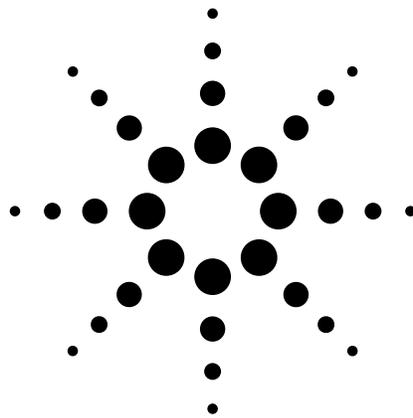


System Developer Guide

Using LAN in Test Systems:

PC Configuration

Application Note 1465-11



This set of application notes shows you how to simplify test system integration by utilizing open connectivity standards such as local area networking (LAN). The collective goal of these notes is to help you produce reliable results, meet your throughput requirements and stay within your budget.

Using LAN in Test Systems: PC Configuration, the third note in the series, describes the additional capabilities required to enable communication between a PC and LAN-enabled instrumentation. This note is a companion to Application Notes 1465-9 and 1465-10. AN 1465-9, *Using LAN in Test Systems: The Basics*, addresses the benefits of using a LAN interface in a test system. AN 1465-10, *Using LAN in Test Systems: Network Configuration*, describes the structure and basic configuration of two secure topologies for LAN-based test systems.

Please see page 7 for a list of the other titles in this series.

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Agilent Technologies

Creating the right environment

The evolution of LAN technology continues to drive improvements in cost, speed, functionality and ease of use. This has created at least two noteworthy trends. One is the widespread use of LANs within most businesses. The second is the inclusion of LAN as a standard feature of most new PCs.

A third trend is emerging in test-system development: the advantages of LAN technology are making it an attractive alternative to GPIB for system input/output (I/O). As a result, LAN interfaces are becoming more common in test equipment—though LAN ports will likely coexist with GPIB for years to come.

On the surface, this arrangement seems like it should be as simple as connecting a printer to a PC: just grab a network cable and connect the instrument to the PC. Unfortunately, it requires a bit more effort to create the right environment within a PC for transparent communication with LAN-equipped instruments. Making it

work depends on the LAN services of Microsoft®, Windows®, XP and the additional capabilities provided by a suite of I/O libraries from Agilent. Making it “printer easy” becomes possible with an enhanced I/O suite that simplifies and accelerates the connection process.

Exploring network settings in Windows XP

A standard Windows XP installation includes three software components that enable networking: Client for Microsoft Networks, File and Printer Sharing for Microsoft Networks, and Internet Protocol (TCP/IP).¹ TCP/IP is the network protocol that enables data communication with the Internet, your corporate intranet and other computers.

You access the PC’s TCP/IP settings through the Windows XP Control Panel and its Network Connections icon (or Network and Internet Connections category). The Network Connections window will present every installed LAN card under the default name “Local Area Connection” (you can change this name). Each entry will indicate the device’s connection status (enabled or disabled) and manufacturer and model.

Right clicking on a Local Area Connection entry will bring up a menu that includes a Properties selection that opens the Local Area Connection Properties window (Figure 1). This window includes a list of check-box items, and “Internet Protocol (TCP/IP)” is the last item in the list. Clicking on that item (not the check box) and then clicking the “Properties” button will bring up the TCP/IP configuration window. This is where you can change IP address settings (static or dynamic) and other networking parameters.

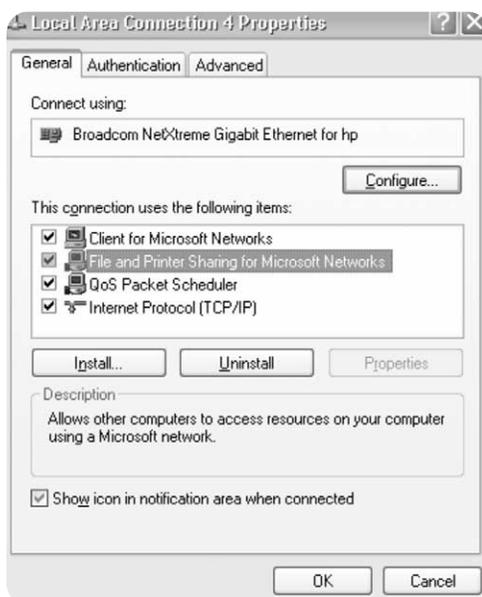


Figure 1. Use the Local Area Connection Properties window to set networking parameters such as the IP address

