Acquisition and Near Real-Time Display of Multispectral Test Data From Widely Separated Test Sites

Brian Donlan
Frank Sabo

Science Applications International Corporation
429 South Tyndall Parkway, Suite H
Panama City, Florida 32404

ABSTRACT

As modern weapons grow more sophisticated and capable of operating autonomously, the challenge of testing these weapons has also grown more complex. Seekers may be multispectral and must be able to overcome threat countermeasures. To effectively analyze the performance of these weapons, time-correlated test data must be efficiently, simultaneously acquired from both the weapons' internal busses and from the threat countermeasures' internal communication busses, often in a "live fire" environment. The test data must be transmitted to a central processing station where test personnel may immediately analyze the performance of the weapon with the assistance of scientific visualization techniques. In addition, the data must be captured on permanent media for future playback and more detailed analysis.

One solution is to link the test article, threat countermeasures and other test support resources through an Integrated Telemetry System (ITS). Instrumentation to acquire high-speed test data is installed in data collection vans that are remotely located in the vicinity of the article under test or in the vicinity of the threat countermeasures systems or test support resources. The remote vans will be interconnected and linked to a control van which provides a centralized test control and monitoring point. Remote Data Formatter (RDF) instrumentation units, located in the remote vans, can acquire data from and control seekers, sensors, emission sources or other equipment located in or near the remote vans. The RDF units can also format the data for transmission to the control van via either fiber optic or microwave radio links. The data transmitted from multiple remote vans is received by Real-time Data Processing System (RTPS) units located in the control van for merging, processing and recording. Some of the processed data can be transferred to a Host Processing System (HPS) where it can be displayed on color graphic workstations. The control van's HPS workstations provide user-friendly displays and menus for test setup and control.

Both the remote and control vans are equipped with secure digital communication systems capable of supporting compressed digital video, audio, high-speed instrumentation data and an Ethernet computer network.

KEY WORDS

Data Acquisition, Distribution of Telemetry Data, Telemetry System Architecture

INTRODUCTION

This paper describes the Integrated Telemetry System (ITS) project which provides a near-term, specific solution to the problem of effectively analyzing the performance of modern precision-guided weapons. This project is sponsored by the Precision Guided Weapons Countermeasures Test and Evaluation Directorate, Office of the Test Director (OTD), White Sands Missile Range, NM. The ITS project implements a cost-effective solution to the problem by modifying two existing government instrumentation vans (over-the-road trailers) that provide the capability to remotely control test resources and remotely acquire, format for transmission, and transmit the test data to a central point for further processing, reduction, and analysis.

INTEGRATED TELEMETRY SYSTEM (ITS)

The ITS instrumentation used to acquire high-speed test data was installed in data collection vans that may be remotely located in the vicinity of the test article and near the threat countermeasures systems and test support resources. The instrumentation in these Remote Vans will collect the test data from these resources. The Remote Vans may be interconnected to each other and also linked to a Control Van which provides a centralized test control and monitoring point. Since the instrumentation system designed for the ITS project is housed in these mobile vans, the instrumentation capability is transportable by land, sea, or air to any location in the world.

Remote Van

The ITS project refurbished and modified a government supplied van. A Remote Van can be located near the test article and could be collocated with other critical test resources, such as threat countermeasures systems. The purpose of the Remote Van is to acquire high-speed test data, format the data for transmission to a centralized control point (a Control Van), and provide the proper interface to the test article or other test resources for controlling these devices. Since the instrumentation systems in the Remote Van may be operated remotely from the Control Van, the Remote Van may be most advantageously located in the vicinity of the test article or targets during

hazardous tests without endangering human operators. A diagram of an ITS Remote Van may be found in Figure 1..

- Remote Data Formatter Subsystem

The central piece of instrumentation installed in the Remote Van is the Remote Data Formatter (RDF). These RDF units interfaces with, acquires data from, and controls test articles, seekers, sensors, emission sources, or other equipment located in or near the Remote Vans. The RDF units also properly format the acquired data for transmission to the Control Van via either fiber-optic or microwave radio links.

The RDF instrumentation components are housed in a 20-slot, forced air-cooled VME chassis. A set of commercially available, off-the-shelf components were chosen for installation in the RDF's VME chassis. A Motorola MVME167 68040-based, 33 MHz CPU running a VxWorks realtime operating system is the heart of the RDF. Other components selected for installation in the RDF's VME chassis were based on the anticipated initial operational utilization requirements of the ITS. These components include:

- Two Simpact 8-channel serial communication coprocessor boards
- Nine Data Translation 16-channel 250 KHz, 12-Bit A/D boards
- One Bancom IRIG time code processor board
- One Pentland 8-channel 660 KHz, 12-Bit D/A board
- One VMIC 128-channel digital input/output board
- One National Instruments dual channel IEEE-488 (GPIB) controller board
- One Interphase Cougar SCSI-2 controller board
- One Bit-3 VME-VME I/F board
- One High-Speed Serial Instrumentation Data Comm board

In addition to the circuit boards listed above, the RDF also contains a 4mm DAT SCSI tape drive and one or more 1 GByte, 3.5-inch half-height SCSI disk.

