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Wireless Sensor Network Serial Nodes

NI WSN-3230 (RS232), NI WSN-3231 (RS485)



- Programmable, autonomous interface to serial sensors, instruments, and control boards
- Deploy embedded code to create a local communication loop between the node and serial device
- Create a reliable network, with support for hundreds of nodes, to monitor your assets or environment
- Programmable with the LabVIEW Wireless Sensor Network (WSN) Module: Customize node behavior to extend battery life, increase sample rates, save data locally, and perform local analysis and DIO control
- NI-WSN software that provides easy network configuration, drag-and-drop LabVIEW programming, and support for logging, alarming, and web-based data visualization
- Low-power operation with up to 3-year battery life
- 2.4 GHz IEEE 802.15.4 radio that provides up to 300 m outdoor range
- 1 serial port per node with user-selectable baud rates, parity bits, stop bits, and flow control
- Two bidirectional digital channels configurable for input, sinking output, or sourcing output
- Industrial ratings: -40 to 70 °C operating temperature and 50 g shock, 5 g vibration

Overview

The National Instruments wireless sensor network (WSN) platform delivers low-power measurement nodes that offer industrial certifications, reliable networking, and optional weatherproof outdoor enclosures for long-term, remote monitoring applications. The measurement nodes have direct sensor connectivity and a 2.4 GHz radio to wirelessly transmit data to a WSN gateway. Each serial node features one serial port and two digital I/O channels that you can configure for input, sinking output, or sourcing output. With NI LabVIEW graphical system design software, you can easily configure your network, collect measurement data, trigger alarms through SMS or email, and even view monitoring data within a web browser. With the NI LabVIEW Wireless Sensor Network (WSN) Module, you can customize the behavior of programmable NI WSN measurement nodes and create an autonomous interface to serial-based sensors, instruments, and control boards. Use this module to optimize node behavior for your application: customize sample and transmission rates, perform onboard analysis or data reduction, respond to digital value changes, perform local control of DIO lines, and even store data to flash memory.

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Application and Technology

Autonomous, Programmable Serial Interface

The NI WSN-3230 and WSN-3231 measurement nodes deliver wireless connectivity to serial-based sensors, instruments, and control boards. Using the LabVIEW WSN Module and the LabVIEW Serial Compatibility API, you can deploy graphical code to embed command, query, and parse algorithms to the node, which creates a local, autonomous communication loop between the node and the serial device, as seen in Figure 1.

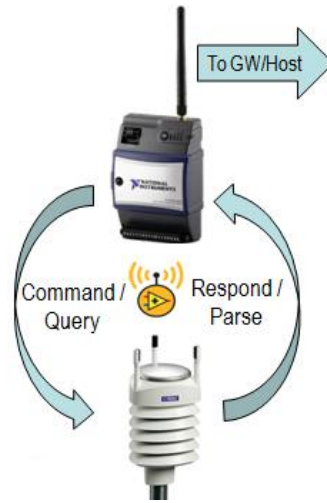


Figure 1. WSN Serial Node Communication Model

The LabVIEW Serial Compatibility API helps you configure baud rate, stop bits, parity bits, and flow control. Using the API, you can initialize the serial channel, send commands to the serial device, and then read back and parse the returned data, all locally without over-the-air communication and associated latency. Then you can send important data over the air back to the WSN gateway/host machine via user-defined I/O variables (UDVs).

With the LabVIEW WSN Module, the custom applications are wirelessly downloaded to the node's onboard processor, and because these applications are written in the LabVIEW graphical development environment, customizing node firmware is easy and does not require low-level assembly or machine code knowledge. With deployed LabVIEW WSN code, you can also conduct local data analysis, respond to digital value changes or network status changes, and perform local control of the two digital I/O lines. The digital I/O lines feature industrial ranges and can be configured for input, sinking output, and sourcing output.

Power

You can power the NI WSN measurement nodes with four 1.5 V AA alkaline or lithium battery cells. The node also features an external power port, so you can provide line power or use other forms of power such as solar or vibration energy harvesting. The nodes support battery backup, meaning you can connect both external and battery power; the node defaults to external power and automatically switches to battery power in the event the external power drops below a voltage threshold. The external power input should be used to power NI WSN nodes operating in router mode, which is a feature that you can enable in software to set up a self-healing mesh network of nodes. Router nodes increase density, distance, and redundancy in your wireless network.

