HIGH DATA RATE RADAR AND TELEMETRY SIGNAL COLLECTION

Colin J. Cumming
Frontier Engineering, Inc.
P.O. Box 1023
Stillwater, Oklahoma 74076

ABSTRACT

Collection of radar and telemetry data has always been limited by bandwidth and storage capacity factors. This paper examines some of the constraining factors in achieving very high data rates and storage capacities. A number of new technologies are examined for applicability. A special purpose modular architecture oriented towards high speed bulk data acquisition is presented. Several systems are described including systems based on Winchester disks, high speed parallel transfer disks, bulk RAMs, HDDR, and others. Special emphasis is placed on the unique data acquisition requirements of radar and telemetry signal collection.

INTRODUCTION

The task of recording and digitizing telemetry or radar signals for analysis requires constant improvements in equipment. Data rates and data quantities continue to escalate, constantly stressing the capabilities of the collection systems. In addition to handling high aggregate data rates, current systems must also be able to handle high burst rates. The signal digitizers and associated computers, and mass storage systems which comprise these collection systems are particularly difficult to generalize because users often have unique requirements. These special requirements have meant in the past that expensive custom systems had to be developed for each requirement. Adapting these systems to provide improved performance and exploiting new technology was often difficult.

THE MODELINT CONCEPT

Frontier Engineering, Inc. has developed a family of standard building block modules from which high performance flexible data acquisition systems can be configured. The MODELINT modules are functionally organized system components based on a highly reliable modular packaging concept.

FEI has developed a family of digitizers based on the MODELINT modules. Each data acquisition system uses the same packaging technology with the specific functionality provided by the particular MODELINT modules incorporated in the system. The standard FEI product line includes the FEI 286DC Dual Channel Radar Signal Digitizer shown in Figure 1. Although the MODELINT modules form the basis for the standard FEI digitizer products, the real power of the MODELINT concept lies in the potential for expansion and in the flexibility it affords. The MODELINT concept allows for a very low risk design-to-cost approach to be used on new data acquisition system developments. A new requirement can be addressed by using the standard MODELINT modules to provide the bulk of the functions, developing custom modules for the functions not available from the standard MODELINT family, and then integrating the system using the standard high reliability packaging approach. Risk is minimized by using standard modules, a standard packaging approach, and only developing a few new modules. In addition, only the desired functions are included, the customer does not end up paying for unneeded capabilities.

THE MODELINT ARCHITECTURE

Traditional data acquisition systems consist of signal conditioning subsystems, converters, buffer, interface, computer, and data storage. The MODELINT architecture provides for all these functions, however it also provides a great deal of flexibility by means of the following;

1. Decoupling of acquisition and storage

2. Processor independence

3. Storage technology independence

Decoupling the acquisition and storage essentially means including a large asynchronous buffer or FIFO. Inclusion of a large FIFO eliminates synchronization problems and simplifies the system design. Design of new front end subsystems, is simplified because only a standard asynchronous interface to the FIFO is required. Similarly, design of new computer or data storage subsystems is simplified.

To achieve maximum flexibility the key MODELINT component, the FIFO buffer is both vertically and horizontally stackable. The module consists of a 64 bit wide by 2K deep asynchronous FIFO capable of 10MHz operation.

In addition to providing the advantage described above, the FIFO also serves to absorb data bursts. In order to analyze the throughput and burst handling capabilities of the data acquisition system, a computer model was developed. The sensitivity of various parameters such as buffer sizes and transfer rates was examined. A key consideration is the amount of data taken before a buffer overflows and data is lost. Based on the typical model shown in Figure 2, the expression given below was derived.

BUFFER OVERFLOW WILL NOT OCCUR BEFORE

$$S_J = K_1 \frac{(\frac{M}{N} K_2 + ME)}{K_2 (\frac{M}{N} - 1) + ME} + K_2$$

WHERE M = INPUT DATA RATE
N = DISK TRANSFER RATE
K_1 = DIGITIZER BUFFER CAPACITY
K_2 = CPU BUFFER CAPACITY
E = INTERRUPT SERVICE TIME
S_J = NUMBER OF SAMPLES

ASSUMING

$$R > M > N, \text{ AND } K_2 \geq \frac{RME}{R-M}$$

Figure 3 shows the beha4ior of this model. It is apparent that increasing buffer size serves only to delay the inevitable. The only way to achieve extended duration acquisition at high data rates is to provide for a high speed transfer directly to the data storage system. Placing a computer in the data path serves only to slow the system down. For this reason, the MODELINT architecture removes the computer from the data path. Although the architecture does provide for computers, they are employed in a control role and do not in general directly handle the data. Although many collection systems have in the past used the same computer for acquisition of the data and for analysis, the throughput rates currently required prohibit this.

