XDS

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R B M

XDS introduces RBM (Real-Time Batch Monitor) a sophisticated monitor system for Sigma 5/7 customers with small to medium configurations. RBM can provide extensive concurrent real-time and batch processing capabilities with a minimum of hardware investment.

FEATURES	BENEFITS TO THE USER
A. Concurrent real-time and batch processing on minimum configuration.	A. Allows user to accomplish sophisticated multimode processing at a very low entry cost.
B. Monitor is self overlaying from RAD.	B. Maximize core utilization by minimizing monitor residency requirements.
C. Background/Foreground partition dynamically adjustable.	C. System is sensitive to users real-time needs.
D. Automatic checkpoint and restore.	D. Foreground programs can temporarily seize all CPU and memory resources with full protection of background stream.
E. Overlay Loader.	E. Conserves core by allowing both FG and BG programs to overlay portions of themselves.
F. I/O Queuing.	F. High priority I/O is not delayed while waiting for I/O operations of lower priority.
G. Symbolic Device Addressing.	G. Allows configuration growth or alteration with minimum disruption.
H. Public Library with reentrant routines.	H. Conserves memory usage.
I. Four Language Processors.	I. Simplifies programming tasks.
J. RBM is a member of SDS supported monitors.	J. Allows upward growth to increasingly more comprehensive monitors with a minimum of reprogramming.

REAL-TIME BATCH MONITOR (RBM)

INTRODUCTION

The Real-Time Batch Monitor is a RAD oriented monitor system providing extensive concurrent real-time and batch processing capabilities on a minimum Sigma 5/7 hardware configuration. RBM requires only 16K words of memory and a 0.75 million byte RAD and provides a complete range of monitor services including RAD File Management. RBM consists of a small resident monitor (approximately 5.5K words), assembly language, Fortran and Simulation Language processors with their associated libraries, and the RAD management package which includes the RAD Editor and Overlay Loader. Also included is a System Generation routine which adapts RBM to a wide variety of Sigma 5/7 configurations.

RBM is generally compatible with the earlier version of RBM (RBM-1). This monitor is related to other SDS operating systems in the following order of increasing capability:

SA < BCM < RBM < BPM < BTM < UTS.

Minimal reprogramming is required to change from RBM to a more complex monitor.

CONFIGURATION INFORMATION

The minimum configuration for RBM is the following (note that only Sigma 5 Model numbers are listed; the corresponding Sigma 7 Model numbers can be substituted).

Model No.	Description
8201	Sigma 5 CPU with integral IOP
*8214	Memory Protect
*8221	Interrupt Control Chassis
*8222	Priority Interrupt, two levels
8251	Memory Module, 4096 words
8252 (3)	Memory Increment, 4096 words each
*8270	External Interface Feature
7201,7202	RAD (0.75 MB)
**7012	Keyboard Printer
**7060	High Speed Paper Tape Reader/Punch

*These items are only required for real-time operations.

**Model 7020 can be substituted for these items.

RBM SALES FEATURES

- Low Cost Entry Configuration

All of the services of RBM are operable on a 16K Sigma 5/7, a 3/4 MB RAD and a keyboard printer with paper tape I/O. A Sigma 5 RBM system (with high speed paper tape I/O) for performing batch processing and real-time is priced at $195,550 or $4,401/month on a 4-year basis. A significant increase in performance can be realized at a slight increase in cost by replacing the paper tape equipment with a 200 CPM card reader and a 225 LPM printer which results in a system price of $214,350 purchase or $4,824/month on a 4-year basis.

Growth to a system with time-sharing or greater batch capability is enhanced by the ease with which a monitor of increased capability is implemented. RBM is functionally compatible with BPM, BTM and UTS.

- Efficient Core Utilization

To maximize available memory, portions of the RBM monitor are overlaid from the RAD. In a 16K configuration, the user can compile Extended FORTRAN IV-H programs in the background with 1-2K words of memory available for real-time foreground operations.

To further increase core efficiency RBM allows the operator to dynamically change the allocation of memory between foreground and background. The boundary between these areas may be temporarily altered to accommodate an exceptionally large job. Also, RBM will automatically checkpoint (save) the current background job if a foreground job temporarily requires additional core memory. When the foreground job releases this area the checkpointed job is restored from the RAD by RBM, again automatically and the operation continues from the point of interruption.

The Overlay Loader under RBM allows both real-time and batch programs to overlay portions of themselves from the RAD. This conserves core and allows much larger programs to be run on a given configuration.

- Effective CPU Utilization

Most real-time systems require less than 100% (continuously) of the CPU capability of a Sigma 5 or 7. The concurrent feature of RBM allows any CPU time not used by real-time jobs to be devoted to batch operations--for example, program preparation. All I/O requests are queued (if necessary) and processed concurrently with program execution. A program requesting an I/O operation can continue doing useful work while the I/O transfer is completed.

Additional CPU time is saved by allowing the hardware interrupt system to priority schedule all real-time programs. No software overhead need be incurred to accomplish this scheduling. This helps maximize the computation/$ ratio.