The RDF is capable of capturing and recording many analog and other type signals at rates up to an equivalent 500 Kbytes/sec.

- Secure Digital Communications Subsystem

Both the Remote and Control Vans are equipped with a Secure Digital Communications Subsystem capable of transmitting and receiving encrypted color video, audio, high-speed instrumentation data, and an Ethernet computer network.

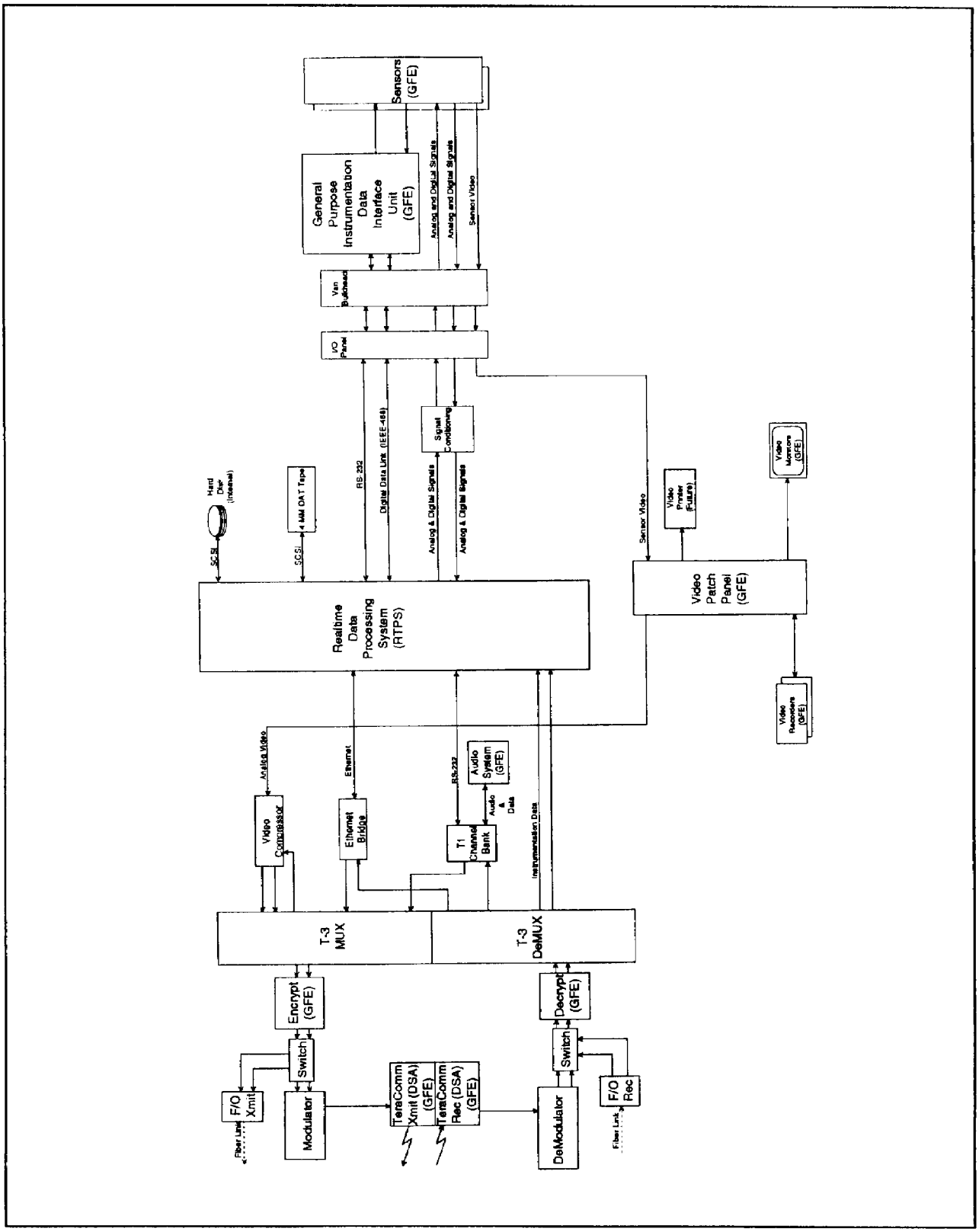

Figure 1 ITS Remote Van

The Remote Van's communication subsystem provides the capability to securely transmit and receive test data and control commands between itself and a Control Van. The Remote Van is also capable of communicating with other Remote Vans if required. This subsystem is an important feature that facilitates the immediate availability of classified test data to analysts in near real-time.