The MODELINT architecture is not based on a specific processor. A variety of computers including HP 9836, IBM PC, DEC VAX, 68000 based VME systems etc. can and have been designed into the system controller role.

The MODELINT architecture is designed so that the data can, if desired, be sent directly to the data storage system without going through the CPU. This allows the data throughput to be governed by the transfer rate of the mass storage system. No single mass storage technology stands out as the optimal technology for collection systems. All of the following have potential:

1. High Density Digital Recorders
2. Hard Disks (parallel transfer disks)
3. Winchester Disks
4. Semiconductor Bulk memory
5. Optical Disks

Each of these storage technologies has advantages and disadvantages. Also the relative superiority of the various technologies change with time. For example optical disks are not a viable media at this time, however they have the potential to provide extremely high capabilities in the future.

The MODELINT architecture is not based on any particular storage technology. The mass storage system and interface is maintained as an independent entity. In this way new system designs can make use of the optimal technology available at the time of the design. It also means that systems could potentially be upgraded through the replacement of the mass storage system with one utilizing superior technology.

THE MODELINT MODULES

The MODELINT modules consist of EUROCARD style packages utilizing the highly reliable DIN 4162 connector system. This is the same packaging used in the rapidly emerging VME bus. This facilitates the incorporation of VME bus processors as controllers and other VME bus cards such as A/D converters and I/O interfaces.

Standard MODELINT modules include front end components such as high speed A/D converters, time base functions such as phase lock oscillators, FIFO memories, measurement modules, processor modules, and interface modules.

CONCLUSION

The MODELINT concept provides a high degree of flexibility in designing custom high performance data acquisition systems with minimal technical risk. The concept is based on utilizing a core set of proven and reliable system building blocks. The functions of these building block modules are in concert with the philosophy of decoupling the acquisition of the data from the storage of the data, removing the computer from the data path, and allowing for flexibility in interfacing to the mass storage media.

