

# **REMOTE MONITORING AND COMMUNICATION OF TELEMETRY DATA**

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## **ABSTRACT**

The Brine Measuring System-Environmental Monitoring and Data Acquisition System (BRIMS-EMDAS) being used at the Bryan Mound, Texas, National Strategic Oil Reservoir will be used as an example to demonstrate the system features of a remote monitoring and data communications system.

A buoy-mounted telemetry system is used to measure ocean temperature, conductivity and flow required for monitoring salinity levels near pumped brine outputs. The monitoring and communication system described in this presentation provides computer-to-computer communication via network as well as remote user display of data inventory, configuration and engineering unit data.

The system stresses ease in configuration and inventory control. Configuration make, change and list functions and inventory list, archive and delete functions are provided.

## **INTRODUCTION**

Science Applications, Inc. has designed the BRIMS-EMDA System to include the following features:

- Control the power-on/power-off state of the Remote Sensor and PCM Encoding/Transmission Subsystem (RSPETS).
- Acquire and store raw PCM data,
  - Automatically - at user specified time periods, taking data for specified time intervals.
  - Upon command from personnel both at the local site and at remote locations.
- Process the raw PCM data
  - Compression of the raw PCM data (averaging) over the specified number of frames to reduce storage requirements.

- Conversion of the compressed data to Engineering Units (EU's) via the specified transformation polynomial.
- Computation of derived parameter equations on the specified data.
- Storage of the results
- Data Inventory Control (List, Archive, Delete)
- Display of Processed EU Data to local and remote sites (query).
- Generation of a consolidated data file for network transmission to remote computer sites for further analysis.
- Automated archival of data files to magnetic tape for permanent storage
- Automated deletion of data files from the Inventory.
- Privilege system to allow only authorized personnel system configuration and inventory control.
- Total user configurable PCM data formats, sensor conversion coefficients, derivation parameter control, display control, etc.
- Degraded operation with minimal system effect.

To allow remote users to utilize the system, a communications system is provided which will allow for remote initiation of the command to acquire data and for the query of existing Engineering Unit data files (EU files). In addition, the communications subsystem provides direct file access and transfer through a computer-to-computer network facility.

## **SYSTEM FUNCTIONS**

There are three operating modes of the BRIMS-EMDA system. These are:

1. System and Diagnostic
2. Configuration/Inventory Control
3. Data Collection

## **SYSTEM MODE**

When not operating in one of the other modes described below, the user has access to the capabilities of the Digital Equipment Corporation RSX11-M operating system. RSX11-M is a multi-user system designed specifically to support real-time tasks running on the PDP-11/34 controller. In addition to the operating system, a full complement of system functions are available.

Diagnostics are also provided which test devices to identify the source of errors. Malfunctions can be tested on disk memories, the tape unit, and the console terminal.

## CONFIGURATION/INVENTORY CONTROL MODE

The Configuration/Inventory Control Mode is used to:

- Set up configuration files for the control of the system resources/system access, PCM data processing display of data, intervals between automatic samples, etc.
- Archival of data currently in the system inventory.
- Deletion of archived data files from the system inventory.
- Determining the contents of the system inventory.

Although this mode can be entered at any time automatic data collection is not in progress, it will be suspended during the automatic data collection period (ADCP) to be resumed after the ADCP. Notification to all users of the beginning of ADCP and the end of ADCP is provided by the system. The access to privileged commands is controlled by the user's password and on system name but, in general, to be a privileged user the System Manager must have granted the user the BRIMS Privileged System Name and BRIMS Privileged Password. All other BRIMS users are non-privileged and therefore restricted in their use of the system as outlined below.

In the BRIMS system, the non-privileged user in this mode may:

- Determine the current BRIMS configuration (controlled by privileged users).
- Determine the data that is currently in the system inventory.
- Display the contents of any EU file within the inventory as well as that generated by a commanded data acquisition by a non-privileged user.

In general, the non-privileged user has access to any data currently in the systems inventory, can determine what the configuration is and can display any file in the inventory but cannot change the configuration or alter the system inventory in any way; i.e., he is an observer.

