



Introduction

to the

QNX Smart Energy Reference

What is the QNX Smart Energy Reference?

Sophisticated human machine interfaces (HMIs), network connectivity, and audio and video are increasingly converging in industrial applications, such as advanced building control systems, Security, Monitoring and Automation (SMA), and Smart Metering systems.

The QNX Smart Energy Reference combines the QNX Aviage HMI and Multimedia Suites to showcase how developers can build the next generation of SMA applications. Focusing on home energy management, it demonstrates how an easy-to-use and attractive building management user interface can be implemented on the QNX® Neutrino® RTOS. The reference design also shows how Home Area Networks (HAN), Zigbee sensors, streaming IP video cameras, and internet connectivity can be integrated into a comprehensive and efficient system.

Figure 1 below shows the QNX Smart Energy Reference connected to sensors, cameras, controls, and information and data sources.

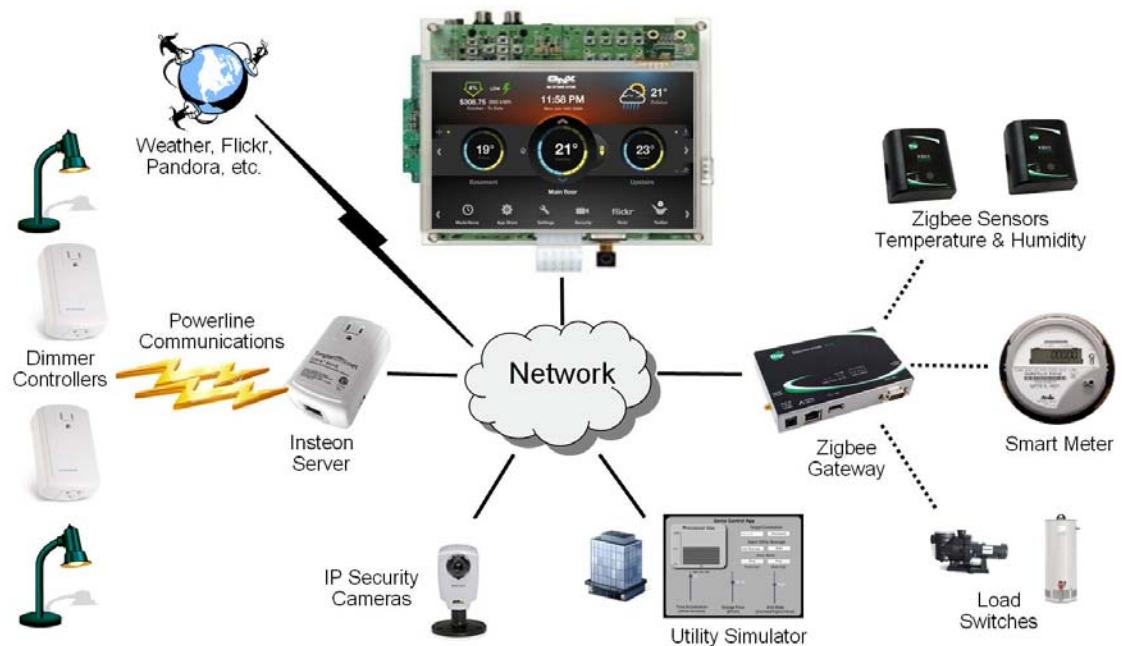


Figure 1 — QNX Smart Energy Reference connected to sensors, meters, cameras, controls, information sources, and the Reference Control Application

QNX HMI Suite

The QNX Smart Energy Reference presents just some of the possibilities offered by building management applications with the QNX HMI Suite, which consists of the Adobe Flash Lite 3 engine, plus QNX-specific enhancements that provide:

- an application management framework
- multiple window support through an OpenKODE composition manager
- improved rendering performance
- native extension support, through QNX Action Script Extensions (ASE)
- remote access capabilities

Overview

The QNX Smart Energy Reference demonstrates implementations of applications for energy efficiency and security managed through an elegant and easy-to-use HMI.

