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# Internet Enabled Measurements

*The widespread availability of networking technologies and the innovation in measurement hardware and software products is fuelling the measurement revolution by transforming the components traditionally found inside the PC into a platform for network measurements. With this new platform you can easily deploy powerful distributed measurement and automation systems while connecting with your business systems to create your technical enterprise. With LabVIEW 6i users can deploy measurement applications to the Web, share data across an organization, and perform remote measurement from any location. Users can also quickly publish measurements on the Internet with a few mouse clicks, or use the Web to distribute LabVIEW applications to anyone, even those without LabVIEW, through the new LabVIEW Player.*

## DISTRIBUTED MEASUREMENTS

### Network Measurement Building Blocks

Ethernet networks and the Web have revolutionised how we communicate information and distribute tasks throughout a company. Incorporating test and measurement data into the network improves access to information and allows the organisation to make decisions effectively. Essentially the network backbone has allowed not only sharing of data via static reports, but opportunities to share live data, control remote data acquisition devices and distribute an application across many different machines.

*The network forms a backbone*

The networked measurement solution normally comprises 3 blocks. These are the acquisition, analysis and presentation/control blocks. In a traditional system, these blocks would all reside on the same machine. In contrast, a networked measurement solution gives us the idea that we can acquire anywhere, analyse anywhere, and present anywhere on the network.

Measurement nodes are acquisition devices that you deploy independently on a network. These can range from I/O modules of a few I/O points, typically acquiring data in a low-speed data-logging mode from slower moving physical phenomena such as temperature, pressure of flow. On the other end of the scale is a stand-alone computer connected to measurement devices through a bus such as PCI, GPIB, USB, or RS-232/485. These measurement systems include traditional GPIB rack and stack systems or plug-in data acquisition boards in a PC used for machine monitoring and control applications. In all cases, these systems can be quickly added to a measurement network by simply adding a network card or Ethernet to a local bus converter. Once these systems can communicate with each other, engineers can develop powerful applications that share information between nodes and with other applications.

This machine is essentially a server. This is a networked computer that is capable of managing large channel counts and performing Supervisory control and data acquisition (SCADA). You can also use them to warehouse your data and analyse that data either on or off line for parameters that will improve the manufacturing process.

Measurement browsers are Web browsers or other software interfaces that can view the measurements or analysed information published by the measurement nodes as well as the information collected and produced by measurement servers.

What differentiates these systems is the ease with which the developer can create an application via a

