NETWORKING AND REMOTE COMMUNICATION ON A WORKSTATION-BASED Shaker Control SYSTEM

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Authors' Biographies

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Abstract

This paper discusses industry standard networking and remote operation capabilities for a Shaker Control system. The Unix-based system utilizes Ethernet local area networking with support for TCP/IP NFS, PCNFS, and other industry standard protocols.

The flexible architecture and the X11 based user interface attributes allow for secure operation of the vibration control peripheral from nearly any type of workstation, X-termial, or personal computer on the same network. Also discussed, are capabilities for remote control and status communication with climatic chamber controllers and with other computer-based equipment in an automated test facility.

Keywords

Shaker Control system, network, Ethernet, remote communication, remote control.

Introduction

Test equipment must be easily integrated into today's modern environmental test laboratory. In order to compete in the world markets, both your laboratory's capital equipment budget and staff size may be shrinking. You must increase productivity. An important component of lab modernization and automation is through the utilization of high speed computer networks and remote communication features.

Modern workstation user interfaces utilize the industry standard MIT X Window System and industry standard graphical user interfaces. These workstations normally utilize high performance RISC central processing units and include standard items such as graphics accelerators, Ethernet network interfaces, SCSI peripheral interfaces, serial interfaces, parallel interfaces, support for PostScript devices, and support for sound (microphone and speaker).

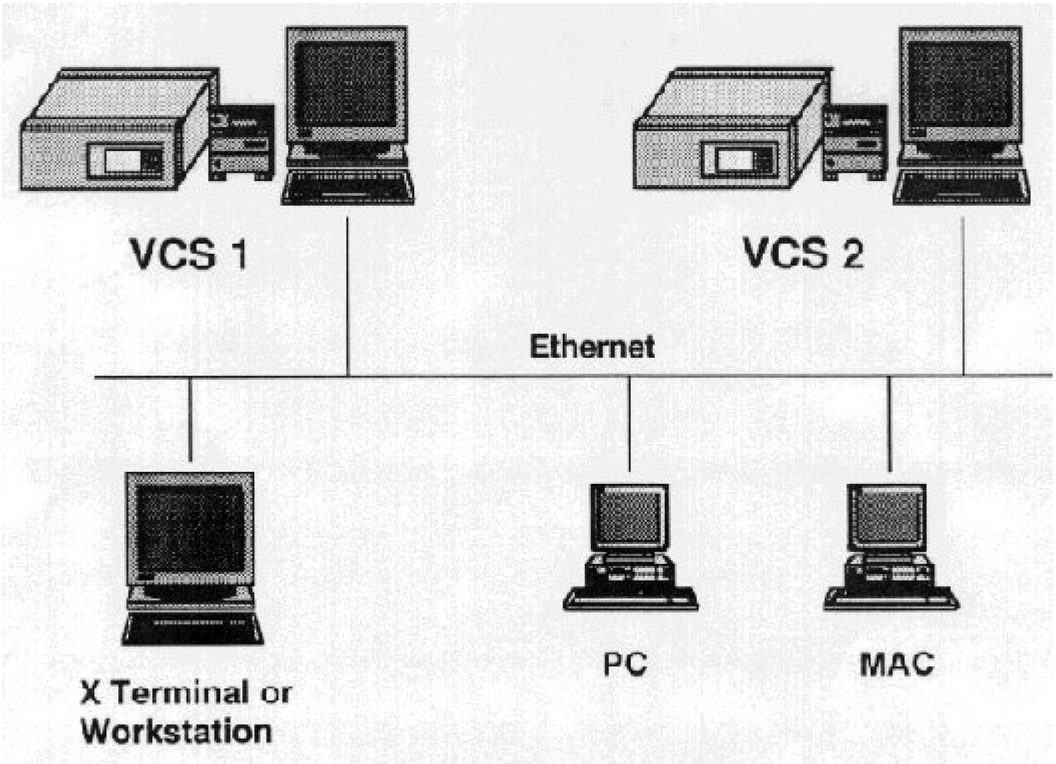
A flexible Shaker Control system architecture can support the operation of VCS applications directly from a host workstation, and also can allow operation from other workstations or suitably equipped X-terminals on an Ethernet network such as the one shown in Figure 1. Standard security measures provided by the Unix operating system can also be used to protect your laboratory from inadvertent or intentional use of a system from unauthorized locations and unauthorized user accounts.