- Real-Time Response

Fastest interrupt response of all our operating systems, dedicated peripherals and direct single seek RAD access allow critical data acquisition probelms to operate at a rate limited only by the experiment. The direct I/O execution (IOEX) feature further enhances the throughput capabilities of an RBM system. With IOEX, a user may directly program (including data and command chaning) any peripheral device. Maximum performance can be achieved with an absolute minimum of software overhead. Only one RAD access is required to bring in an entire segment at execution time.

All requests to the RBM Monitor for I/O service are queued and executed according to the priority of the calling program. Critical real-time I/O operations are not delayed by background batch requests.

- Growth and Flexibility

In conjunction with the normal ease of expansion of the Sigma 5/7 hardware, RBM offers complete software flexibility. By addressing I/O units symbolically the system is device independent. Upgrading of peripherals causes minimal interference with operations. In addition, any items from the following list can be added for increased performance and will be specifically supported by RBM.

8218/8418	Floating Point Arithmetic
8419	Decimal Arithmetic
8251/8451	Memory Module
8252/8452	Memory Increment
8273, 72, 75, 77	Multiplexor IOP
8285/8485	Selector IOP
7012	Keyboard Printer
7060	High Speed P.T. Reader/Punch
7121/7122/7140	Card Readers
7160	Card Punch
*720X, 12, 32	RADs
7320,22,23	9-track magnetic tape
7361,62,65,71,72,74	7-track magnetic tape
7440	Buffered Line Printers

*7231 w/o 7235 when 7232 is used as the system disc

- Public Library

Further minimizing memory usage, all subroutines commonly used by both real-time and batch programs may be combined and loaded into an area of the foreground called the Public Library. These subroutines are reentrant and can be dynamically shared by all operating programs.

- Multiple Processor Languages

A total of four language processors are supported by RBM:

Symbol
Macro-Symbol
Extended Fortran IV-H
SL-1 (A CSSL Based Simulation Language)

MARKET AREAS

RBM is designed to operate in any of the following environments:

Batch Processing - RBM is especially applicable in small to medium size Sigma 5/7 configurations where the batch processing sophistication of BPM is not required. Applications would include general purpose scientific computation and large data reduction problems.

Services available to the batch user include the language processors (Symbol, Macro-Symbol, Extended Fortran IV-H and the simulation language SL-1) and the service processors (Overlay Loader and RAD Editor).

Additional services include device independent I/O programming and File Management. Device independent programming allows a user to refer to peripheral units symbolically and, consequently, as configurations change or are expanded, no reprogramming is necessary.

File Management in RBM reduces programming effort and monitor time overhead by providing a variety of file organization and access methods. Files may be blocked, unblocked and compressed (for EBCDIC records) and these files may be accessed sequentially or directly.

Real-Time Processing - RBM is applicable to a wide variety of real-time environments including telemetry, hybrid, data acquisition, biomedical and multiexperiment processing.

Services available to the real-time foreground user include the ability to accommodate any number of real-time programs--limited only by available core and interrupts. These programs, which may be resident or nonresident, are scheduled by the priority of their associated interrupts. Fast interrupt response (less than 50 microseconds), dedicated peripherals (high throughput) and reentrant monitor and library routines (each routine may be shared by all users) also facilitate real-time operations. Response time to external interrupts is fastest of all our operating systems.

Concurrent Real-Time/Batch Processing - RBM allows maximum utilization of the Sigma 5/7 system. While being fully responsive to real-time needs, RBM automatically devotes unused system resources to the batch background. Thus when real-time processes are using less than 100% of the CPU, the user may be compiling, debugging or executing programs.

Features such as Public Library (less core required), system integrity (both core and RAD are write protected by hardware and software) and queued priority scheduled I/O further contribute to this concurrent mode of operation.

COMPETITIVE INFORMATION

The three major competitors to a Sigma 5/7 RBM system are the IBM 360/44, DEC PDP-10, and Honeywell H-632.

IBM 360/44 With Data Acquisition Multiprogramming System (DAMPS-2) - DAMPS-2 is an extended version of Model 44 PS (Programming System). (PS is a disc oriented sequential batch system offering Fortran IV-H, an assembler, file management and overlay loader capabilities. It does not support foreground programming, symbionts, or multiprogramming.)

DAMPS-2 requires a 32K word system (11K words for the monitor) and will concurrently execute one foreground real-time application and a sequential batch job stream. Each real-time application consists of one or more foreground tasks. Since the supervisor routines are non-reentrant, interrupt processing is accomplished by multi-level calling sequences. These calling sequences string together the required sub-routines/tasks which when connected comprise the required processing program. The collecting and priority assignments are accomplished via software!

RBM advantages over DAMPS-2:

- RBM provides multiple independent real-time programs--any or all of which may contain overlay segments. Only one foreground program under DAMPS-2.

- RBM provides for resident or nonresident foreground programs. DAMPS-2 requires foreground program residency.

- RBM provides automatic checkpointing and continuation of background jobs via the RAD on demand by the foreground program or the operator. There is no checkpoint capability under DAMPS-2.

- RBM assigns areas vacated after checkpoint to the foreground areas.