Each node offers bidirectional digital I/O channels for input, sinking output, or sourcing output. You must use an external power supply to provide sourcing output through the digital I/O channels, with a maximum total current output (aggregate on all channels) of 1 A. The serial nodes also feature a sensor power output channel, which delivers up to 50 mA at 12 V, and can be used to deliver power to external devices or sensors.

Battery Lifetime

With the flexibility of the node, you can specify baud rates, packet lengths, parity bits, stop bits, and flow control. Using LabVIEW WSN, you can customize the node to modify transmit intervals (when data is passed back over the air to the gateway). These factors, among others, influence the battery-powered lifetime of the devices, as seen in the following graphs. Results are typical, and you can assume 25 °C operating temperature, alkaline cells, sensor power turned off, and a single node network.

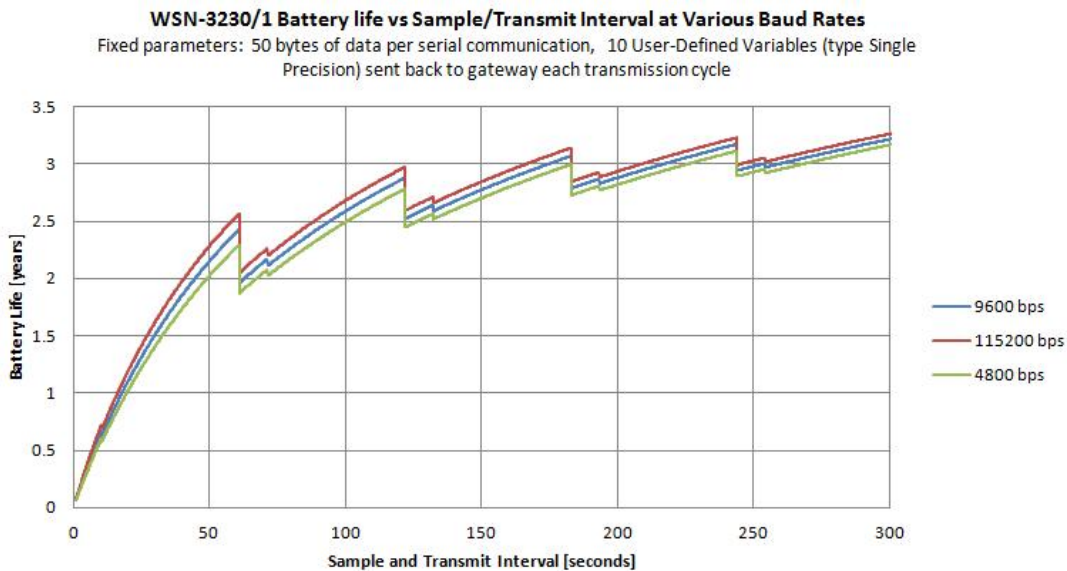


Figure 2. Serial Node Battery Life Versus Sample/Transmit Interval at Various Baud Rates

WSN-3230/1 Battery life vs Sample/Transmit Interval for Various Data Type/Lengths Sent back to Gateway per Transmission Cycle
 Fixed parameters: 50 bytes of data per serial communication, 9600 bps baud rate

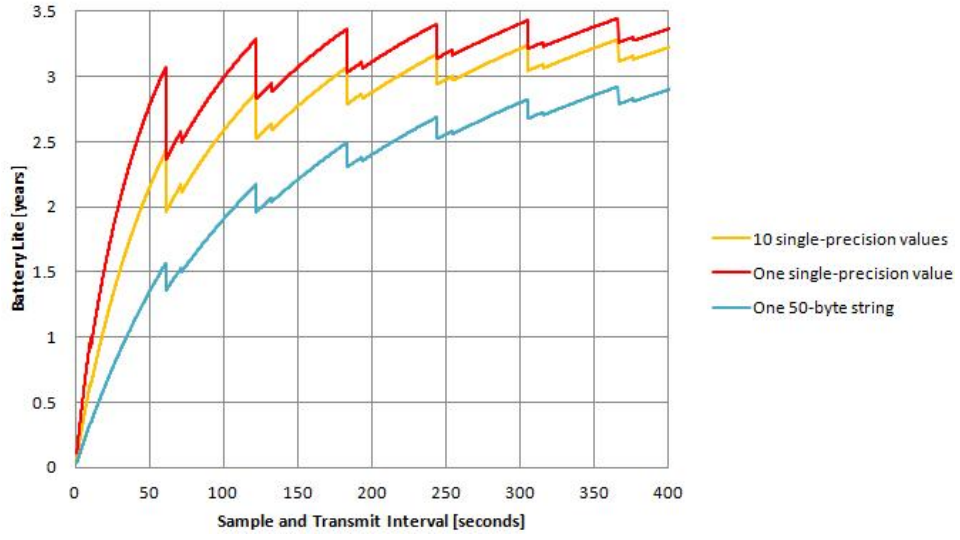


Figure 3. Serial Node Battery Life Versus Sample/Transmit Interval for Various Data Types/Lengths

