these multiple satellites. A detailed technical description of Geostar's RDSS system is provided in a paper presented by L.O. Snively and W.P. Osborne at the AIAA 11th Communications Satellite Systems Conference entitled, "Analysis of the Geostar Position Determination System."[5]

The general operation of Geostar's dedicated RDSS system is illustrated in Figure 2. This RDSS system will integrate the position determination and messaging functions into a single operation. In the RDSS system, a continuous outbound signal is transmitted to provide time reference marks and an outbound time division multiplex data stream. To determine the position of a mobile unit, the mobile unit retransmits one of the time reference marks, adding its unique identification code and other information, through two or more geosynchronous RDSS satellites. The position of the mobile unit is calculated at the central earth station from the round trip propagation times through three satellites, or by the round trip propagation times through two satellites and altitude information obtained from a digitized terrain map or on-board altimeter. The calculated position and any other information addressed to the user is transmitted back on the outbound data stream between the system time reference marks. The positioning accuracy of Geostar's dedicated RDSS system is expected to be better than fifty meters.

A miniaturized terminal is currently under development for government customers which will measure 5.6 by 3.1 by 1.6 inches and weigh 22 ounces, excluding battery pack. This user terminal includes a keyboard display containing a 2-line by 39 character display and 3-row by 10-column alphanumeric keypad. The unit also includes the L-band transmitter, S-band receiver, omnidirectional patch antennas, and internal processor module. Geostar expects that similar user terminals will also be commercially available to the general public.

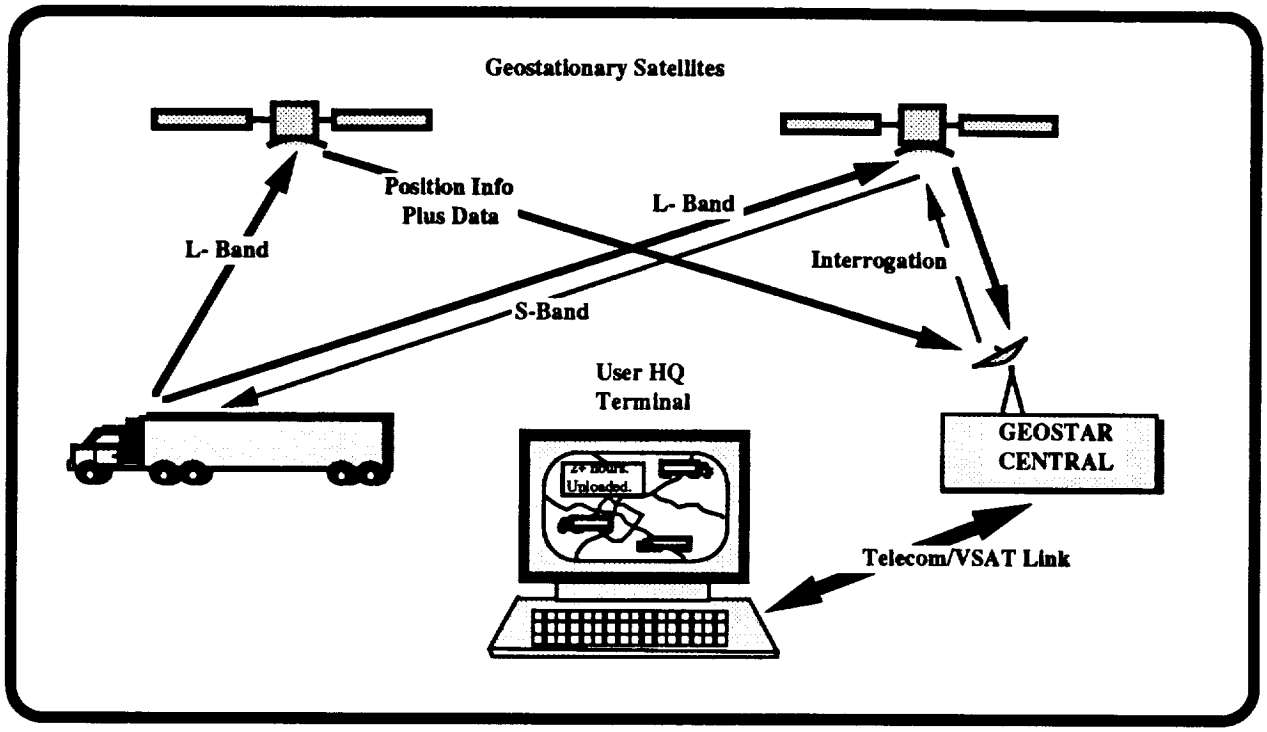

Figure 2. RDSS System Architecture

INTERNATIONAL RDSS

Significant progress is being made in developing RDSS in other parts of the world. In Europe, Locstar is developing an RDSS system that will be interoperable with Geostar. In March 1990, Locstar increased its capitalization from 100,000,000 French Francs to 676,000,000 FF (approximately $17.4 and $117.7 million, respectively), with 42 European partners from 13 countries. Locstar plans to launch two RDSS satellites in 1992 covering Europe and the Mediterranean basin. Mobile terminals are being developed by three consortia, lead by MAN, SAGEM and Techniphone. An RDSS processing and control center is being established in Marseilles, France.

Geostar is also establishing a Mexican affiliate to provide a position reporting and messaging service in Mexico using a combination of Geostar's RDSS relays and the Morelos system. In addition, the second generation of AUSSAT satellites will carry RDSS relays, and Geostar is working to establish an Australian RDSS venture.

REFERENCES

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