REAL TIME TELEMETRY DATA PROCESSING
AND DATA DISPLAY

FILIBERTO MACIAS
TELEMETRY DATA CENTER

ABSTRACT

The Telemetry Data Center (TDC) at White Sands Missile Range (WSMR) is now beginning to modernize its existing telemetry data processing system. Modern networking and interactive graphical displays are now being introduced. This infusion of modern technology will allow the TDC to provide our customers with enhanced data processing and display capability. The intent of this project is to outline this undertaking.

KEY WORDS

Real time telemetry data processing, networking, interactive graphics.

INTRODUCTION

Telemetry data processing systems typically all perform the same tasks. These include the acquisition of the data, decommutation, and processing of this information. Finally, the data is displayed and analyzed. Recent introduction of intelligent networks, interactive graphics, and animation have greatly improved the data visualization and analysis capability of telemetry data processing engines. The ability of the system to process and deliver a trustworthy model of the “real world” determines the true merit of the system’s capability. The true objective of the processing system is basically to provide the data analyst with a better perception of what occurred or is occurring during a test. Modern networking and graphical presentation offer an augmentation to data displayed as a mathematical presentation (graph, plot, etc.) on a video screen or strip chart recorder. However, certain parameters, depending on response or sampling time, are more conducive to presentation on strip chart; others offer great possibilities to be used to drive graphical presentations. The advantage with the use of telemetry data to drive displays is that attitude information, guidance and other pertinent data can be obtained from Inertial Measurement Units (IMU) usually configured into modern missile systems. Also, telemetry data is the only method that can provide the information to conclude why a test was successful or not. Therefore, combining modern telemetry data processing with modern networks and graphical systems will only prove to enhance “real time” displays.
Modeling using simulated or “real” data could be used for a variety of applications which will be discussed in this paper. The Telemetry Data Center (TDC) at White Sands Missile Range (WSMR) is now in the process of introducing intelligent networking and enhancing its display capability to include animation and visualization. (see figure 1.)

THE TELEMETRY DATA CENTER AT WSMR

The core of the TDC’s processing capability is centered on three separate and almost identical systems designated as Telemetry Data Handling Systems (TDHS). These systems are designated as TDHS-A, TDHS-B and TDHS-C. Each TDHS is a stand-alone system capable of performing data distribution, decommutation, data tagging, merging, processing, archiving and finally the display of data. Each can support operations in three possible modes such as preflight, real-time and post-flight exercises. All TDHS systems are configured with EMR 8715 Telemetry Processors as the heart of its processing capacity. Though all of the systems are quite capable of handling all of the TDC’s present support requirements, the existing TDHS A/B used for primary support by TDC are aging. These systems are based on mid-1980s technology. Each TDHS is configured with Concurrent 3280 computers used for telemetry front-end setup, telemetry processing setup and data archival. This configuration (TDHS/Concurrent) lacks all the current standards of open architecture or networking. Therefore, it is not conducive to any real time animation.
The current processing environment in which the TDC operates during real time and during other processing activities could be described as a serial mode. Telemetry data arrives from a variety of sources. It is decommutated and processed in the EMR 8715. The EMR 8715 sends its data out to various destinations which include other Concurrent systems for further processing, and finally display. This extensive routing of data throughout the system increases the time before processed data arrives for display. It becomes obvious that the additional time affects the deterministic qualities of a system. Before any realism in any real-time visualization can be achieved, two problems would have to be resolved. These are data latency and the lack of any multiprocessing or parallel processing. (see figure 2.) The introduction of multiple processing engines co-existing on a network, each responsible for a certain aspect of telemetry data processing has now been implemented onto TDHS-C. The direct benefits of this implementation are:

- High speed throughput multiprocessing
- Improved response times
- Improved data storage and access
- Improved software for various tasks

![Diagram of data flow](image.png)
TELEMISTRY DATA PROCESSING SYSTEM

The Telemetry Data Processing engine on TDHS-C is a Lockheed Martin O/S 90 8715. The O/S 90 8715 is well suited to acquire and perform the required processing on specific data parameters using a vast complement of data handling algorithms. It is configured with networking capability (Ethernet/ FDDI) such that data products can be delivered to multiple destinations simultaneously. The O/S 90 uses Transmission Control Protocol/Internet Protocol (TCP/IP) for broadcast of data. The 8715 has the capability of performing a large number of data processing functions at high speed. It can accept integer or floating point data, either in raw or engineering units form. Data processing performed within the 8715 solves the problem of data latency since the additional processing that was once performed by various computer systems can now be performed within the telemetry processor. The O/S 90 8715 utilizes the computational capacity of multiple SPARC computers within the unit to perform the additional data handling. Subsequently, the need for other systems to perform additional tasks is eliminated or at least reduced. (see figure 3.)