Recapping Application Notes 1465-9 and 1465-10

Several factors can increase the burden on the I/O connection in a test system. Examples include the number of instruments in the system, the number of tests being performed, and the volume of commands, status messages and test data being transferred. LAN technology is one of the best ways to handle that burden. It offers a fast, low-cost alternative to GPIB, and it surpasses USB with longer reach and locking connectors.

Most current-generation PCs have built-in LAN ports, which means the computing portion of a test system needs minimal physical configuration. LAN ports are also becoming more common in test equipment. Devices such as the Agilent E5810A LAN/GPIB gateway make it easy to include older, GPIB-only instruments in LAN-based test systems.

The decision to use LAN for system I/O delivers valuable benefits to your company and your team, making it much easier for colleagues to share data, results, reports and so on. However, it also opens the door to malicious threats and inadvertent risks that can affect system performance and integrity. Fortunately, the creation of a private, protected LAN can shield the test system from many of those risks, and ensure maximum throughput. The standard capabilities of most Windows PCs and many low-cost networking products enable two viable approaches: one is built around a LAN router and the other is based on a PC equipped with two LAN cards.

¹ Transfer Control Protocol, Internet Protocol. Please see page 6 for a glossary of relevant networking terms.

Using multiple network connections

It's possible to install multiple network cards in a Windows XP machine. One reason to use two LAN interfaces in one PC is described in Application Note 1465-10: the PC can do double duty as the host computer for a LAN-based test system and as a router that links a private network (for the test system) to the corporate intranet (Figure 2). The Interconnection Connection Sharing (ICS) feature of Windows XP—accessed through the Local Area Connection Properties window—makes this configuration possible.

Managing IP addresses

In the dual LAN card configuration, the PC will act as the network controller for the private network, enabling access to the public network and providing network address translation (NAT) and dynamic host configuration protocol (DHCP) services to connected devices. NAT is the key capability that enables the private, protected LAN by shielding private IP addresses from the public network.

DHCP automatically assigns an IP address to any device connected to the network, and also ensures that no two devices receive the same IP address. This is the default setting in Windows XP and most LAN routers: it's very simple and it works well 99 percent of the time—as long as the default DHCP server on the network is up and running.

Of course, the “dynamic” part of DHCP means that a device may receive a different IP address if it is disconnected and later reconnected to the network. This can cause problems in a LAN-based test system: if, for example, the system contains two power supplies and DHCP reverses their IP addresses, the device under test (DUT) could receive the wrong voltages at the wrong points and suffer severe damage.

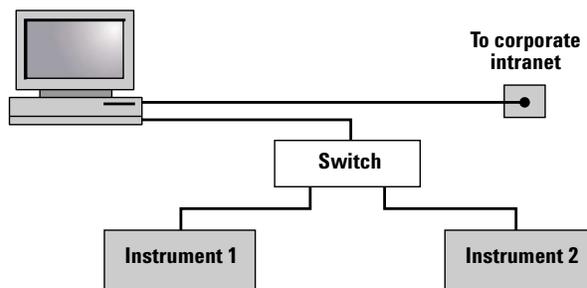
There are two alternatives. One is to assign permanent (static) IP addresses to every device on the network. This lets you fine tune the network and its settings; it also isolates the network from any failure of the corporate DHCP server. On the downside, this approach can become overwhelming in a large network, increasing the chances of configuration errors or bad settings that may attract the attention of IT staff.

The other alternative is to use a dynamic domain name server (dynamic DNS or DDNS) on the local network. DDNS lets an instrument, PC or other network device establish a specific host name when it connects to the network.² Large corporate intranets usually have such a server, which allows other devices to use the host name with DNS to find the device's IP address and connect to it. If an instrument's IP address changes, DDNS ensures a quick update of the DNS table of addresses. This approach has one major caveat: DDNS will not typically be available on the small, secure networks we recommend for test-system applications.