WSN-3230/1 Battery life vs Sample/Transmit Interval for Various Data Lengths per Serial Communication
 Fixed parameters: 9600 bps baud rate, 10 User-Defined Variables (type Single Precision) sent back to gateway each transmission cycle

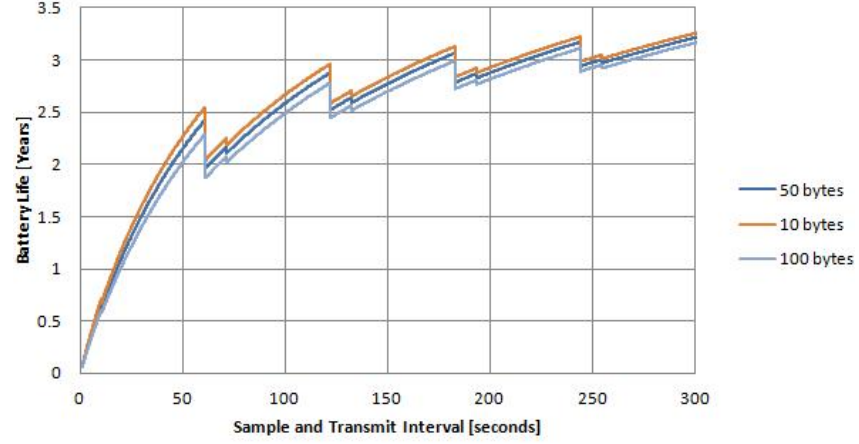


Figure 4. Serial Node Battery Life Versus Sample/Transmit Interval for Various Data Lengths

Using LabVIEW WSN to limit over-the-air transactions, you can achieve significant battery lifetime improvement, as shown Figure 5.

WSN-3230/1 Battery Life vs Sample Interval at Various Transmit Intervals

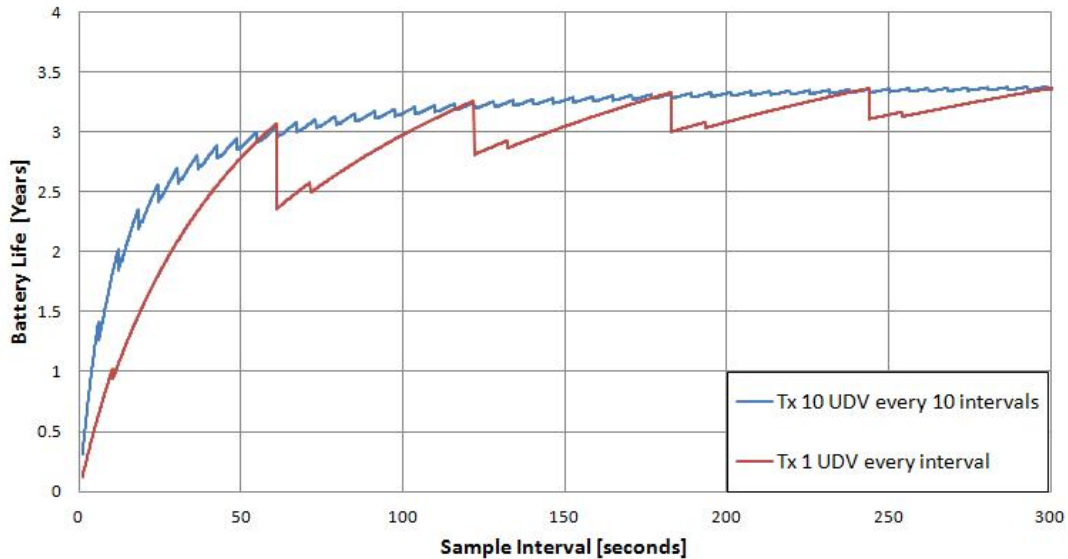


Figure 5. Using LabVIEW WSN can greatly increase battery life for sample intervals under 60 seconds.