The privileged user has available to him all of the features of the non-privileged user in this mode, but in addition may:

- Change the current BRIMS configuration.
- Generate or modify a Configuration file (which controls the system configuration).
- Archive data files currently contained in the inventory.
- Delete archived data files from the inventory.
- Start/stop the automatic data collection sequence.

Detailed descriptions of all of these options are contained in subsequent sections.

## **DATA ACQUISITION MODE**

### **Automatic Data Acquisition and Processing**

The BRIMS-EMDA system will normally be in this mode and performing this function on a 24-hours-per-day basis. In this mode, data collection can be initiated by several means, as dictated by the configuration file. These are:

- Automatic, by time of day clock, at specified time periods for specified intervals.
- When commanded by the RSPETS by the power-on state and PCM in-lock signal.
- As commanded by the on-site operator.

The type of automatic data collection initiation is part of the privileged system configuration as described later.

The normal operating set-up is for automatic commanded data collection. Each data collection span collects the required data channels of environmental data and of buoy housekeeping data. At the end of each span an engineering units file is generated which contains the Engineering Units Values for the averages of all measurements during the data acquisition period and derived parameters, one of which is salinity.

Since the periodic automatic data collections are needed for interface to additional analysis and modeling, this data collection has highest priority. Data collection can be also commanded when model data acquisition is not in operation and if no interference with the model time period will be made.

A raw data-to-engineering unit conversion program is operated immediately following a data collection period and a file is generated of averaged data in engineering units. The results of this computation can then be displayed on the users terminal.

In the BRIMS example, a salinity equation is then used to convert temperature and conductivity variables to salinity and values are made a part of the calculated engineering unit file. When requested, the Engineering Unit files are consolidated and formatted for network transmission for the specified time period.

### **Commanded Data Acquisition and Processing**

In the BRIMS system data may be acquired and processed at any time upon command from a remote or operator user, provided this sampling and processing will not interfere with the automatic data sample.

The current system has included in it four “remote” user names and passwords. Each of these users is considered a non-privileged user; however, as determined by the configuration file, any user can command the buoy to take data, process it as described in the Automatic Data Acquisition and Processing section, and store it in a format suitable for display. This user may then have the data that was just acquired and processed displayed at this terminal. The data taken in this manner is considered “for information purposes only” and is therefore not entered into the system inventory.

A lock feature is included in the system which will allow the system manager to “not” allow the remote user to command data acquisition.

In either case, the remote user may display, upon command, the latest data taken by the automatic data sample.

## **SYSTEM CONFIGURATION**

### **Hardware Configuration**

The hardware at the Bryan Mounds location consists of:

DEC	PDP 11/34	Controller 16KW memory
DEC	Dual RL01	Disk memories
MDB	DR11B	Direct memory access interface
ACT	QUADRASYNC/E	Four serial interface board with full mode control
MDB	DU11	Serial synchronous interface with full modem control
DEC	DR11C	Parallel digital interface
DEC	LA36	Printer terminal
DP	TCU100	Calendar clock
RV	VA3455	Modem (2)
CDS	d/pad 3	Telemetry preprocessor/display
HP	2621A	Interactive terminal
SM	PINCOMM	
	PS PDP11	64K word memory
WP	TC-130	Western peripherals magnetic tape controller
CD	900X	Cipher magnetic tape, 9 track, 800 bpi (2)

Digital Equipment Corporation system software installed in the above equipment are the RSX11-M Version 3.2 operating system, MACRO 11 Assembly Language, and DECNET.

Hardware at the NOAA Washington, D.C. location (NOAA Center for Environmental Assessment Services, 3300 Whitehaven Street, N.W., Washington, D.C. 20235) is installed in an existing PDP 11/50 operating under IAS. The installed items are a remote network link and a network line unit, DMC11-AR and DMC11-DA respectively. DECNET software is also installed. A Racal Vadic VA3455 modem and a VA871 telephone are also installed. DECNET provides for direct file access communications software.