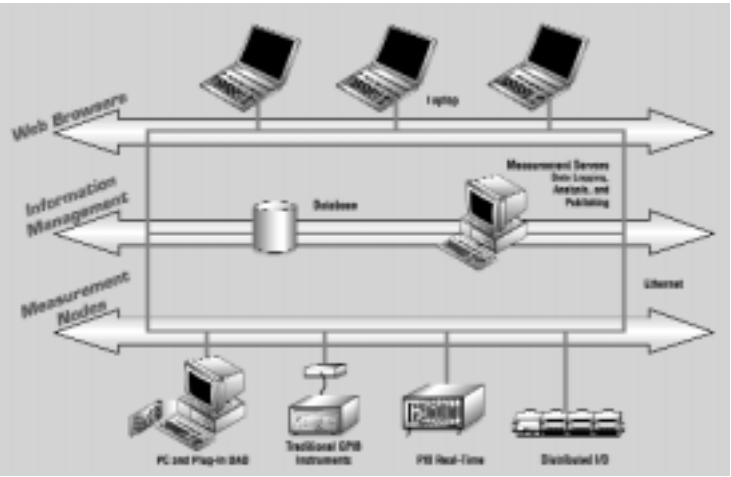


*Figure 1. The technical enterprise.*

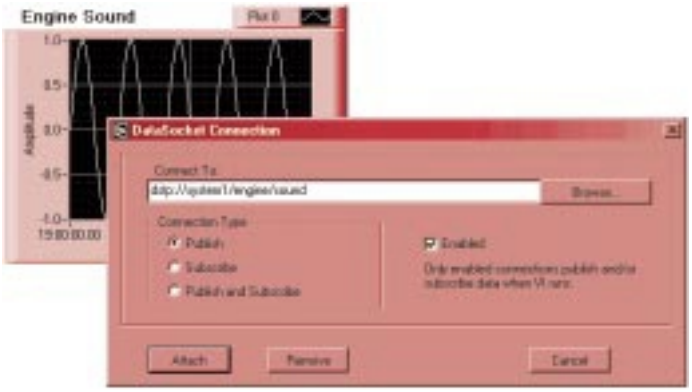


*Figure 2. DataSocket Connection.*

software-programming environment. Both the underlying drivers and the application development environment need to work in a seamless fashion, allowing the developer to develop on one machine, and then deploy the application across several networked machines.

*Techniques for Information Sharing*

There are three basic techniques of information sharing you can employ with a network measurement solution:

- Remote measurement
- Remote publishing
- Remote control and execution

### Remote Measurement

It is often desirable or even requisite that measurements be made at locations physically separated from a host PC. Data collection in harsh or dangerous environments or across a large geographic area often require I/O to be near the physical phenomena being measured while analysis and presentation occur in a safe or centralised location. In this case, you can use network technologies to deploy a measurement node with the required measurement capabilities in the remote location that returns data over the network for further analysis and presentation. Another option, appropriately named Remote Data Access (RDA) allows one PC to transparently share a data acquisition device with other machines. Using RDA ensures that an application developed for a local data acquisition device can be moved to a different networked machine with no change to the application.

### Remote Publishing of Data

In many applications, real-time access to acquired data is needed to control or monitor a process or test across the network. The results of one measurement or automation process can be passed directly into the next process, or any monitoring task that requires live streaming of data between applications can be developed.

Many commercial technologies allow you to stream information between applications including Real Networks real audio format and National Instruments DataSocket™, a protocol layered on top of TCP/IP. DataSocket can be applied to a wide range of streaming measurements in application such as data logging, remote data collection, and machine monitoring and control.

*What is DataSocket™?*

DataSocket, is based on industry-standard TCP/IP, and allows live data to be exchanged between computers connected via a network. Although a variety of different technologies exist today to share data between applications, such as TCP/IP and DDE, most of these tools are not tuned for live data transfer. DataSocket consists of two pieces - the DataSocket API and the DataSocket Server. The DataSocket API presents a single interface for communicating with multiple data types from multiple languages. DataSocket Server simplifies Internet communication by managing the underlying TCP/IP protocol for you.

*Commonality - DataSocket API*

DataSocket is a single, unified, end-user API based on URLs for connecting to measurement and automation data located anywhere, be it on a local computer or anywhere on the Internet. It is a protocol-independent, language-independent, and OS-independent API designed to simplify binary data publishing. The DataSocket API is implemented as an ActiveX control, a LabWindows/CVI C library, and a set of LabVIEW VIs, so you can use it in any programming environment. In LabVIEW 6i, the data socket protocol has been extended and is bound to every front panel item in a users application, allowing data sharing without developing any code.

The DataSocket API automatically converts the user's measurement data into a stream of packets that is sent across the network. The subscribing DataSocket application automatically converts the stream back into its original form. This automatic conversion eliminates network complexity, which accounts for a substantial amount of code that you must write when using TCP/IP libraries. Apart from data conversion, the API also incorporates check sums and block counters to ensure data integrity.

