White Paper:

System-Wide Data Monitoring For Embedded Systems

Dedicated monitoring modules for standard open-architecture points within the embedded system provide valuable data for software development, system integration, performance monitoring, diagnostics and prognostics.

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Challenge

Current embedded systems are becoming increasingly more complex with multiple processors communicating over various media including backplanes, data busses and discrete signal lines (see Figure 1). These dissimilar elements require a variety of support tools and frequent updates due to obsolescence and technology changes in commercial off-the-shelf (COTS) products.

The challenge has become how to efficiently and cost-effectively develop, insure proper operation and maintain these multi-processor, software-intensive, heterogeneous embedded systems.
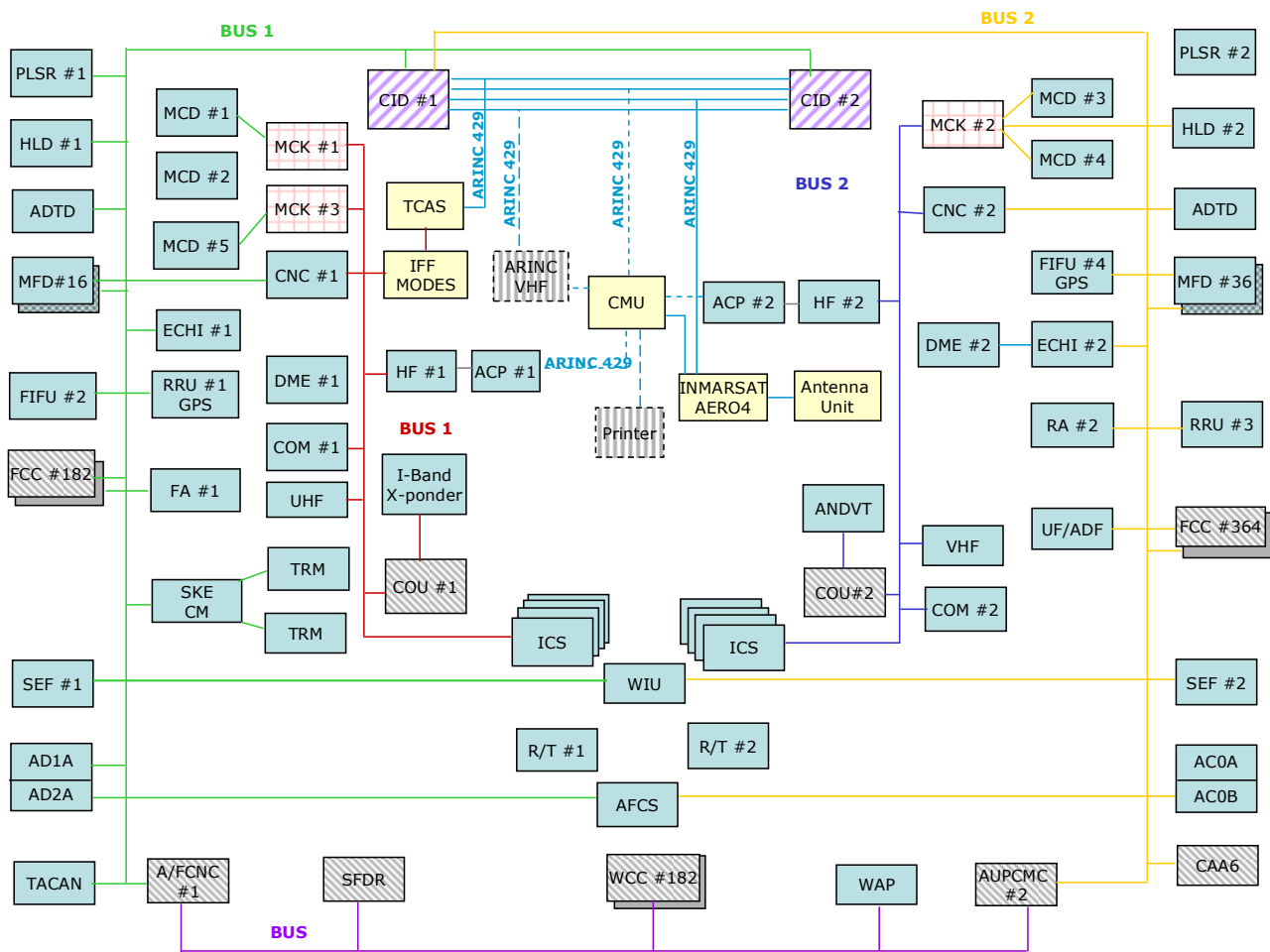

Figure 1. Representative Military Embedded System.

What is Needed

What is needed is instrumentation that can monitor, collect and verify data from multiple points throughout the embedded system. Currently, tools are available to support *individual* elements of the embedded system. However, few tools are available to support the entire *system*.