Wireless and Mesh Networking

The measurement nodes and gateways communicate wirelessly using 2.4 GHz radios and the reliable NI WSN protocol based on IEEE 802.15.4. The network accommodates up to 36 nodes per gateway, with access to 14 nonoverlapping wireless channels, so that you can reliably configure fourteen 36-node networks (2,016 analog channels) in the same vicinity without sharing any wireless bandwidth. Each radio delivers an outdoor range of up to 300 m with line of sight, and up to 100 m indoors, performing reliably even in high EMI environments.

Gateways, routers, and end nodes work together to form a mesh network. Measurement nodes can operate as routers or end nodes, providing the flexibility to extend the range or density of your sensor network. When nodes are configured as routers, they can repeat messages from end nodes and extend network range while acquiring measurement data.

When a node powers up, it scans for available networks, locates either a gateway or router node, and attempts to join. When the node joins the network, it downloads the latest configuration from the gateway and begins its normal operation of acquiring measurement data, controlling digital I/O, and transmitting data back to the gateway for processing, alarming, and visualization.

Software Overview

With NI-WSN software, you can easily configure your sensor network and quickly extract measurement data from your wireless sensor network with the LabVIEW graphical development environment.

NI WSN measurement nodes configured with a gateway are automatically added to your LabVIEW project, giving you instant access to their I/O and properties. Simply drag and drop I/O variables from a LabVIEW project to a LabVIEW block diagram for data extraction, analysis, and presentation. Using the drag-and-drop LabVIEW variables, you can monitor the digital channels as well as other node attributes such as link quality, battery voltage, and whether a node is configured as a router or end node. These properties help you intelligently maintain your network and choose the best locations for your measurement nodes.

With the NI WSN serial nodes, you can determine when to send data back to the gateway. You can create custom I/O channels called user-defined I/O variables (UDVs) to transmit data from the node to the gateway/host. This could be string or numeric data, depending on the type of serial instrument you are interfacing with and the type of data returned by each serial command/query. These variables are created within the LabVIEW project, and can be written to or read from in LabVIEW.

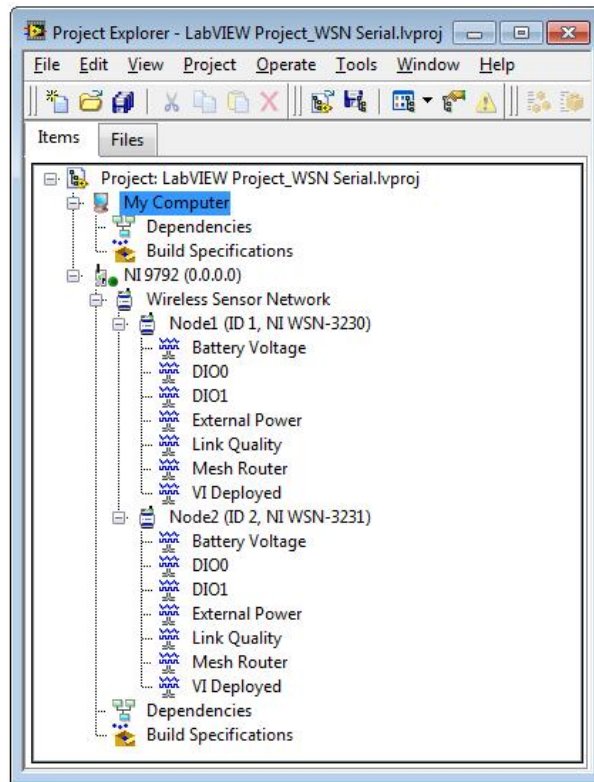


Figure 6. LabVIEW Project Window Showing Serial Node Hierarchy

Node Programming (LabVIEW WSN)

The LabVIEW Serial Compatibility API helps you configure baud rate, stop bits, parity bits, and flow control. Using the API, you can initialize the serial channel, send commands to the serial device, and then read back and parse the returned data, all locally without over-the-air communication and associated latency. Then you can send important data over the air back to the WSN gateway/host machine via UDV's. Figure 7 shows an example. "Temperature," "Status," and "String from Sensor" are three different types of user-defined variables that contain information from the serial device.