The DataSocket API consists of four basic actions (open, read, write, and close) that are similar to standard file I/O calls. You can use the same DataSocket API in your programs to read data from:

- Data items on HTTP servers
- Data items on FTP servers
- Local files
- Data items on OLE for Process Control (OPC) servers
- Data items on DSTP servers

*Broadcasting Live Data - DataSocket Server*

The DataSocket Server is a lightweight, stand-alone component with which programs using the DataSocket API can broadcast live measurement data

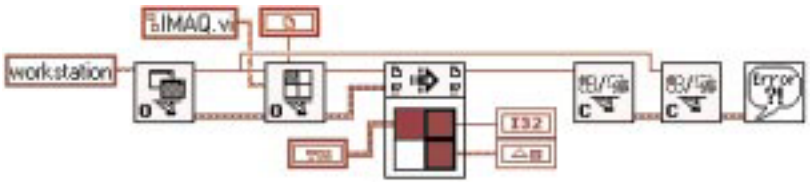


*Figure 3. LabVIEW 6i Remote VI Execution Call.*

at high rates across the Internet to several remote clients concurrently. The DataSocket Server simplifies network TCP programming by automatically managing connections to clients.

Broadcasting data with the DataSocket Server requires three "actors" - a publisher, the DataSocket Server, and a subscriber. A publishing application uses the DataSocket API to write data to the server. A subscribing application uses the DataSocket API to read data from the server. Both the publishing and the subscribing applications are "clients" of the DataSocket Server. The three actors can reside on the same machine, but more often the three actors run on different machines. The ability to run the DataSocket server on another machine improves performance and provides security by isolating network connections from your measurement application.

The DataSocket Server restricts access to data by administering security and permissions. With DataSocket, you can share confidential measurement data over the Internet while preventing access by unauthorised viewers.

One example of this is how Oak Ridge National Laboratories in Oak Ridge, Tennessee, is using data streaming applications to remotely monitor experiments over the Internet. Their systems are designed for emissions monitoring on industrial stacks, and the measurement system consists of a video camera to view the test bed and a measurement system for gathering temperature, humidity, pH, flow, and gas concentration measurements. The monitoring application accepts streaming video from the test bed, while also receiving real-time updates of the measurement process. The monitoring application can also send new set point and control data directly to the remote test site.

### *Remote Execution*

With network access to various measurement nodes, users can develop software that utilises each computer to complete a portion of the application. Using distributed execution, engineers can remotely operate another computer to control the execution of their application. While splitting an application into too many pieces will result in diminished returns, there are many instances in which distributed execution yields increased productivity.

For example, when developing measurement systems that acquire data in hazardous or remote environments, it may be too expensive or time consuming for engineers to continually change a measurement system. This is often true in environmental testing. It can require hours for an environmental chamber to achieve the desired settings. This may cause some frustration for system designers who must constantly tweak the system. Using distributed execution, a system designer can reconfigure and change the system for many different tests without ever entering the chamber. This concept easily extends into hazardous and remote environments.

Many technologies for distributing and controlling distributed execution exist. At a low level, remote procedure calls in C and C++ and remote method invocation in Java allow users to programmatically execute functions remotely. Many applications in measurement and automation expose distributed execution through ActiveX including National Instruments LabVIEW and Agilent VEE Pro. LabVIEW further extends this capability by allowing users to distribute execution without ActiveX and across the many platforms, including Microsoft Windows, Apple MacOS, and Linux.

An example of remote execution is at University College London, UK. Steve Boon, senior experimental officer, is using LabVIEW to control experiments on ice core samples. Due to the intense pressures and stresses the samples are subjected to, the PC controlling the servo system is located in the experimental chamber and data captured from this PC is passed to anther PC, located in the control room, which processes, presents and stores the data. This distributed system ensures that experiments can be run without endangering operator safety.

*Network Measurement Solutions*

You can use National Instruments measurement devices to create a wide variety of measurement nodes tailored to your unique requirements. With National Instruments LabVIEW™ software, you can maximise your productivity when creating network measurement solutions. The ability to acquire measurements from your measurement nodes and to publish the results to clients around the world is included in the LabVIEW package. You can use LabVIEW to distribute processor intensive routines to other computers on your network to improve the speed and efficiency of your applications. With the LabVIEW real-time capabilities, you can execute deterministic control routines on your remote measurement nodes

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your business systems to create your technical enterprise.