A Shaker Control system architecture that enhances the remote communication attributes of the system is shown in Figure 2. The host workstation and user interface support high performance industry standard protocols and interfaces. The Vibration Control Peripheral (VCP) utilizes a modular distributed architecture that allows a high degree of separation between the workstation and the control peripheral while maintaining the ability to easily share test data and test status information. A description of the software architecture is provided in Reference 1.

Network Protocols and Terminology

One of the most commonly used local area networks (LAN) is based on the 10Base-T Ethernet technology and Ethernet standard, IEEE 802.3. There is an estimated installed base of over 30 million nodes. The bandwidth for 10Base-T Ethernet is 10 Mbps. There are other emerging protocols that operate at various higher bandwidths such as:

- Fast Ethernet at 100 Mbps from the Fast Ethernet Alliance. This proposal is also under the IEEE 802.3 standard.
- 100BaseVG-AnyLAN at 100 Mbps from HP. This proposal falls under an IEEE 802.12 standard.
- FDDI fiber optic networks rated at 100 Mbps.
- Asynchronous Transfer Mode (ATM) is an advanced networking technology that features a scaleable bandwidth and supports multiple information types, such as voice, video, image, and data Interfaces rated at 155 Mbps full-duplex bandwidth are available.



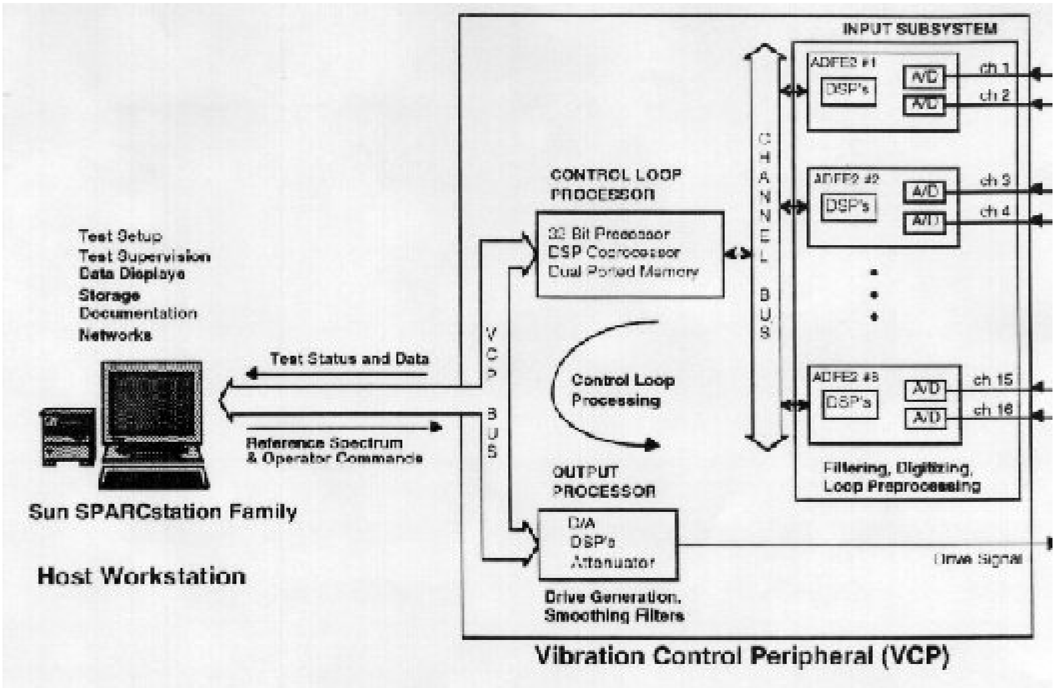
The types of cabling supported by high speed networks have been changing over the years. When Ethernet was introduced it required a heavy duty coaxial cable for the network "backbone" and multi-wire cables as taps. Today this is commonly called "thickwire" cabling. Thinwire Ethernet utilizes unshielded twisted pair (thin) wiring similar to modular telephone cables. This is sometimes referred to as Category 3 or 5 UTP. Multimode fiber optic cables are also common for moderate-to-long distance fiber optic networks. The 100 Mbps Fast Ethernet supports unshielded and shielded twisted pair wiring and fiber optic cables. The ATM technology also supports UTP wiring and fiber optic cables.