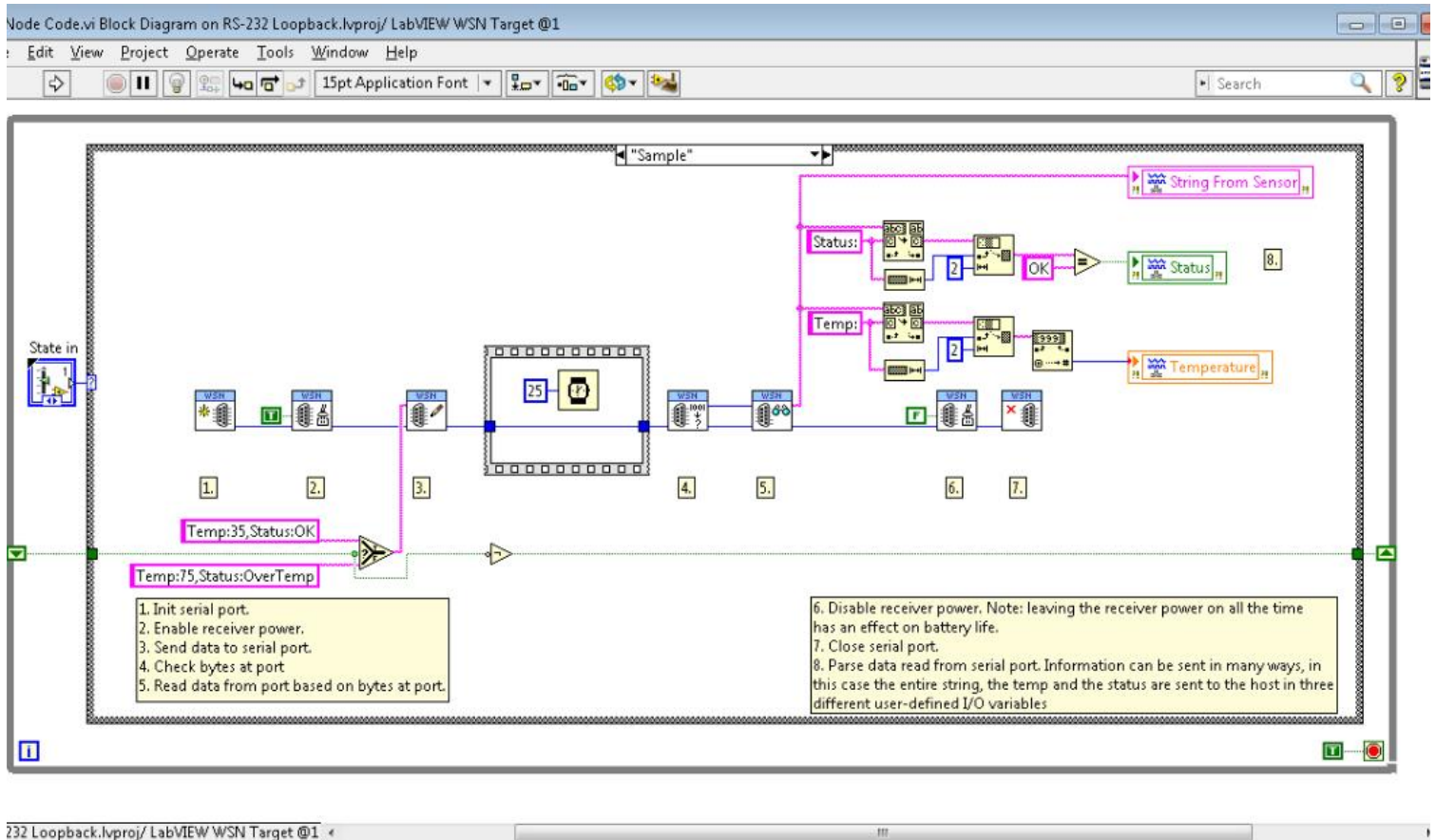


Figure 7. Use LabVIEW WSN to create a programmable serial interface to sensors, instruments, and control boards.

In addition to using the LabVIEW WSN Module to create a local, autonomous interface to serial devices, you can use this module to perform custom analysis, extend battery life,

and embed local decision making on NI WSN measurement nodes.

With the LabVIEW WSN Module, you can significantly increase the battery life of your NI WSN measurement nodes while increasing performance and flexibility. Instead of transmitting every received string or value back to the gateway, in many applications it is sufficient to simply monitor a given input for a threshold crossing or average values over a period of time. In these applications, powering the radio to transmit every acquired sample uses excessive power and reduces battery life. With LabVIEW WSN, you can add intelligence to the node to transmit data only when required. Additionally, you can monitor battery voltage and network status as well as modify the sample interval of the node to optimize behavior for specific operating conditions.