In addition to use in the R&D lab for software development and integration, this instrumentation should be capable of being embedded on-board for mission and performance monitoring and diagnostic applications. Therefore, it needs to have adequate storage capability to collect the data during operation.

Ideally, this monitoring must be done in real-time and data collection needs to be non-intrusive so that it does not affect system operation.

SystemTrace

SystemTrace is a new tool used to develop, maintain and monitor embedded systems. It traces data flow by monitoring standard open-architecture points throughout the embedded system (backplanes, data busses and discrete signal lines). A generalized diagram of the SystemTrace application is illustrated below (see Figure 2).

SystemTrace utilizes Real-Time Non-Intrusive (RTNI) monitoring, which provides accurate analysis without disturbing system function. More importantly, it allows software developers and system integrators to observe the dynamics of embedded system anomalies in the environment in which they occur – during real-time, at full speed. The result is that software errors are detected quickly and easily which saves time and reduces cost.
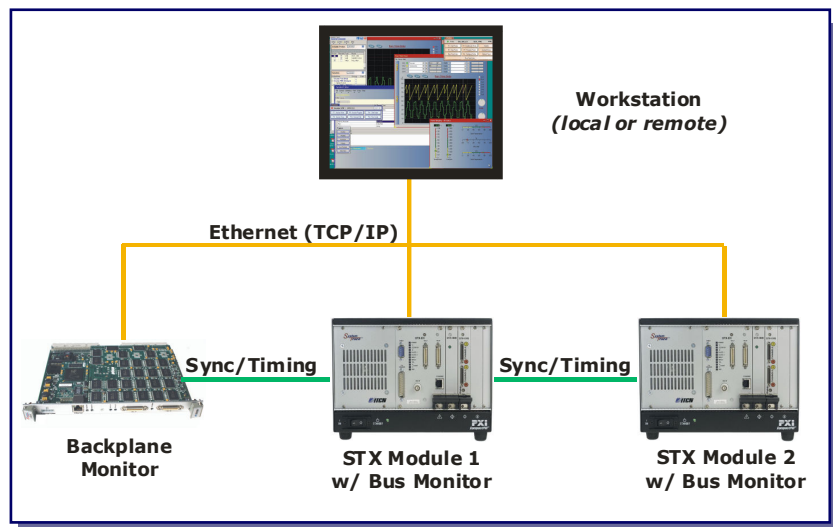

Figure 2.   SystemTrace application diagram.   Any combination of backplane, data bus and discrete modules can be embedded to the user's specific application architecture needs.

Architecture

The SystemTrace architecture consists of one or more w*orkstations*, a c*ommunication network* and one or more *modules.*

The *module* is the central component of the instrumentation system and multiple modules can be embedded throughout the system. Modules consist of all the functional elements necessary to attach to the target and monitor target activity.

Unlike traditional general-purpose data acquisition devices, SystemTrace provides a dedicated module for every type of monitor point in the system including backplanes, busses and discretes. The first SystemTrace module is a VMEbus Monitor (see Figure 3). Modules are in development for MIL-STD-1553, PCI, cPCI, PMC, Ethernet, RS-232, RS-422, and ARINC 429.
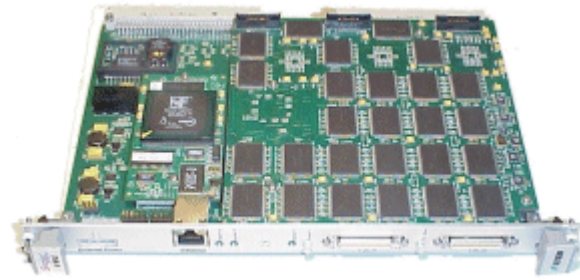
Figure 3. SystemTrace VMEbus Monitor (Model number: ST-201).
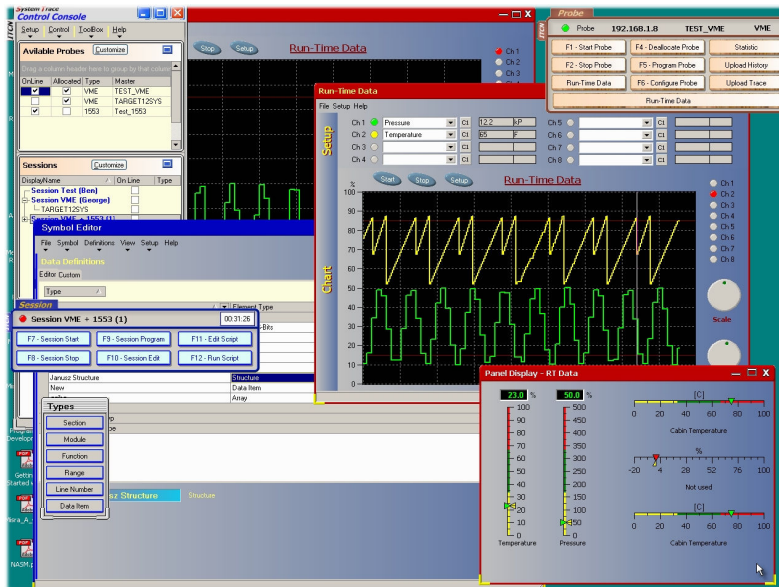
Figure 4.   SystemTrace Graphical User Interface.