A network communications protocol is a set of formal rules that describe how software and hardware should interact within a network. Most Unix-based systems use the TCP/IP protocol which includes the Internet protocol (IP), the transmission control protocol (TCP), and several other protocols. "The Internet," a popular wide are network (WAN) for governmental, educational, and commercial applications, uses these protocols.

The TCP/IP protocol can be described in terms of a series of layers. One description uses the Open Systems Interconnect (OSI) Reference model; another uses the TCP/IP Protocol Architecture model. The seven layers of the ISO model are:

- Application: Consists of user-accessed application programs and network services.
- Presentation: Defines the way in which cooperating networks represent the data. Not used by TCP/IP.
- Session: Manages connections between cooperating application. Handled by the next layer in TCP/IP.
- Transport: Manages the transfer of data and assures that received and transmitted data are identical
- Network: Manages data addressing and delivery between networks. This is essentially the IP protocol.

- Data Link Manages the delivery of data across the physical network. Describes how the internet protocol (IP) should use existing data link protocols such as IEEE 802.
- Physical: This layer describes the network hardware such as Ethernet hardware.



The TCP/IP Protocol Architecture model combines the functions of several OSI layers into a single layer, or does not use certain layers. The four layers are:

- Physical Network Hardware (Ethernet) layer.
- Internet Layer Accepts and transmits IP datagrams, determines the transmission path, provides transmission formatting, etc.
- Transport Layer Enables communication between application programs running on separate machines, assures that data arrives in sequence and without error, etc.
- Application Layer Supports various standard services, including telnet (terminal interface), ftp (file transfer protocol), rcp (remote copy protocol), and tftp (trivial file transfer protocol similar to ftp without an interactive connection).

NFS is a service that enables computers of different architectures running different operating systems to share resources across a network. It has been implemented on operating systems ranging from MS-DOS to VMS.

NFS makes it possible for a computer to share local files and directories, and permits remote users to access those files and directories as though they were local to the user's machine. This can reduce disk storage costs by having systems share applications and data Data consistency and reliability may be enhanced by having all users read the same set of files.

Networked Remote Control And Display

There are requirements in many laboratories to operate or monitor Shaker Control systems remotely. One example is the case where a shaker and the control system are installed in a secure location such as a bunker. The bunker may be required because explosives are involved in a test. The user may want to operate the system directly from the bunker during a setup phase when the explosives are removed. However, during the "live" test the user wants to be relatively far away from the bunker.

Another example could be the case where multiple users want convenient access to the system for monitoring a test, controlling a test, and/or for defining test setups. The convenience to operate the Shaker Control system over a suitable network from an office, instead of directly on the system in the lab, can result in a large productivity gain.

It has become nearly trivial to connect workstation-based systems into an existing network. Ethernet interfaces are now commonly built into the motherboard of a workstation and default versions of operating system are configured to automatically connect to a network (with suitable time-outs that allow you to proceed if you choose not to connect).

If your network and the computers and Shaker Control systems on your network support protocols, such as TCP/IP, NFS, and X11, then you may easily share filesystems and may have a variety of other opportunities for automation and increased productivity.

The Shaker Control system discussed in this paper can not only be fully operated from any other VCS on the network, but also from any stand-alone workstation (from any vendor) or from any X-terminal or personal computer. The only requirement is that the computers or terminals must support the industry standard X11 window system. The VCS graphical user interface has been architected such that a single command allows the entire user interface to be exported for both viewing and full interactive control (select application, select test setup, mouse clicks on panels, etc.).