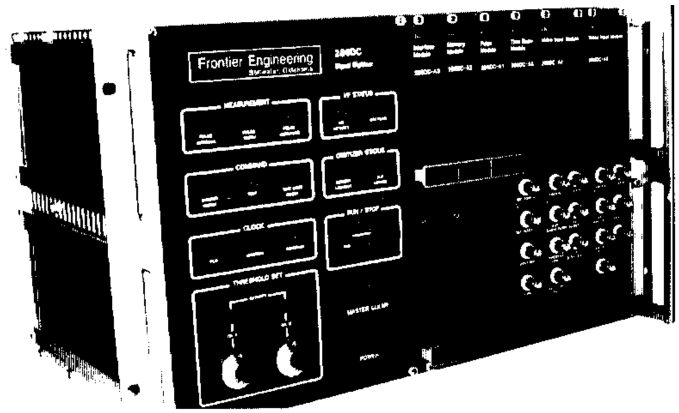

FIGURE 1
FEI 286DC RADAR SIGNAL DIGITIZER

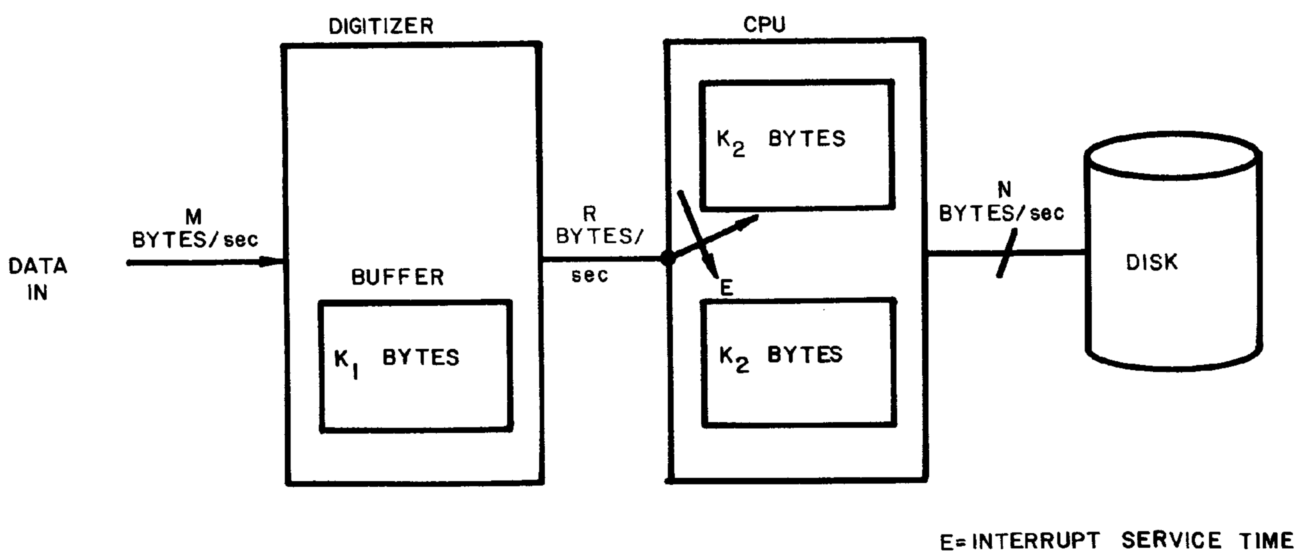

FIGURE 2 DATA TRANSFER MODEL

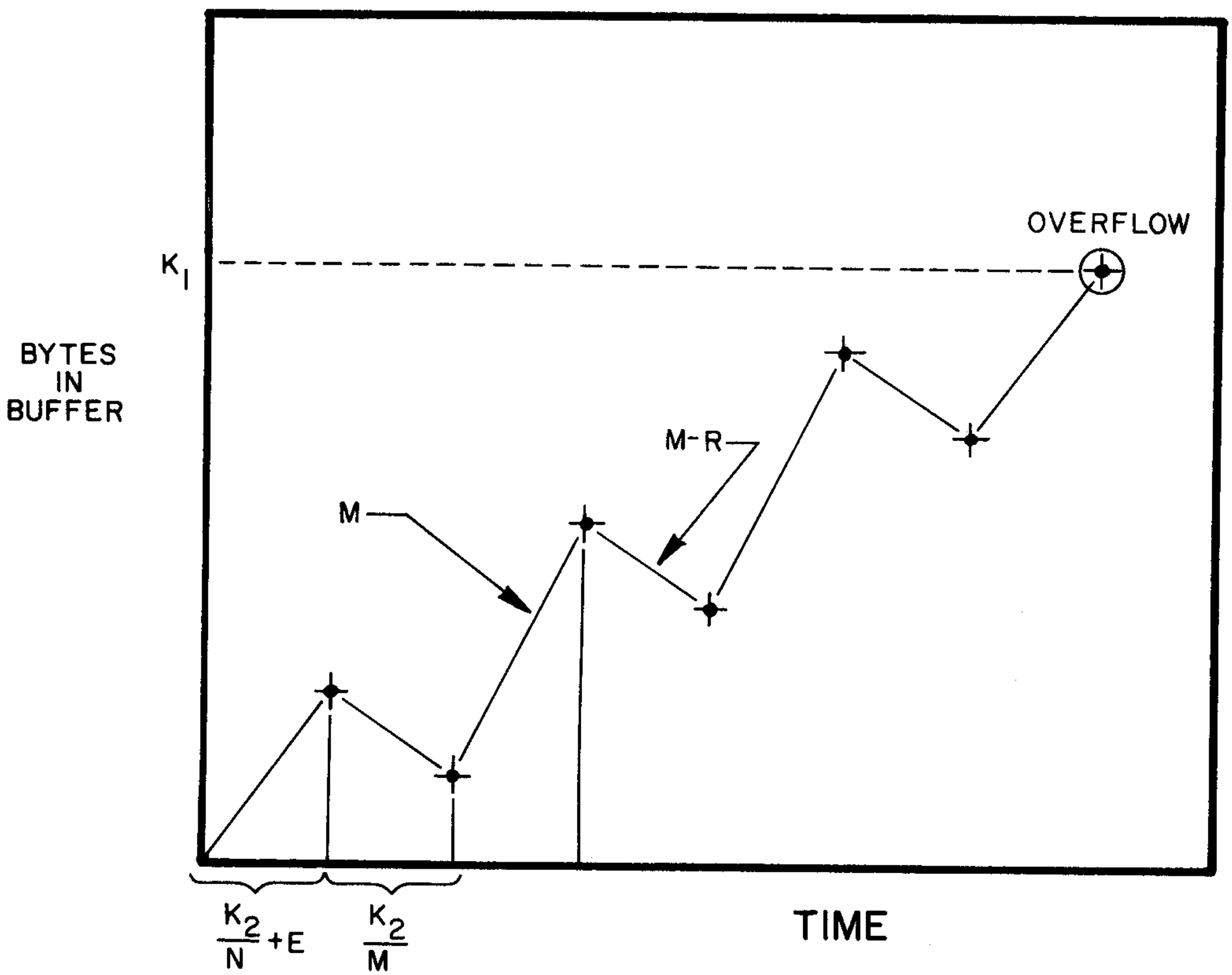

FIGURE 3   DIGITIZER BUFFER FILL RATE