Each of the remote stations have Hewlett Packard 2621P printing terminals, Racal Vadic VA3455 modems and Racal Vadic VA871 telephones.

Hardware interfaces are: direct memory access for raw data, parallel interface for d/pad 3 status and for data collection control, monitor console interface, serial printer terminal (LA36) interface for error logging, and modem interfaces for both remote station and DECNET operation.

The telemetry preprocessor and display (d/pad 3) subsystem accepts a serial PCM stream from CFE receivers or tape recorders and provides quick-look information as well as outputs for computer input. Quick-look capability is provided by two means: CRT display allows the operator to select any 12 PCM words and display in real-time their average and cyclic values in engineering units. Buoy housekeeping parameters are normally selected and displayed. Automatic limit checking also checks average values against an upper end or lower value, as well as check the cyclic (A.C. component) values against 2 levels of cyclic limits.

Analog outputs allow outputting of any of the PCM channels as an analog voltage to allow strip chart recording or monitoring by other analog devices (meters, spectrum analyzer, phase meters, oscilloscope, etc.).

## **BRIMS SYSTEM COMPONENTS**

When the system power-up procedure is complete, the computer system is in the DEC System Monitor Console Routine (MCR) mode and is ready to accept RSX-11M commands.

In addition to being in MCR Mode, the following BRIMS System Tasks are installed automatically by the system boot procedure.

1. BRI - The BRIMS Data Acquisition Manager
2. RMT - The Remote Site Data Acquisition Manager
3. INV - The Inventory Control Manager

4. PLU - The Plume Data/DECNET Manager
5. CON - The BRIMS Configuration Manager
6. ENG - The Raw to EU Conversion Manager
7. DIS - The Display Manager

In order to insure BRIMS System security, there are two types of commands that can be processed by these BRIMS System Tasks. These are commands that effect system performance/system configuration and are therefore restricted, and commands that do not effect system performance/system configuration and are available to all users of the system.

### **BRI - The BRIMS System Data Acquisition Manager**

Of all of the system components, BRI is the only one which needs to be initialized following the system power-up procedure in order to bring the system to the ready state. There are two restricted initialization options available to the BRIMS Operator: the GO Option and the INIT Option.

#### **BRI GO Initialization Option**

The Go Initialization Option is the option normally used to bring the system to the ready state after short periods of down-time such as for system maintenance. This option does not take any action on files currently in the system inventory but does make provisions for filling data files which may have been lost during the down-period with dummy data,

#### **BRI INIT Initialization Option**

When it is desired to bring the system up with no data being maintained in the BRIMS Inventory, the INIT Option is used. This option deletes all data files and re-initializes the inventory control file, INVENTORY.

### **RMT - The Remote Site Data Acquisition Manager**

The Remote site data acquisition manager controls the data sampling and display of data taken during the sample period. All commands for the RMT task are non-restricted i.e., any BRIMS user may invoke them, provided the remote site has been enabled in the configuration under which the system is currently running.

## **REM SAMPLE Command**

In order to direct the BRIMS system to acquire and process data from a remote site for a sample, the SAMPLE Command is used.

## **RMT DISPLAY Command**

The DISPLAY Command is used to output to the users terminal/printer the Sample Data Taken. The BRIMS system maintains the last sample taken in the inventory as well as a copy of the last scheduled PLUME data therefore, the user need not gather data via the SAMPLE command in order to display data taken within the last PLUME data sample period (normally 30 minutes).

The user then inputs the page number of the data he wishes to view. Normally the page numbers indicated:

- 1 = Temperature Data
- 2 =Conductivity Data
- 3 =Metrological Data
- 4 =Salinity Data
- 5 =Housekeeping Data
- 6 =Ocean Current Data

## **INV - The Inventory Control Manager**

The Inventory Control Manager is responsible for maintaining the Plume Data Inventory on the system disc. This task is responsible for listing the current inventory contents, deleting files from the inventory (restricted), and generating the indirect command file for use in archiving Plume Data Files (restricted).

## **INV LIST Command**

The LIST Command is used to output a chronological list of the Plume Data Files currently in the BRIMS inventory.



