CGMS XXVII USA WP-19
USA
Agenda Item I.3.2

THE FUTURE GOES DCS SYSTEM

Summary and Purpose of Document

As the National Environmental Satellite, Data and Information Service (NESDIS) heads into the 21st century, the GOES Data Collection System's (DCS) computers and interfaces are approaching the end of their service lives. The DCS Automated Processing System (DAPS II) procurement project will replace the current aging DAPS, with modern user friendly hardware and software to maximize effectiveness and minimize life-cycle costs. The DAPS II will enable NESDIS to meet its obligations to the domestic and international DCS community and maintain its position as the world's premier satellite data collection service.
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Action Requested: None

CGMS XXVII
USA
Agenda Item: F.1

THE FUTURE GOES DCS SYSTEM

INTRODUCTION

As millions were glued to television sets across the nation to watch record breaking floods on the giant Missouri and Mississippi Rivers rampage through the Midwest. The summer months became a time of heavy, unprecedented storms and pelting unrelenting rainfall on the States of Minnesota, Nebraska, Iowa, Kansas, Illinois and Missouri. During June and July heavy rains fell 39 out of 54 days. Tributary reservoirs in Kansas, Missouri and Iowa filled to capacity, then overflowed their banks. Tens of thousands of volunteers worked around the clock piling sandbags into makeshift levees. The Missouri and Mississippi rivers, sometimes destroying and washing away everything in their paths, crested at all time highs.

What the press often fails to report is that the same satellite technology that enabled television viewers to see stormfronts moving across the Midwest creating the disaster, is also responsible for saving untold lives and flood losses estimated at more than $6 billion in the Missouri River Basin alone.

A network of hundreds of automated Satellite Data Collection Platforms (DCPs) interfaced with self-reporting gauges used to measure such crucial data as rainfall and river levels provide fast, reliable realtime weather and flood data. Ship observations and ocean buoys provided information about the climatological event that was responsible for the unusual precipitation in the mid-west. The warming of the pacific ocean in the mid-latitudes was monitored by the same satellite that provided the outstanding images of El Nino.

NOAA's little known sensor system, GOES DCS, that was so reliable in providing the ground truth data for so many satellite instruments, global programs and numerical prediction models is entering the age of retirement. Information provided by the DCS supports several state, local and federal agencies, national and international organizations. The original Data General configuration purchased in 1987 is beyond its operational life expectancy. Currently, NESDIS is replacing the current system with a state-of-the-art open systems technology. Also, new procedures for managing the system resources as well as new technology will allow NOAA the opportunity to continue providing this quality in the new millennium.

THE CURRENT DCS SYSTEM

The GOES system, operated and controlled by NESDIS, operates from geostationary orbit and consists of several observing subsystems, including visible and infrared imagers, sounders, and the Data Collection System (DCS). The DCS functions as a communications relay system using 400 MHz of the spacecraft transponder for the multiplexing and transmission of DCS environmental data from remotely located, in-situ DCPs at or near the Earth's surface and within the radio transmission view of the receiving GOES. The DCP UHF-uplink transmission is converted by the GOES transponder to an S-band downlink received at the Wallops Command and Data Acquisition (CDA) site from which the data are passed to the Wallops DAPS. The DCS data are relayed to users via Domsat, NWS Telecommunications Gateway, or direct from DAPS via dial-in telephone lines providing 300, 1200, 2400, and 9600 bits per second (bps) selective data access. Independent users can procure their own Direct Readout Ground Station (DRGS) and receive DCS data directly from GOES. The user in this case bears all costs of receipt and processing for use. There are presently 17 DRGS users, who in turn support 65 sub-users. The elements of the DCS are discussed in more detail in later sections. Agencies using their own DRGS are required to adhere to the channel assignments and schedules coordinated for the GOES DCS by NESDIS. Operators of DRGS are encouraged to notify the NESDIS operators in order to receive notification of operational schedules and changes. There are no formal agreements between DRGS users and NESDIS, other than the normal Memorandum of Agreement (MOA).