## GRAPHICAL PROGRAMMING FOR INTERNET-READY MEASUREMENT APPLICATIONS

With LabVIEW 6i users can deploy measurement applications to the Web, share data across an organization, and perform remote measurement from any location. Users can also quickly publish measurements on the Internet with a few mouse clicks, or use the Web to distribute LabVIEW applications to anyone, even those without LabVIEW, through the new LabVIEW Player.

### *Introduction*

Today, the Internet is an essential part of the way a business operates. Not only does the Internet provide engineers and scientists with a way to gain visibility, share information, and sell products, but it also gives users the power to improve the way they design, manufacture, and test products. Engineers and scientists can use the Web as a tool to decrease design time, ensure quality, and share information throughout an enterprise.

Users can quickly build high-performance measurement and automation applications and easily incorporate them throughout all levels of an enterprise with National Instruments LabVIEW™ 6i and advanced Internet technology.

With LabVIEW 6i users can deploy measurement applications to the Web, share data across an organization, and perform remote measurement from any location. Users can also quickly publish measurements on the Internet with a few mouse clicks, or use the Web to distribute LabVIEW applications to anyone, even those without LabVIEW, through the new LabVIEW Player.

LabVIEW 6i continues to build on the measurement features of previous versions. Through the tight integration of hardware and software, LabVIEW 6i offers measurement intelligence that combines hardware configuration with powerful new measurement, analysis, and display functions. LabVIEW 6i also delivers significant advances in the areas of productivity, user interface development, and performance.

### *Develop Internet-Ready Applications*

With LabVIEW 6i and the new LabVIEW Player, users around the world can instantly access virtual instruments (VIs) programs from their Web browser. Whether publishing test results programs, sharing data for additional processing, or distributing application execution across many computers, LabVIEW 6i makes sharing data easy and convenient. Users can create VIs and distribute them across the Web to colleagues who then can open and run these VIs with the LabVIEW Player, even if they do not have LabVIEW. The LabVIEW Player is available for FREE from National Instruments at ni.com/labview.

In addition to sharing VIs, LabVIEW 6i users can instantly publish data using DataSocket from any user interface object to other applications or Web pages with only a few mouse clicks and without any programming. LabVIEW also facilitates distributing user VIs and applications throughout the enterprise by transparently performing execution and data sharing across a network, regardless of the operating system of the computers on the network. Using the improved VI server, users can create distributed applications that acquire data on a remote computer, analyze the data on a powerful workstation, and present the results anywhere.

To further integrate applications into the Web, users can take advantage of the new LabVIEW 6i report generation functions to publish reports in HTML format. Built on the existing National Instruments report framework, these new functions professionally document the results of an application quickly and easily by adding graphics, panels, bulleted lists, and tables.

With the LabVIEW 6i report generation tools, it is easy to automatically create reports and output them in various formats, including HTML. LabVIEW has always done a great job plotting vast amounts of data into nice-looking graphs. Now you can save time by outputting this data into an HTML report format.

### *Connectivity to Plant Floor Devices*

With LabVIEW tools for datalogging and supervisory control, manufacturers manage and control networked data across the plant floor. LabVIEW gives manufacturers powerful data and network system management tools, so they can easily supervise and control distributed and high channel-count manufacturing applications. The OPC client interface provides standardized connectivity to plant floor devices, making integration significantly easier in a multivendor environment and providing users with more choices in selecting hardware and software vendors for automation systems. Users can distribute data in a standard format to clients, including HMI products and high-level business systems, with OPC server capabilities. By providing configured tools for high channel-count data management and supervisory control of distributed systems, users can keep track of all data pertaining to the manufacturing process. These tools include full alarm and event management, built-in security, a networked database for distributed datalogging, and real-time and historical trending.

### *Real-Time Control*

In addition to datalogging and supervisory control capabilities, users can develop time-critical machine control applications with a real-time embedded system. LabVIEW provides easy-to-use tools for deterministic real-time control. With LabVIEW RT, users can develop a control loop in LabVIEW and automatically download the code to run embedded on an independent processor located on a RT Series board. A real-time application running on RT Series devices or PXI™/CompactPCI™ real-time controllers continues to run, even if the host PC crashes. With LabVIEW 6i, National Instruments extends Internet and measurement functionality available to users through a wide

variety of powerful tools that can increase your productivity on the manufacturing floor.