Upon receipt of this command, INV will output the file names in the following format:

File Name	Sample Data	Sample Time	Sample Type	Sample Location
E12800109.235	Jan-09-80	1):30 PM	Plume Data	Bryan Mound
P12800109.235	Jan-09-80	11:30 PM	PCM Data	Bryan Mound
E12800110.000	Jan-10-80	12:00 AM	Plume Data	Bryan Mound
P12800110.00	Jan-10-80	12:00 AM	PCM Data	Bryan Mound

The following file naming convention is used to produce the inventory list:

Symbol	Character		
b	1	data type	E = engineering unit
r	2	location	P = raw data 1 = Bryan Mound 2 = Other 3 = Other
i	3	initiation mode	1 = buoy 2 = automatic (computer clock) 3 -operator 4-9 remote site number
y	4 and 5	year	last two digits
mm	6 and 7	month	01 = January 02 = February 03 = March 04 = April 05 = May 06 = June 07 = July 08 = August 09 = September 10 = October 11 = November 12 = December
dd	8 and 9	day	2 day of month date digits required for system extensions
HH	11 and 12	hour	00 through 23 clock hours
M	13	tenth of hour	hour rounded to nearest tenths

## **INV ARCHIVE Command**

The ARCHIVE Command is used to automatically archive to magnetic tape the data files directed.

## **INV DELETE Command**

The DELETE Command is used to delete data files or periods of data files from the system. Unless the /OVERRIDE switch defined below is used, the ARCHIVE command must have been issued previously on the files to be deleted.

## **PLU - The Plume Data/DECNET Manager**

The PLU System task is used to construct a transmission Data File which is named PLUME.DAT and contains all data in coded form. Filling for lost samples for the period specified is provided. This file can then be transferred to NOAA's PDP 11/50 via DECNET for processing by the PLUME simulation model.

## **CON - The BRIMS Configuration Manager**

CON is responsible for listing the data contained in the specified configuration file, changing a configuration file, or making a new configuration file. Listing of the configuration file is a non-restricted command. Changing and making a new configuration file are restricted commands.

## **CON LIST Command**

The CON LIST Command is used to list the contents of a configuration file.

## **CON CHANGE Command**

The CHANGE Command is used to change the contents of the specified configuration file. This is a privileged command.

When this command is received at the users terminal the following directives may be input:

{C<cr>}	Change the Configuration Record
{M<cr>}	Change a Measurement Record
{A<cr>}	Add a New Measurement Record
{E<cr>}	Exit
{H<cr>}	Type out some helpful text

Note that after receipt of the {M<cr>} command the system will solicit the measurement number.

### **The C CHANGE Configuration Record Command**

Upon receiving the C command the system begins an interactive dialogue requesting the items required for all entries in the configuration record. With the exception of questions which require a yes/no answer, all items will be left unchanged if a <cr> is input instead of an answer.

### **The M Change Measurement or Sensor Record Command**

Upon receiving the M Command, the system outputs the current contents of the specified measurement and asks if you want to change this one. If the answer is yes, an interactive dialogue is entered and the same default or “no change” rules as with the C Command apply. Note that floating point answers as for the Coefficients and Maximum/Minimum Values require the n.m <cr> format i.e., 1.0 for floating one (a 1.<cr> is not correct) .

### **The A - Add Measurement or Sensor Record Command**

Upon receiving the A Command the system enters into an interactive dialogue requesting the sensor record items. No defaults are supplied and each question must be answered with the same floating point input described above.

### **The E - Exit Command**

This command closes the file being modified and exits to the monitor.

### **CON Make Command**

The CON Make Command is used to generate, from scratch, a totally new configuration file. This is a privileged command.

Following receipt of this command, the system enters into an interactive dialogue which asks questions which must be answered by the user.

## **SUMMARY**

A functional description of the BRIMS-EMDAS system has been given to demonstrate the achievement of a versatile data monitoring and communications system. The concept of real time requests for data from multiple/remote locations for environmental monitoring and modeling has been implemented so that important projects can proceed while the environment is being protected.