It is also possible to monitor the progress of a test running on a VCS by simultaneously viewing the test display on another workstation. This required additional software development within each application to send the test displays to both the primary X11 window system and also over the network. An X11 "listen" program on the secondary workstation then captures the appropriate data for display on that workstation.

Recently announced new products for the multi-media markets take these features several steps further. The ShowMe SharedApp software from SunSolutions enables users to share their applications by providing an identical view of an application and allowing users to collaboratively interact with the application. The capability is enabled in steps similar to those for initiating a telephone conference. The initiator of the conference can elect to share one or more of their applications with the other participants in the conference. Once an application is shared, both the initiator and participants have full and simultaneous access to the applications capabilities, such as viewing the application and its data, and controlling it. The VCS application software runs on the VCS workstation and provides the X11 displays to the VCS display and all the participants' displays (X-terminals or workstations). The use of this product required no changes to the VCS application software. It works with X11 compliant applications as a Unix process that sends and receives X11 protocol messages. It appears as an X11 client to the system s X11 server, and appears as an X11 server to the Xll client.

One interesting feature of SharedApp is the capability to transfer (back and forth) full operating control and status of a test to other operators. For example, a long Random test may be initiated by operator A. After the test is equalized and safely running at full level, it may be desirable (or required) that operator A take a work-break or temporarily work on another assignment. Operator A could pass control to operator B (B must accept control). When Operator A becomes available, then he/she may again request control. The operator in control has full use of the application.

It is also possible for the initiator to setup a conference such that the other participants have only viewing privileges, i.e. no control. In this manner multiple people may view the tests without "interfering" with the operation. The full ShowMe suite includes modules for video (with video camera), audio. and a "whiteboard" feature that allows interactive drawing of diagrams, writing notes and annotation, etc..

Basic Remote Communication - TTL Level Commands

Many laboratories contain equipment that use basic methods and protocols for communicating with and controlling other equipment. A common example is the use of TTL level signals supplied by common parallel interfaces. These "level signals" are normally used as triggering mechanisms to initiate other processes.

A Shaker Control system must be able to respond to at least the following basic types of externally supplied commands:

- Select a specific VCS test setup from disk.
- Start a test.
- Change the test level.
- Stop a test.
- Resume a stopped test.
- Abort the entire process.
- Display a programmed message.

The Shaker Control system must also be able to supply the following status information that may command other instrumentation:

- Application name (Random, Sine, Shock, etc.).
- VCS process state (standby, test, etc.).
- Test level status (loop check, startup, full level).
- Sweep status (hold, sweep up/down).
- Test alarm condition (spectral line alarm, etc.).
- Test abort condition (control signal loss, operator abort, etc.).
- Limit channel is (partially) in control.
- Shock pulse is imminent.

Most (if not all) thermal chambers include standard interfaces that output TTL levels when programmed events occur such as reaching a specified thermal level. This TTL level could be supplied to the VCS to start a vibration test, stop a test, change levels, etc.

Some computer disk drives now contain shock sensors that disable the read/write heads when a predetermined shock level is exceeded. When features like these are being developed, the disk drive manufacturer typically uses a shaker and vibration control system to control the shock levels, pulse types, and drive spectrum. It is not only important for the VCS to control the shock test but to also acquire data on auxiliary measurement channels for post-test analysis and to trigger other equipment that may be involved in functional testing for the disk drive. The VCS must supply a TTL level "pulse imminent" signal to trigger and/or enable other equipment just prior to the shock event

Conclusions

This paper has presented several examples on how computer networks and remote communication can help automate and increase the productivity of an environmental test laboratory. If the computer-based equipment in your laboratory utilizes industry standard protocols for networking and graphical user interfaces, then the applications can readily take advantage of both hardware and software advances that are made by the general computer industry.

It is also important for a Shaker Control system to support basic communication protocols, such as, TTL level commands and status via parallel interfaces. This allows implementation of a wide variety of automation and productivity processes that may involve many generations of equipment.

References

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