- RBM allows creation of reentrant subroutines which are commonly accessible to all real-time and batch users--the Public Library. There exists no such capability under DAMPS-2.

- RBM services are reentrant and therefore useable by any foreground program. The majority of monitor services are not reentrant under DAMPS-2.

- RBM is not required to schedule priority since this is handled by hardware. The foreground tasks are software scheduled under DAMPS-2 which effectively supports only one independent foreground program.

- RBM supports four languages. Only Fortran IV-H and Basic Assembly Language are available under DAMPS-2.

- RBM is a subset of the more comprehensive monitors BPM, BTM and UTS. The 360/44 and DAMPS-2 are glitches in the 360 family of computers and operating systems. There is no compatibility in either direction.

SDS publication 68-09-20 "Competitive Comparison & Sales Guide" provides extensive information on Sigma 5/7 versus the 360/44.

DEC PDP-10 - The PDP-10 is an RBM Sigma 5/7 competitor by virtue of its low price not necessarily by performance. Essentially three monitor systems are available for the different PDP-10 models. These monitors provide sequential, multiprogrammed or time-shared

(swapped) batch operations with little regard given to real-time needs.

1. PDP-10/20, 10/30 - a very simple resident monitor for control of sequential batch operations. The monitor elements include a Console Monitor, which interprets and executes control commands, and an I/O package, which allows device independent I/O programming. The controlling of batch jobs is done by a BATCH subsystem which in turn calls the USAII Standard Fortran or Macro-10, the assembler.

   Real-Time programs can be run in one of three ways with this monitor:

   a. In place of the batch job. This method allows individual real-time programs to be run at varying times without changing monitors. Each R-T program must alter the monitor, however, to link any R-T I/O routines, which must be user written, to the monitor. This is one real-time program loaded at a time using monitor I/O services.

   b. The R-T program is embedded in the monitor by using System Builder. This would be the case for a dedicated R-T system.

   c. The R-T program is integral to the monitor and batch jobs are run in the remaining core. This is the closest thing to foreground/background processing possible on the PDP-10 and compares roughly to SDS BCM without hardware memory protection of monitor, foreground and background areas.

2. PDP-10/40 - this monitor is essentially the same as the 10/30 with an additional facility that schedules machine resources among several resident users (multiprogramming).

3. PDP-10/50 - this addition of a disc allows the 10/50 monitor to dynamically swap users in and out of core thus providing a time-shared multiprogramming system. Two methods for handling R-T users are available under either the 10/40 or 10/50 monitors:

a. The R-T program is treated like any other user program. It is either resident, and periodically given a time slice or it is swapped in and out of core. This can hardly be called real-time. In addition, the R-T user can preempt machine resouces to the detriment (disaster?) of the other non R-T or R-T users, i.e., no checkpoint capability.

b. The R-T program can be made a monitor routine thus not subjecting it to time slicing or swapping. However the R-T program can still preempt the machine and response to interrupts will be "sluggish" due to high software overhead.

RBM advantages over PDP-10/X:

- RBM designed for real-time users. The software for the PDP-10 is adapted from that originally written for the PDP-6 and thus is primarily terminal or console oriented stand alone software.

- RBM allows any or all programs to contain overlay segments.

- RBM services include: Checkpoint, Public Library, Foreground Mailboxes and Reentrant Monitor Routines. PDP-10/X has none of these.

- RBM supports four languages including Extended Fortran IV-H and SL-1. Only non Real-Time Fortran and an assembly language (Macro-10) available from PDP-10X. Macro-10 is significantly inferior to Macro-Symbol.

- RBM allows fast interrupt response time due to extensive hardware involvement. PDP-10/X uses a software scanning and scheduling technique.

- RBM provides for multiple interrupt priority scheduled Real-Time Foreground jobs while the PDP-10 can handle four at most.

Honeywell H-632 with OS-1 - The H-632 operating system (OS-1) functions as a monitor coordinating the I/O activity between the calling program and the various peripheral device handlers. OS-1 loads the systems programs or processors as required and provides communications functions to the operator. This is roughly equivalent to the SDS Basic Control Monitor (BCM). Software available under OS-1 includes a two pass assembler (MAC-32)

with macro capability, a Fortran IV compiler which has some extensions to the USASI Standard, Math Library, Loader, On-Line Debug Program and various test and maintenance programs. An additional operating system OS-4, is currently planned for delivery in mid 1970. Honeywell has not publicly announced the product or defined its characteristics. The Fortran IV under OS-1 is roughly between SDS Fortran IV-H and SDS Fortran IV in capability while MAC-32 and SDS Macro Symbol are approximately equivalent. This is all the software available from Honeywell.

RBM advantages over OS-1 are:

- RBM provides checkpoint services.
- RBM allows dynamic adjustment of the partition between the background and foreground areas.
- RBM permits multiple foreground programs with background programs.
- RBM supports four languages including the simulation language SL-1.
- RBM provides for concurrent processing of batch and real-time jobs.
- RBM allows the operator or the foreground program to control the background process.
- RBM provides for a non-resident foreground program.
- RBM is disc oriented. OS-1 is not.
- RBM > BCM::RBM > OS-1 (for the logicians in the audience).