Running a network without DHCP

If a device running TCP/IP is set to obtain its IP address automatically but there is no DHCP server available, the device will use a capability called Automatic Private IP Addressing (APIPA or “auto IP”) to assign itself an address about two minutes after boot-up. This feature is built into Windows PCs and most Agilent instruments. Auto IP creates addresses that are designed to be compatible with each other, enabling the establishment of a network without DHCP or the configuration of static IP addresses. Also, most of Agilent's LAN-enabled instruments use the NetBIOS (Network Basic Input/ Output System) protocol: in a network configuration that lacks a DHCP server, the PC can connect to the instrument by using the host name that is configured from the instrument front panel. This makes it easy to create a direct connection from a PC to a single instrument, and all it takes is a LAN crossover cable.

Figure 2. A PC configured with two LAN cards enables the creation of a private, protected LAN for the test system



² The host name can typically be entered via the front panel of a LAN-enabled instrument.

Configuring LAN with Agilent IO Libraries Suite 14

The preceding section describes a tedious process that could take hours (perhaps days) to complete for a large test system. It all became much easier with the recently announced Agilent N2094N IO Libraries Suite 14. This is an enhanced version of the Agilent IO libraries that simplifies and accelerates the process of connecting test equipment to a PC. One of its greatest contributions is a set of automated tools that detect connected instruments, configure the interfaces and verify the connections—even in test systems that mix multiple interfaces and instruments from multiple vendors.

Using the Connection Expert

One of these new tools is the Agilent Connection Expert. Once the I/O libraries are installed, the Connection Expert automatically discovers connected instruments and configures the PC's interfaces for communication. It simultaneously manages GPIB, RS-232 and VXI interfaces as well as LAN and USB. The Connection Expert also includes an on-screen task guide that helps both occasional and expert users perform connection tasks. In most cases, you should be able to establish error-free connections in less than 15 minutes.

The Agilent Connection Expert makes programming easier, too. It can help you find information relevant to your instruments in popular development environments such as C, C++, Visual Basic, Visual Basic .NET, Agilent VEE Pro and NI LabVIEW. The Connection Expert can also point you to numerous example programs written in various languages. Another nice touch: it lets you create an alias name for each instrument so you don't have to change the source code if you change an instrument's IP address. You can even switch from GPIB to LAN

connectivity and use an alias that looks like the old GPIB address. Using this feature, you can often make older programs work via LAN without reconfiguring or recompiling the code.

Debugging with I/O utilities

The Agilent IO Libraries Suite 14 also includes a set of utilities that will help you perform various debugging tasks from the PC (Figure 3):

- **Interactive I/O:** Allows you to query instruments one command at a time, sending commands and reading the responses.
- **Remote I/O Server:** Lets you connect to instruments that are attached to a different PC that resides on the same network.
- **VXI Resource Manager:** Helps you configure the Agilent E8491 IEEE-1394 PC link to the VXI interface.
- **ViFind32 Debug Utility:** Uses VISA functions to find resources and lists them in a console window.

These utilities are just one more way Agilent can help you streamline your test-system development activities.

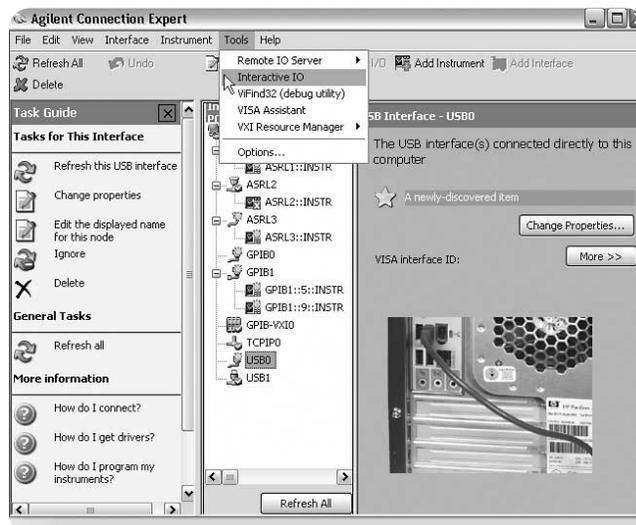


Figure 3. The Agilent Connection Expert provides quick, easy access to connection utilities