Test instrumentation data from the RDF is multiplexed with compressed digitized video, ethernet data, and T-1 audio/RS-232 channels by the Secure Digital Communications Subsystem's multiplexer unit into a 44 Megabit/sec T-3 data stream. The multiplexed data is processed through a government-supplied encryption device prior to routing to either a fiber-optic transmitter or the modulator for the microwave radio transmitter.

In the reverse path, communications from a Control Van is received either by a fiber-optic receiver or a microwave radio receiver and then processed through a decryption device. After decryption, the data is separated into the various components by the Secure Digital Communications Subsystem's T-3 demultiplexer unit. Outputs from the demultiplexer are distributed to a T1 channel bank (audio and RS-232) and the RDF (via ethernet and a high-speed instrumentation data link), and an optional video decompressor.

- Other Remote Van Features

Since the remote van is capable of capturing a large number of analog signals, the Remote Van includes analog signal conditioning equipment. National Instrument's modular SCXI signal conditioning chassis and modules are used to condition, scale, and isolate the seeker and sensor analog signals. The signal conditioning units can be located in the Remote Van or externally to it.

The Remote Van also includes a large number of input/output patch panels for conveniently interfacing with the input/output boards contained in the RDF's VME chassis. This feature has been found through experience to be very desirable when the Remote Van is required to support many different types of tests with relatively short turn-around time between tests.

Control Van

The data transmitted from multiple Remote Vans is received by Real-time Data Processing System (RTPS) units located in the Control Van. The purpose of the RTPS is for merging, processing, and recording. Some of the processed data may be transferred to a Host Processing System (HPS) where it can be displayed on a color

graphic workstation. The Control Van's HPS workstations provide user-friendly displays and menus for test setup and control. Figure 2 shows a diagram of an ITS Control Van.

- Real-time Data Processing System

As the RDF is the centerpiece of the instrumentation in the Remote Van, the central instrumentation component in the Control Van is the Real-time Data Processing System (RTPS). The RTPS provides the capability for the Control Van to process test data from one or several Remote Vans and to send control commands to test articles or other test resources that may be located in the vicinity of the Remote Vans. In addition, the RTPS provides the capability for a Control Van to operate autonomously by interfacing directly with a test article or test support resources whenever a Remote Van is not available. This feature enhances the flexibility of the ITS system.

Since the RTPS and RDF provide similar capabilities to the Control Van and Remote Van, respectively, the design of the RTPS is similar to the RDF. Please refer to the previous discussion of the RDF for a complete description of the physical design of the RTPS. The list of components and growth considerations for the RTPS are also the same as those detailed in the RDF section.

Although the Control Vans has an inherent autonomous operational capability, the most likely scenario is for a Control Van to operate with a Remote Van as a pair. In this arrangement, a Control Van operator team may be simultaneously performing setup and configuration planning for a future test, may be performing data reduction and analysis for a preceding test, and may also be monitoring a third test in progress. The following feature of the Control Van provides this robust capability.

- Host Processing System

The Control Van's Host Processing System (HPS) is designed around the capabilities of two Silicon Graphics workstations. A Silicon Graphics Crimson workstation serves as the main interface with the RTPS.

In addition to the above components, an Advanced Processing Laboratories' software product called VMEwindow provides a graphical user interface tool for setup and real-time control of the realtime VME-based RTPS. Also through the Secure Digital Communications Subsystem, VMEwindow provides control and data displays from the realtime VME-based RDF located in a Remote Van.