### Measurement Intelligence Generates Instant Results

LabVIEW 6i delivers measurement intelligence - the tight integration of measurement hardware with software - to simplify configuration and improve measurement functionality. Measurement intelligence integrates enhanced measurement capabilities that boost users to new levels of productivity. LabVIEW 6i measurement intelligence includes simplified measurement and device configuration, new measurement and display functions, and a new, comprehensive waveform data format.

Measurement intelligence in LabVIEW 6i extends connectivity beyond data acquisition and instrument control by now including image acquisition and motion control libraries. With these new libraries, users can add imaging and inspection to measurement applications or automate them with motion control.

"With measurement intelligence - the integration of measurement hardware, sensors, and software to automatically recognize and configure available measurement components - LabVIEW 6i delivers functions you have looked forward to for years. It is much more efficient with the new array processing functions. In addition, the ability to create dynamic link libraries (DLLs) and shared libraries with LabVIEW 6i adds plenty of flexibility and power to your applications programming. And the new data acquisition waveform data type simplifies block diagram programming and data flow tremendously.

### Integrate LabVIEW into Other Applications

To ensure LabVIEW code easily integrates with different programming languages and enterprise tools, LabVIEW 6i generates a 32-bit DLL or shared library from any VI. Users can easily integrate these DLLs or shared libraries into other programming environments, such as Microsoft Visual Basic or Visual C++, or National Instruments Measurement Studio.

### Enhanced Productivity

Through the years, LabVIEW has made measurement and automation system developers more productive by helping them concentrate on developing products instead of spending time on the mechanics of programming. LabVIEW 6i enhances this productivity gain by introducing a number of features to further accelerate measurement and automation application development. With the new grouping feature, front panel objects maintain their sizes and positions relative to each other when moved or resized. The newly added locking functionality anchors controls and indicators to front panels so they cannot be moved or deleted. With control references, LabVIEW 6i programmers pass information about front panel objects to subVIs for programmatic property configuration and retrieval. Therefore, users build cleaner code components that modify the appearance or behavior of user interfaces, which users can reuse in other LabVIEW applications.

Automatic wiring further enhances productivity by automatically connecting block diagram objects together when users move or place objects on the diagram. LabVIEW 6i delivers a number of improvements in array and string functions for even easier insertion, replacement, and deletion of characters and elements in strings and arrays. Incorporation of LabVIEW 6i polymorphic VIs into applications means users can create VIs whose functionality adapts according to input data. This enhancement leads to more compact code and also improves the potential for code reuse. With LabVIEW 6i, users can quickly search through the controls and functions palettes with a navigation bar that behaves like the familiar navigation buttons in a Web browser. These palettes also provide a search button for text-based searches on controls, functions, and VIs.

### Improved Performance

Driven by stringent performance requirements, LabVIEW 6i dramatically improves execution speed, application launch time, and memory and disk footprints. Many real-time and embedded applications, as well as large applications requiring datalogging and supervisory control, demand high-performance solutions. Production test applications are no different because decreased test times mean higher production throughput.

### Delivering Internet-Ready Measurement Intelligence

LabVIEW 6i provides the power and flexibility to create high-performance measurement and automation systems faster and more efficiently than ever before. The new measurement functionality combines tight integration with the Web and changes the way companies produce products. No matter what phase of the product lifecycle, LabVIEW is the software platform for measurement and automation applications ■

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*Ryan sets the strategic direction for the LabVIEW product line. Before his involvement in Marketing, he worked as an Applications Engineer, providing technical support for LabVIEW, ComponentWorks, data acquisition, GPIB, motion control, and image acquisition products for National Instruments. Ryan holds a Bachelor of Science degree in Electrical Engineering from Brigham Young University.*