Configuring LAN with older I/O libraries

The basic LAN settings in Windows XP are not sufficient to enable connectivity and communication with a LAN-enabled test instrument. This requires additional capabilities that are provided by the Agilent IO Libraries,³ which provide configuration tools, utilities for verifying the PC-to-instrument connection, and an instrument communication protocol.

Completing the configuration process

The Agilent IO Libraries include a tool called IO Config that is used to configure the PC for a LAN connection to test instruments. This tool includes a feature called AutoConfig which will set up a generic LAN connection that can be used by two application programming interfaces (APIs) specific to test-and-measurement applications: the Virtual Instrument Software Alliance (VISA) I/O API and the Standard Instrument Control Language (SICL) I/O API.

Enabling discovery: Windows XP supports automatic discovery of LAN devices that support the Universal Plug & Play (UPnP) protocol. Such devices will appear in the My Network Places window. However, older versions of the Agilent IO Libraries lack automatic discovery capabilities. Instead, each address (device) must be opened directly from a software component such as the VISA I/O API. This requires that you find or define the IP address of each instrument, configure the TCPIP type in VISA and then open the address directly from the VISA I/O API. You can also use IO Config to configure the TCPIP type and manually add LAN devices. This

will let “discovery APIs” such as viFindRsrc in VISA include the address of each device in its list of “found instruments.”

Verifying connections: The Agilent IO Libraries also provide a tool called VISA Assistant, which can verify connections to instruments. However, because this tool only works with instruments that can be discovered on the network, you must first run IO Config and manually add each instrument, as described above.

Enabling communication with instruments

With connectivity completed and verified, the next step is to ensure and enable communication between the PC and the instruments. As one example, the VISA I/O API can use two different methods to communicate with LAN devices: the VXI-11 communication protocol and raw TCP/IP socket communication. VXI-11 is the preferred choice and sockets should only be used when the host PC does not support VXI-11.

VXI refers to both a test-and-measurement standards body and its multi-vendor standard for modular, cardcage-based test systems. VXI-11 is a separate—and more recent—standard that defines LAN-based connectivity for all types of test equipment, not just VXI. It supports a variety of useful capabilities including asynchronous interrupts and service requests.

From the PC’s point of view, the VXI-11 protocol creates an I/O connection that looks and behaves like GPIB. In practice, this means applications written for GPIB are likely to work on VXI-11 instruments. Almost all of Agilent’s LAN-enabled instruments support the VXI-11 protocol.

Shaping the future of test systems

Fast and inexpensive LAN technology has achieved widespread adoption in the computer world and is now shaping the future of test-system development. The advantages of LAN technology make it an attractive alternative to GPIB in test systems, and LAN ports are becoming more common in test equipment—though they will likely coexist alongside GPIB for many years.

With LAN ports in most current-generation PCs and many new-generation test instruments, connecting the two should be as simple as plugging a network cable into the ports. Today, it’s almost that easy when you apply the capabilities and tools that are part of the Agilent IO Libraries Suite 14.

To discover more ways to simplify system integration, accelerate system development and apply the advantages of open connectivity, please visit the Web site at www.agilent.com/find/systemcomponents.

³ We use “IO” rather than “I/O” in the product name because most operating systems don’t allow the slash character in file names.

Glossary

Adapter — the LAN card and connector that provides an electrical interface to the network

APIPA — Automatic Private IP Addressing; lets a device assign itself an IP address when a DHCP server isn't available

Auto IP — sometimes used informally when referring to APIPA

Bridge — a LAN device that connects segments of a network

Crossover cable — a network cable with its send and receive lines crossed, allowing direct connection of two LAN devices; normal LAN cables are labeled "straight" or "straight through"

DHCP — dynamic host configuration protocol; a method of automatically obtaining an IP address for a LAN-connected device (e.g., PC, router, instrument, etc.)

