

Milstar II's Digital Processing
Space Technology
Northrop Grumman Corporation

Milstar II's Digital Processing Subsystem: Key to the Medium Data Rate Payload

Milstar II satellites (see box below) will benefit from a Northrop Grumman-developed digital processing subsystem that delivers data 640 times faster than Milstar I payloads, while capitalizing on dramatic advances in microelectronics and manufacturing processes to lower payload costs, weight, and part counts. The result is a system well adapted to fast-moving tactical military uses, as well as one that preserves Milstar's core communications requirements for worldwide, antijam, scintillation-resistant services with low probability of interception.

The digital processing subsystem, combined with the RF subsystem built by Boeing Satellite Systems, constitutes the medium data rate (MDR) payload electronics package. Boeing integrates the MDR payload for Milstar prime contractor Lockheed Martin. MDR services will provide U.S. military forces with on-demand availability of interactive voice, video, and data links at rates up to 1.544 megabits per second. That's more than 50 times faster than the 28.8-kilobit-per-second modem used with many personal computers.

The MDR payload is tailored to meet the needs of third world threats and regional conflicts. Flexible onboard processing instantly reconfigures networks to suit evolving command and control requirements.

The use of EHF frequencies and highly directional nulling antennas reduce the probability of jamming and intercept. Lightweight portable terminals on land, sea, and in the air can be easily moved during tactical operations

Milstar I and II

The first two Milstar satellites, now operating on orbit, are referred to as Milstar I. They employ a low data rate (LDR) payload that transmits secure data at a maximum of 2400 bits per second.

Flights 3 through 6 collectively are called Milstar II. Milstar II satellites will carry both LDR and medium data rate (MDR) payloads. The full constellation of six Milstar satellites is scheduled to be in orbit by 2001.

Northrop Grumman is the LDR payload integrator. Northrop Grumman also provides the MDR antennas and digital processing subsystem to Boeing Satellite Systems, the MDR payload integrating contractor; Lockheed Martin is the Milstar prime contractor.

Connectivity among Milstar satellites is established via space-to-space crosslinks in the 60 GHz band. Crosslinking will allow user communication networks to extend around the globe without retransmission through intermediate ground stations.

Benefits of Onboard Digital Processing

Quickly changing battlefield conditions and spontaneous requirements for interservice connectivity demand Milstar's highly sophisticated onboard network configuration capabilities.

Each MDR payload has eight antennas, each independently steerable and operating at extremely high frequencies (EHF). Terminal users may communicate with other users within the same antenna beam or with users located in other MDR antenna beams from any of the Milstar II satellites. The on-orbit digital router establishes and maintains links within and among beams and responds to users' changing and differing bandwidth requirements.

From each uplink beam the MDR payload processes the communication data, sorting and routing them to the proper downlink beams. If a data destination is found to lie outside the areas covered by a satellite's antenna beams, the payload routes the message via crosslink antenna to another satellite for downlinking.

In addition to sorting and routing messages, the digital processing subsystem performs other key functions such as demodulation of the EHF signal, authenticating and granting user access, and dynamically configuring payload resources (antennas, receivers, processors, etc.) to establish networks and provide bandwidth on demand.

To perform these complex functions, the MDR digital processing subsystem relies on 14 custom application-specific integrated circuits and 397 large-scale integrated (LSI) circuits, all fabricated in CMOS technology. This figure represents a decrease of 37 percent from the 630 custom LSI circuits required for each LDR payload.

Fast, Flexible, MDR Flight Software

The software that controls MDR payload resources, like the processors it runs on, delivers higher performance at reduced cost than its flight-proven counterpart in the LDR payload.

The software is responsible for managing all MDR payload resources (uplink, downlink, and crosslink) employed for user communication. The software acts as a “switchboard in space,” dynamically changing the routing path of communications data, based upon user requests. In addition the software performs all the multisatellite coordination with other Milstar satellites to support worldwide communications without resorting to intermediate ground links.

The ability to improve performance and functionality while lowering development risk and reducing cost stems largely from two key factors. One is the selection of the Milstar Advanced Processor (MAP) as the MDR resource controller. MAP is a high-performance, general-purpose computer, developed for the Milstar program and used in other capacities on Milstar spacecraft. The other risk- and cost-reduction factor is the extensive reuse of LDR processing design and software code, which shortened development time dramatically. In addition, Milstar requirements and external interfaces were already well defined by the time MDR development began.

Although software in the MDR and LDR payloads provides similar functionality, the MDR software incorporates a number of important system improvements. MDR software:

- Employs a centralized database architecture. This means that database information about users is not duplicated on multiple satellites. Instead, service operations are coordinated by a single satellite with full service information. Centralizing this function simplifies multi-satellite coordination and lowers the amount of crosslink traffic devoted to system administration “overhead.”
- Adds a new “fencing” capability. Fencing ensures that designated user groups in the three military services can procure access to allotted satellite resources. In times of crisis, fencing guarantees these user groups Milstar availability.
- Increases system flexibility. The software is both configurable and

uploadable from the ground. This feature provides the ability to add software patches and improvements “on the fly,” or to replace the software with an updated version.

- Supports LDR-aided acquisition of the MDR payload. This feature permits LDR users to log onto the MDR payload.

Savings in Time, Weight and Power

Payload engineers took advantages of advances in microelectronics technology to pack more processing power into smaller digital units, or “configured items,” as the boxes are called.

For example, the MDR digital processing subsystem requires only two configured items to perform demodulation and routing functions. The LDR payload management subsystem (PMS) required four configured items to perform the same two functions. Overall, the MDR’s digital subsystem weighs about 40 percent less than its equivalent configured units on the LDR PMS. The MDR units consume only half the power of their LDR counterparts.

The MDR design also paid off in savings of time and manpower. The integration and acceptance of the MDR digital processing subsystem took less than three months, about half the time required to complete the same tasks for the LDR PMS. In addition, the size of the crew needed for integration and test was reduced by one-fourth. Add the savings in support personnel and the manpower required for integration and acceptance testing was cut in half.

MDR Digital Processing Demonstrates Continuous Milstar Improvements

The MDR payload not only boosts Milstar performance by giving forces in the field the wideband services they need for high-speed communications and dynamic network configuration. It also demonstrates the Milstar program’s ongoing progress in providing greater performance from electronic payload units that weigh less, consume less power, and require fewer people to build and test. All of which is necessary to meeting the U.S. military evolving communications needs in the post-Cold War world.

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