OLD vs NEW

* WITH O/S90 UPGRADE, SETUP & LOGGING IS DONE WITH THE 8715

figure 3.
DISPLAY ENGINE

The O/S 90 Telemetry Processor is configured with a device called an Ethernet Output Module (EOM). This device provides the connection between the telemetry processor and the real time network. Resident on the network exist several workstations, each with a specific task to perform. For example, one station acts as the system server, responsible for all interaction (database creation, system administration, etc.) with the processor.

Situated on this real time network, is a Silicon Graphics workstation running a graphical software system called Designers Workbench (DWB) developed by Coryphaeus Software. This software is used for database modeling, dynamic display development and provides an environment for simulation activities. DWB provides the user with the capability to create, view, modify and animate three dimensional graphical presentations. The two major features of the DWB is its ability of constructing databases used for graphical rendering and its ability in linking these databases to actual real time data.

The DWB requires a 4D series Silicon Graphics IRIS workstation using 4D series IRIX operating system of version 5.2 or greater. The DWB used by the TDC is configured with two software modules. These are the Link/Animation Editor (LE) and the Real-Time Module (RTM). DWB allows a programmer to use databases built to run as standalone without the need of an editing environment. Drawing routines are optimized in an effort to maximize the update rate of a particular display. This in effect allows for the creation of interactive displays. However, performance is entirely dependent on the hardware available and in use. The LE is used to support quick verification and testing of graphical displays. The LE provides DWB with the means to link database elements as defined as needed. During telemetry operations (real time or otherwise) the needed or desired processed telemetry parameters are sent via the Ethernet from the O/S 90 8715 to a workstation running DWB. The user is allowed to select items in a database, tag or identify them for uses in the desired task to be performed. (see figure 4.)

TELEMETRY DATA DISPLAYS

The intent is not only to be able to provide the normal or present complement of existing real time displays, such as the mathematical representation, plot, graph, etc., on a strip chart or computer screen, but to combine various parameters to augment these data presentations. It is possible to provide, in real time, computer generated visuals to enhance a person's perception of a particular event or sequence of events. Engineering analysis will become more efficient through the integration of real-time archived data with simulated data. Cause and effect activities could allow for realistic simulation using real time data to validate it. The resulting simulated modeling is recognized as a viable tool for solving
complex problems or developing scenarios that can have a great impact on real time activities.

The TDC is using this graphical capability to create numerous attitude models of missile or aircraft systems now being tested at WSMR. One of the more visible and important use of this aspect of telemetry display has been in support of Missile Flight Safety (MFS). Typically, the type of data that MFS uses for their real time decision making process includes vehicle guidance, vehicle dynamics and attitude information. All of this data is easily obtained from normal telemetry data processing. Up to this point, support of MFS was to provide data displays on a strip chart or CRT scrolling tabular information or plots and graphs. By combining various parameters, indicating vehicle attitude and guidance, performance of this vehical can be depicted.

Before a real time operation, MFS will request from a missile developer a hardware-in-loop simulation. This simulated data will illustrate to MFS how a vehicle is expected to perform during a flight. Since the data is simulated, a nominal flight as well as a missile failure can be created. This data is processed through the telemetry system and fed to the real time displays for MFS verification. Also, MFS will use this opportunity to familiarize themselves with important mission events that are expected to occur (missile lift, motor cutoff, booster separation, etc.). The use of attitude models using hardware-in-the-loop simulations has provided MFS with the realism of a real time mission. Other proposed projects are:

- Interceptor vs target scenarios
- Miss distance displays
CONCLUSION

The TDC’s effort in modeling and simulation is admittedly still in its infancy. We are continuously learning to improve the fidelity of our graphical presentations. The advantage in using real data is that the renderings can be validated with actual data. This results in realistic simulated scenarios. Also, the use of commercial-off-the-shelf (COTS) hardware and software has provided us with the conduit to enter this arena quickly. COTS software also provides a cost and time savings approach to having to develop these systems from scratch.