Two operational GOES spacecraft normally are located over the Equator, at 75W and 135W. These spacecraft have a radio view of most of the Earth from 0 longitude westward to 150E, and between 77S to 77N. (Coverage is restricted to lower latitudes when moving east or west from the receiving satellite sub-point longitude.) The National Weather Service (NWS) has requested that a third GOES spacecraft be positioned at 105W (mid-way between the two operational satellites). These spacecraft are complemented by non-U.S. geosynchronous satellites with compatible DCS capability provided by Europe (Meteorological Satellite METEOSAT) and Japan (Geosynchronous Meteorological Satellite GMS) and located over the equator at 0W, and 140E, respectively. The compatibility between the U.S. and non-U.S. DCS systems is restricted to 33 channels having 3 kHz bandwidth (channel separation). These channels are designated "international." DCPs assigned to the international channels are usually mobile platforms, except in special circumstances such as the Tropical Ocean Global Atmosphere (TOGA) experiment.

Downlinked GOES DCP data are acquired by the Wallops CDA site. The DCP data are demodulated by the 13 Data Acquisition and Monitoring Subsystems (DAMS). Each DAMS contains 10 demodulators. Each demodulator can be tuned to any of the 233 DCS channels downlinked from the satellites to demodulate and quality check the DCP messages, and multiplex these data for ingest into the DAPS computers. The DAPS computers prepare messages for the user interface by performing the following specific functions:

- o Storage in the DCS Data Base Management System (DBMS) for 100,000 Platform Description Tables (PDTs), 5000 User Description Tables (UDTs), and 5000 MOA records.

- o Ingest data simultaneously from up to 233 channels (33-3 kHz channels).

- o Output a complete set of DCP message data via Domsat direct broadcast. Provide for retransmission of selected Domsat data in response to user requests.

- o Output DCP message data via NWS Telecommunications Gateway (different format than Domsat and dial-in data).

- o Support the Telephone User Dial-up service. Allow DCS users to access data via ten 300/1200/2400/9600-bps dial-up circuits.

- o Maintain all DCP message data in accessible storage for up to 72 hours (72-hour limit on storage is becoming a deficiency for a significant number of research and development users).

- o Ingest DCP data from up to twenty-seven 100-bps, ten 120-bps, and twenty 30-bps DAMS units.

- o Monitor the quality of all DCS/DCP message data ingested, DCS demodulator status, and communication circuits.

- o Monitor the arrival of self-timed and interrogated DCP messages as per data stored in the central PDT data base.

- o Automatically control two interrogate modulators and two test transmitters.

DCS users can receive DCP data via four basic routes:

- o Direct readout of the DCS data obtained from the GOES spacecraft using a DRGS. This is an independent configuration with the user responsible for the antenna, hardware, software, processing costs, and performance.

- o Data from GOES via DAPS to Domsat. Provides selective access to all DCP data and a retransmission capability to the user. The user is fully responsible for the local Domsat readout capability, the Domsat Receive-Only Terminal (DROT), which may cost

$15,000 to $20,000. NESDIS contracts for Domsat uplink and transmission channels. User support is coordinated by the STIWG.

- o Data from GOES via DAPS to NWS Telecommunications Gateway. Data available in limited or restricted capacity, and only through special arrangements with NWS.

- o Stored DCP data from the DAPS via dial-in telephone. Provides selective access to all DCP data. Ten phone lines provide dial-in asynchronous service at 300/1200/2400/9600-bps access to the DAPS. The user assumes phone line expenses and interface costs with DAPS.

Although the GOES DCS was made operational over twenty years ago, the current DCS Automatic Data Processing System (DAPS) was not made operational until 1989. Since 1989 the number of DCP allocations and the number of DCS users has grown at a 10 per cent per annum rate. To accommodate this growth, NESDIS has added new equipment, upgraded requirements, and modified the DAPS accordingly. Some of the changes to the DAPS over this time frame are:

- o Support of SCSI Disks - Original DAPS 592 Mbyte disk drives have been replaced by 2.1 Gbyte redundant SCSI disks for increased reliability, with an increased storage capacity.

- o Added Internet Interface - The initial DAPS data access and dissemination capabilities have been augmented by an Internet interface with TELNET capabilities to allow user access to Message Files (MF), reports and manuals, with selective access to modify their Platform Description Table (PDT) and User Description Table (UDT) to update their content.

- o Split Operation - Initial implementation of DAPS provided fully redundant processors, each ingesting and processing data in unison, with one processor designated as operational, with the DAPS external interfaces and devices, and the other as stand-by. In the event of failure of the operational processor, Fallback Switch equipment, supported by a"Watchdog" software monitor, would automatically activate the stand-by processor as operational, transferring the external interfaces to it. Current operation is split such that the two DACS processors are operated independently, with the automatic fail-over feature disabled.