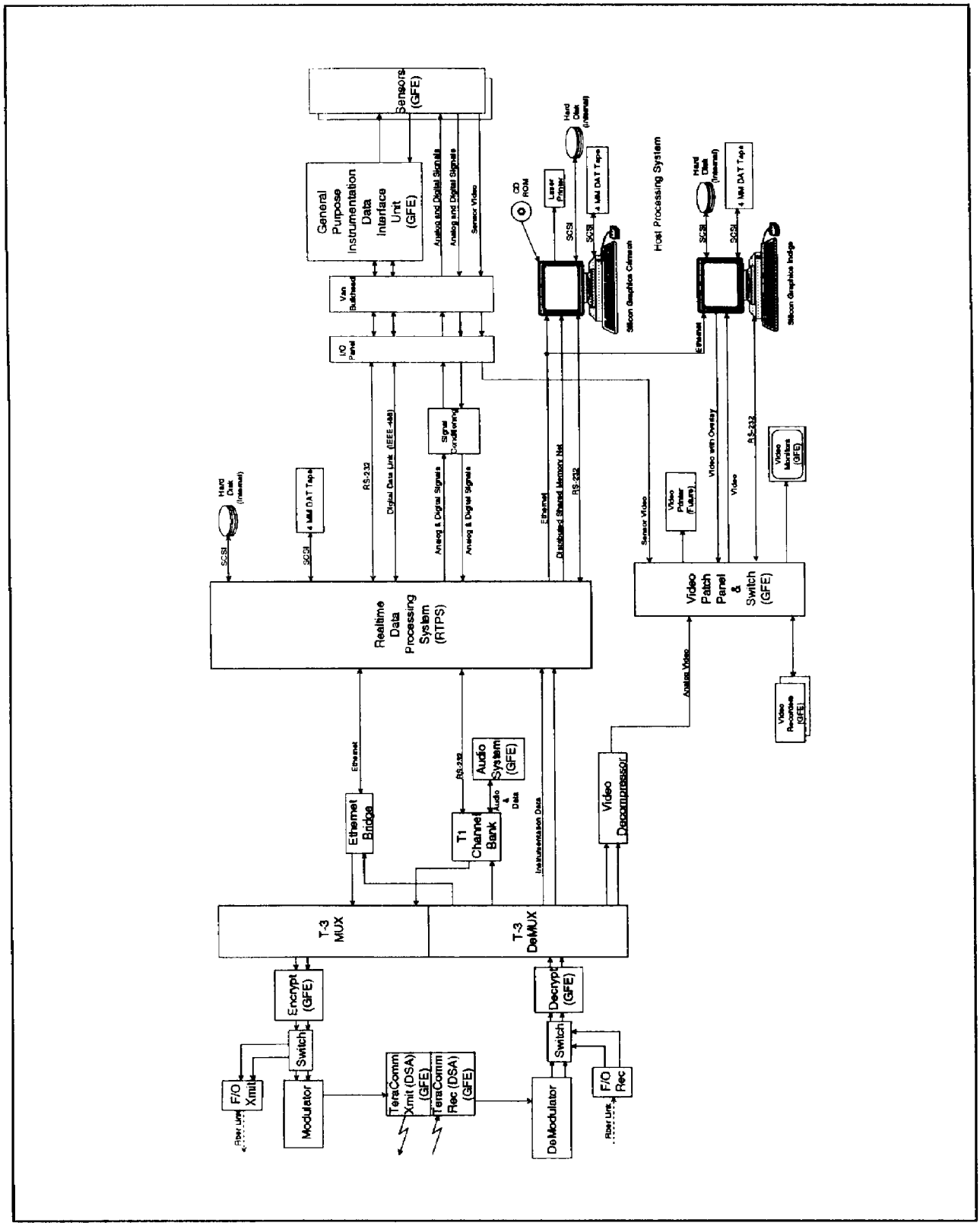

Figure 2 ITS Control Van

A Silicon Graphics Indigo workstation provides the pre-test setup and configuration planning and post-test data reduction and analysis capability.

In addition to the above, there are two additional software products loaded on the Indigo workstation. Talarian's RTworks provides a graphical user interface tool for a reconfigurable, real-time test control and monitoring capability, including sophisticated real-time data display. RTworks is a very capable graphics package to graphically present complex test events. The tool is capable of real-time inferencing and data archiving. The second software product is Visual Numerics' PV Wave. PV Wave is also a graphical user interface tool that provides an excellent post-test data analysis capability including two-, three-, and four-dimensional graphics. This tool can prepare data for presentation in easily understood formats.

- Secure Digital Communications Subsystem

The Control Van's Secure Communication Subsystem is very similar to the system discussed under the Remote Van.

- Other Control Van Features

Since the Control Van is also capable of capturing a large number of analog signals, the Control Van includes analog signal conditioning equipment. National Instrument's modular SCXI signal conditioning chassis and modules are used to condition, scale, and isolate the seeker and sensor analog signals. The signal conditioning units can be located in the Control Van or externally to it.

The Control Van also includes a large number of input/output patch panels for conveniently interfacing with the input/output boards contained in the RDF's VME chassis. As indicated above, another feature is the Control Van's video switch for routing the received video to convenient locations throughout the Control Van, including the Silicon Graphics Indigo workstation for graphical video overlay. The Control Van also features a Laser printer to support report generation or other data products.

SUMMARY AND CONCLUSIONS

The need exists for a set of flexible, robust, highly mobile instrumentation vans to support the test and evaluation of modern, precision-guided weapons. The Integrated Telemetry System (ITS) meets this need by providing a Remote Van which may be safely employed in the vicinity of test articles or targets during test programs involving "live fire" events. The ITS also includes a Control Van which provides the

multiple capabilities of remotely controlling the instrumentation systems installed in the Remote Van, pre-test setup and configuration planning, and post-test data reduction and analysis.

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