The SystemTrace W*orkstation* is a PC, running WINDOWS 2000 or NT, with the SystemTrace GUI (Graphical User Interface) that provides a means to setup, control, and retrieve data from the Modules.

The GUI (see Figure 4) provides a common look and feel for monitoring multiple, dissimilar targets. The advantage is that all targets can be monitored from one or more workstations with the same tool. This saves time and money by reducing the learning curve and eliminating the need to buy separate tools for each unique target.

The *Communication Network* provides the interface between the modules and their controlling workstation. SystemTrace has an open interface to perform setup, control, and data retrieval operations via TCP/IP. SystemTrace allows multiple users to access the data on the same network (see Figure 5).
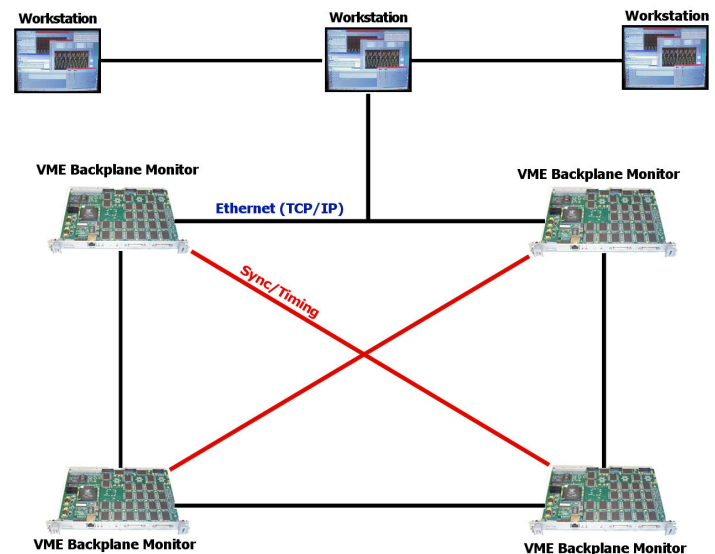
Data Collection

SystemTrace takes a unique approach to data collection. Traditionally, data is collected by sampling the monitor points periodically. This requires a sample rate high enough to capture all "events of interest". Another approach is to watch for events that are predefined in a data collection scenario and capture them as they occur. ITCN designed SystemTrace

Figure 5.   Illustration of multiple users accessing data from the communication network as the SystemTrace VME modules monitor and collect data from the embedded system.

with the point of view that all system activity is a series of events that can be defined as triggers in a data collection scenario, and tailored to each monitor point in the system. These scenarios can then be configured into the monitor modules. The modules then watch for the events to occur and record them with an associated time-stamp. Each module is capable of long-term data acquisition & storage (20GB per module), which allows them to be embedded for on-board monitoring and diagnostic applications.

Time-Correlation

In order to gain a system-wide perspective, it is important to monitor and examine the activity among different points in the system. For example, when examining software anomalies it is useful to look at data on various backplanes and busses at the point in time an error occurs. This can be accomplished is by capturing the data at each point in the system simultaneously and providing an associated time-stamp. Every backplane, data bus and signal line is a potential monitor point and must be viewed simultaneously.

SystemTrace provides simultaneous monitoring of these targets and time-correlates the data that is collected. The result is insight into timing-related issues. This time-correlation capability synchronizes all monitored events with an internal master precision source or an external source such as the I-RIG B Standard or GPS.

Conclusion

To effectively and efficiently develop, maintain and monitor today's complex embedded systems, software developers and system integrators need insight into how their system operates from a system-wide perspective. This requires simultaneous visibility into key points of interest within the system. SystemTrace provides a dedicated monitoring module for each target and can time-correlate the data collected across the entire system, resulting in event interaction visibility.

This RTNI system monitoring allows engineers to quickly identify software anomalies, optimize code and verify code execution. The result is time and money saved and increased system availability, sustainability and reliability.

About Us

ITCN has over 15 years of experience providing instrumentation for military and commercial programs such as the B-2, C-17, F-15, F-18, P-3, 747, TITAN, HAWK, ALQ-135 and LANTIRN. Our products have helped major corporations and government organizations around the world save time and money developing complex embedded system applications, while improving product quality.

Contact ITCN's sales staff for detailed information about our test equipment and services at 800-439-4039, or visit our website at www.itcninc.com.

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