- o Dial-in Modem Upgrade - The originally installed 9.6 bps dial-in modem has been upgraded to a 19.2 bps data rate.

After adding the above changes and numerous other less significant ones, NESDIS has decided to replace the current DAPS with a subsystem that can meet the DCS processing, routing, and management requirements for the Year 2000 decade.

PLANNED DCS UPGRADES

NESDIS is in the process of upgrading the current DCS system for the new millennium. The new system is known as DAPS II. DAPS II is envisioned to support the DCS well into the decade of Year 2000. It contains a substantial upgrade in the number of DCPs and DCS users supported as well as considerable enhancements in the DCS data management areas. The DAPS II is to serve three basic missions: maintaining the central DCS data bases; carrying out all DCS real time operations without operator intervention; and servicing DCS management, operators, and users with numerous utilities.

The DAPS II will maintain the central DCS data bases. These include:

- Platform Description Table (PDT) data base containing up to 150,000 DCP records;
- User Description Table (UDT) data base containing up to 5,000 DCS user records; and
- Management Description Table (MDT) data Base consisting of text records and management reports.

Each PDT record defines DCP operating specifics, some of which are platform inherent, some of which are defined by its owner, and some of which are DCS operator assigned. Entries in the PDT are used to perform real time functions and to keep track of the platform record. The UDT records identify all DCS users and retain pertinent information concerning their type, address, and message dissemination requirements. The MDT contains DCP certification data. Aside from these central data bases, the DAPS II also must support many other data files to carry out its real time functions.

DAPS II real time operations support its primary mission to relay environmental data from DCPs to the DCS users. Operating in real time, the DAPS II will ingest and demultiplex DCP messages from three types of Demod/Multiplexors; monitor each message for data quality, conformity with schedule, and proper channel assignment(s); maintain statistics on DCP messages; store the messages and retransmit them to the DCS user community; diagnose DCS channel interference, monitor DAPS II components or system failures; compile and retain statistics associated with DCS operations; and log DCS system events. At the same time, the DAPS II will monitor, command, and control the operation of the DCS interrogate modulators and test transmitter(s).

As a collateral duty, the DAPS II will also provide responsive support to DCS management and operations with a diverse set of reporting, system control, and administrative utilities. In addition, the DAPS II is to provide timely support to the DCS users. The DCS user community requires a diverse set of support functions. With DAPS II, most users will receive their data by way of a leased domestic satellite (DOMSAT) broadcast link or the Internet, while users with relatively small data gathering requirements will continue to access their DCS data through a DAPS II asynchronous dial-in telephone link. At the opposite extreme in terms of data volume, the National Meteorological Center (NMC) requires special data formatting support and a dedicated communications link. Users who operate and maintain DCPs (known as Owners in the UDT) will also require TELNET or dial-in support to perform interactive updates to their associated DAPS II records and to retrieve statistics related to the performance of their DCPs.

System Management Utilities will be provided to assist NESDIS in operating, monitoring, controlling, and administering the DCS. These utilities will be accessible via a Graphical User Interface (GUI). The GUI will be tailored to the DAPS II, and will provide all of the functions performed by the current DCS system. The GUI will also provide the features demonstrated by the DAPS experimental Internet web site, which may be accessed at http://dcs.noaa.gov. The DAPS II GUI will be designed to allow the present user interface in the same manner with the only differences being the system access privileges. Separate GUI screens for NESDIS and the users will be provided with pull-down menus containing valid entries wherever possible.

NESDIS and DCS users will have the capability to update each database description table record according to access privilege, both interactively and in batch mode. New applicants and current users will be given the option of completing applications on-line and submitting to the NESDIS for review. The users/applicant will be able to check the status of an application at any time. In addition, DAPS II will provide NESDIS will an automatic MOA renewal system. A notice will be generated for review of the user's compliance with system policies before offering renewal. After review of the notice, NESDIS will contact the user about the status of the agreement.

NESDIS will implement the Channel Interference Monitoring System (CIMS) to immediately identify sources of interference. CIMS provides continuous, automatic testing and reporting for both GOES East and West international channels. Its capabilities have also been expanded to provide scheduled testing of all GOES DCS channels, both International and Domestic. Along with statistical reporting of Radio Frequency Interference (RFI), the CIMS proves the capability to capture, archive and analyze a Spectrum Analyzer plot of all tested signals.