Using a subset of LabVIEW analysis functions and floating-point math operations, you can preprocess data acquired by NI WSN measurement nodes. A variety of analog and digital sensors can interface directly with these nodes, and you can use LabVIEW WSN to scale and convert raw sensor data into meaningful engineering units before transmitting.

With LabVIEW WSN, you can also embed intelligence on NI WSN measurement nodes, so decisions can be made autonomously without transmitting the stimulus and response to and from a host computer or embedded controller. You can use the digital output lines on an NI WSN measurement node to actuate relays and perform simple on/off control. For example, a programmed node can turn on a fan when a temperature threshold is exceeded, which reduces response time and increases reliability by removing the need for host interaction.

NI WSN Applications and Architectures

NI wireless sensor networks are ideally suited for long-term remote monitoring applications such as environmental monitoring, water quality monitoring, structural health monitoring, energy quality and consumption monitoring, transportation, and machine condition monitoring. NI WSN measurement nodes can withstand outdoor and industrial environments and reliably monitor assets or surroundings to provide enhanced visibility into the overall health of your systems or processes.

The NI WSN platform can function as a simple, stand-alone wireless monitoring system, or be combined with other hardware components to achieve a complete wired and wireless measurement and control system. Through LabVIEW, you can combine NI WSN devices with other NI platforms to customize and enhance your measurement capabilities. You can complement your NI WSN with embedded NI CompactRIO systems, vision systems, or even human machine interfaces (HMIs) to create a fully integrated solution that meets the unique needs of your application.

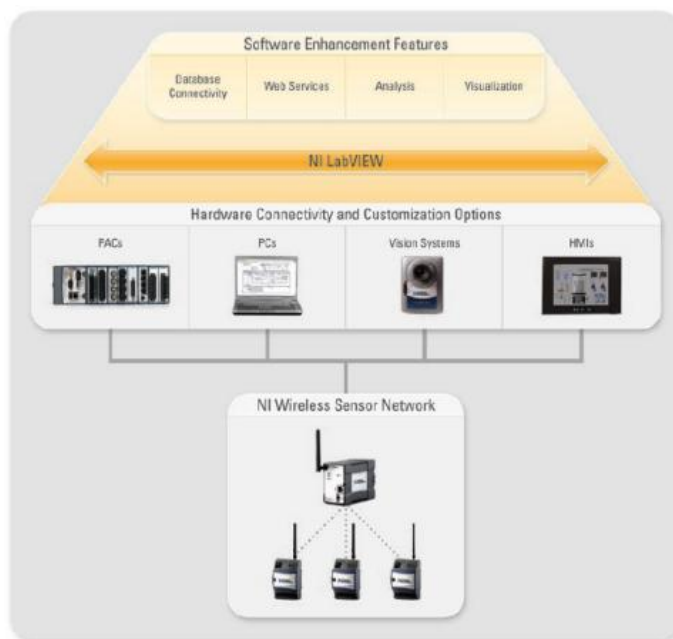


Figure 8. Complement NI WSN systems with additional hardware and software.

Accessories

NI WSN accessories include options for gateway and measurement node mounting as well as weatherproof enclosures for outdoor use of the measurement nodes and gateways. Available mounting accessories include options to panel mount and DIN-rail mount WSN measurement nodes and gateways. The NI WSN-3281 magnetic panel mount kit provides easy setup and takedown on virtually any metal surface. For high shock and vibration applications, NI recommends a panel mounting configuration rather than DIN rail.

The NI WSN-3291 is an outdoor weatherproof enclosure for NI WSN measurement nodes. The enclosure features two I/O glands for routing power or sensor cables and is shipped with four I/O gland inserts and two I/O gland plugs so you can customize the glands for your application. The WSN-3291 offers an IP65 (Ingress Protection) rating to protect NI WSN measurement nodes for long-term, outdoor deployment.

Please view the WSN accessories data sheet for a complete list of WSN mounting accessories, outdoor enclosures, backshell kits, and power supplies.

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. NI offers a number of calibration services to help maintain the ongoing accuracy of your measurement hardware. These services allow you to be completely confident in your measurements, and help you maintain compliance to standards like ISO 9001, ANSI/NCSL Z540-1 and ISO/IEC 17025. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit ni.com/calibration.

Technical Support

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While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

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Extended Warranty

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