DMZ — De-militarized zone; a firewall configuration that helps secure the private LAN

DDNS — dynamic domain name server; a service that allows a network device to establish its host name when it connects to the network. This lets other devices use that host name with DNS to find the device's IP address and connect to it.

DNS — domain name server; maps specific names to IP addresses, enabling use of names in place of IP addresses in test programs

DUT — device under test; the component, subassembly or product to be measured by the test system

Ethernet — a specific LAN technology that is the dominant implementation of the physical and data link layers; also known as IEEE 802.3

Firewall — a hardware device or software program (or combination) that protects a computer network from unauthorized access

Gateway — a hardware device that connects devices that use different standards and protocols (e.g., LAN to GPIB)

GPIB — General Purpose Interface Bus; the dominant 8-bit parallel I/O connection for test equipment and test systems

HP-IB — Hewlett-Packard Interface Bus; another name for GPIB

Hub — a multi-port LAN device that connects multiple devices together, usually in a star topology

ICS — Internet connection sharing; allows multiple devices to share a single network connection

IP — Internet protocol; requires an address to communicate

LAN — local area network

MAC — media access control; every LAN device has a unique MAC address

NAT — network address translation; maps private addresses to one or more public addresses to enable access to an intranet or the Internet

NetBIOS — Network Basic Input/Output System; a network configuration protocol that allows Windows computers on ad-hoc networks (those without network controllers such as DNS or DHCP servers) to find and use each others' resources

Router — a LAN device that joins multiple networks and enables creation of small, private networks

Socket — a simple, direct network connection that enables bidirectional communication between two applications

Subnet — a group of connected network devices; used to partition networks into segments for easier administration

Subnet mask — a setting that accompanies an IP address and defines the boundaries of a subnet

Switch — a LAN device that connects multiple devices to a single LAN line; however, unlike a hub, it preserves full network bandwidth to each device

TCP/IP — Transfer Control Protocol and Internet Protocol; the two standards that provide the data communication foundation of the Internet

USB — Universal Serial Bus; designed to replace the RS-232 and RS-422 serial buses used in PCs

Related literature

The other notes in this series provide additional information about the successful use of LAN in test systems:

- *Using LAN in Test Systems: The Basics*, AN 1465-9 (pub no. 5989-1412EN)
<http://cp.literature.agilent.com/litweb/pdf/5989-1412EN.pdf>
- *Using LAN in Test Systems: Network Configuration*, AN 1465-10 (pub no. 5989-1413EN)
<http://cp.literature.agilent.com/litweb/pdf/5989-1413EN.pdf>
- *Using USB in the Test and Measurement Environment*, AN 1465-12 (pub no. 5989-1417EN)
<http://cp.literature.agilent.com/litweb/5989-1417EN.pdf>
- *Using SCPI and Direct IO vs. Drivers*, AN 1465-13 (available in January 2005)
- *Using LAN in Test Systems: Applications*, AN 1465-14 (available in February 2005)

Other Agilent application notes provide additional hints that can help you develop effective test systems:

- *Creating a Wireless LAN Connection to a Measurement System* (AN 1409-3) pub no. 5988-7688EN
<http://cp.literature.agilent.com/litweb/pdf/5988-7688EN>
- *Introduction to Test-System Design* (AN 1465-1) pub. no. 5988-9747EN
<http://cp.literature.agilent.com/litweb/pdf/5988-9747EN.pdf>
- *Computer I/O Considerations* (AN 1465-2) pub. no. 5988-9818EN
<http://cp.literature.agilent.com/litweb/pdf/5988-9818EN.pdf>
- *Understanding Drivers and Direct I/O* (AN 1465-3) pub. no. 5989-0110EN
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- *Choosing Your Test System Software Architecture*, (AN 1465-4) pub no. 5988-9819EN
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- *Choosing Your Test-System Hardware Architecture and Instrumentation* (AN 1465-5) pub. no. 5988-9820EN
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