NESDIS has initiated the procurement of high-data-rate modulators and test transmitter prototypes, operational 300-bps high-data-rate demodulators, and two 300-bps test transmitters (see attachment #1). The contract contains options for additional demodulator purchases. Certification standards for industry to develop high-data-rate DCPs have been established. To illustrate the anticipated increase in system capability a typical assignment of one-minute time slots reporting every three hours at 100 bps results in a maximum of 180 DCPs per channel. At 300 bps, three times the number of DCPs can be assigned to the same channel, e.g., 540. Overall, it is estimated that the system capacity will increase by approximately 200 percent.

FUTURE DCS IMPROVEMENTS

NOAA is committed to providing a quality service to its customers. As users demands increase, the DCS system must be able to provide a reliable, safe and secure service. Eliminating intrusions in the DCS system and maintaining integrity among the data collection platforms will lead to an efficient service for the users. NOAA is determined to keep interference to a minimum in the GOES system. Researching and evaluating methods to locate and identify sources of interference is a requirement for NOAA to manage its RF resources. The Transmitter Location System (TLS) and similar systems will be evaluated by NOAA to determine its benefit to the GOES DCS system.

NOAA realizes that Time Division Multiple Access (TDMA) has its limitations. The guard bands employed in this format is an inefficient use of resources in a restricted system. Experience has shown that interference is a persistent problem that is inherent in any RF system. New technology to utilize or eliminate interference will be beneficial to increased user demands on the GOES DCS service. Investigating resources that will nullify the interference but provide reliable system use is the future of the DCS.

NOAA teamed with other federal agencies to conduct a study of Code Division Multiple Access (CDMA) transmissions through the GOES transponder. The objectives of the study are:

- to demonstrate the feasibility of using CDMA carriers to overlay over the existing TDMA carriers in frequency over the existing GOES UHF-to L transponders,
- to determine the potential for increased transponder usage by using CDMA carriers without degrading, to unusable levels, the current TDMA capacity, and
- to identify possible CDMA architecture and preliminary specifications for a CDMA-based system to operate over the NOAA-GOES satellite.

The study conducted did not reveal all the positive results NOAA had anticipated. Transmissions over the domestic channels did not respond as planned, while transmitting over the international channels was very promising. NESDIS believes that the saturation of the domestic channels caused the poor results with the CDMA distribution. On the international channels, NESDIS analysis of the CDMA signal was positive due to the low population of the international channels. This led NESDIS to believe, in these early stages, that CDMA can not be transmitted over the TDMA (UHF) signal. NESDIS plans to continue investigating the feasibility of using CDMA on the GOES spacecraft. As NOAA continues studying the feasibility of CDMA on the GOES spacecraft, this and other studies will define the upgrades to the ground facility and modifications to the PDTs.

CONCLUSION

Over the next 10 -15 years, NOAA plans to overhaul the current DCS system and improve the service it provides to the users. Improvements in spacecraft systems to support the demand for additional users are a part of the requirements for GOES NOPQ. Improvements in the GOES transponder may support CDMA and increased data rates.

NOAA will continue to investigate and implement methods to manage the system resources and provide the users with a reliable service. The new DAPS system has been budgeted and the final requirements are being developed. The RFP and Statement-of-Work will be issued in the second quarter of FY2000. NOAA is committed to supporting the Data Collection System, domestic and international well into the next millennian.

ATTACHMENT #1

Current GOES Data Collection System High Data Rate

PHASE 2 -OPERATIONAL DEVELOPMENT SCHEDULE

o	0010	Operational Improved Test Transmitter	November 1999
o	0011	Operational HDAMS	
		300 BPS	November 1999
		1200 BPS	November 1999
o	0012	HDR DEMOD Test Set	November 1999
o	0013	HDR Acceptance Testing	Sept-October 1999
o	0014	O & M Manuals	
		DRAFT	November 1999
		FINAL	January 2000
o	0015	Training	December 1999
o	0016	Recommended Test Equipment	June 1999
o	0017	Warranty	One year After

Acceptance

o	Mod	HDR Certification Test Set	November 1999

After November 1999 installation NESDIS Expects

Six Month Experimental Check out

Operational May 2000