Energy Efficiency

The QNX Smart Energy Reference provides network-enabled monitoring and control of building energy use and consumption, including:

- zone temperature controls, including timer settings
- individual and zone light controls
- on-going and period-based energy consumption and monitoring, including cost and carbon footprint
- appliance monitoring and control (water heater, pool pump, whitegoods)

Since the QNX Smart Energy Reference is connected, all energy management capabilities can be accessed remotely; and additional, connected applications are easy to add. For example, energy management applications could include applications connected to weather data sources used to adjust consumption estimates.

Similarly, these applications could use the same weather data to adjust heating, cooling and airflow based, not just on current readings, but also on predicted weather conditions — not just providing a constant and comfortable environment, but also saving energy and money.

Security

The QNX Smart Energy Reference shows how feeds from security cameras can be easily integrated into the HMI.

Ease of Use

The QNX Smart Energy Reference features an attractive, Flash Lite HMI built for a touch screen. The user only needs to touch the screen to view information or change settings.

Any user familiar with the internet will have no difficulty finding his or her way around and using the various applications included in the reference.

Connectivity

The QNX Smart Energy Reference demonstrates how to build a truly connected home energy management system:

- A Zigbee wireless network allows the system to collect temperature and humidity data throughout the home, as well as to connect to other Zigbee enabled devices, such as a smart meter and appliance load switches.
- An Insteon power-line based Home Area Network (HAN) shows how lighting control can be integrated into the system.
- The reference design supports streaming IP video cameras for security, and internet connectivity for connected functionality such as weather information retrieval.
- A simulated source provides data for energy grid status and energy costs; the system updates its data from this source, and uses it to calculate and display actual and estimated costs of energy consumption.

The reference is also designed so that its capabilities can easily be extended for network access and remote monitoring and control.

Simulated conditions and the Reference Control Application

For some of its features, the QNX Smart Energy Reference uses simulated data and sensors, which can easily be replaced with live data and feeds. A small control application is included with the reference to allow you to modify the simulated environment.

Introduction to the HMI

The QNX Smart Energy Reference is delivered with a touch screen. To select something on the touch screen, simply touch it. Of course, if the item you touch is not an active icon or other active screen component, nothing will happen when you touch it.

When the QNX Smart Energy Reference starts up it loads a home screen. This screen is shown below in Figure 2. It provides a quick overview of current conditions, as well as easy access to all functionality.

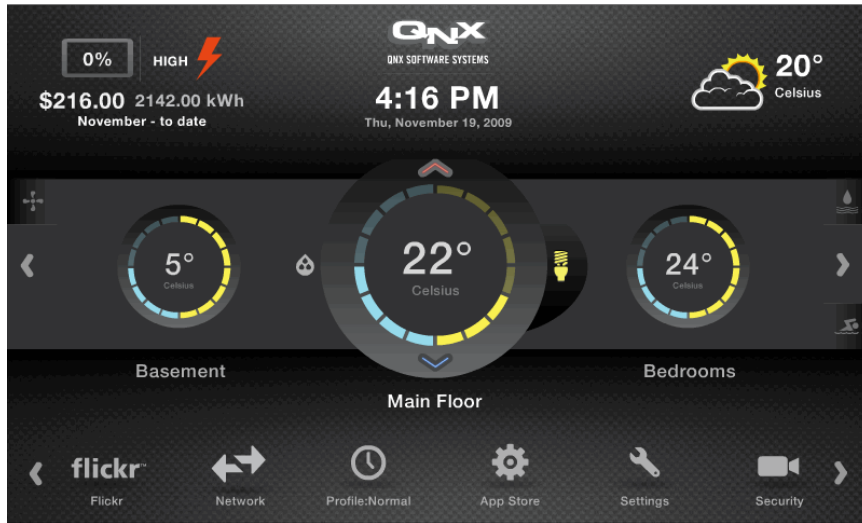


Figure 2 — QNX Smart Energy Reference application home screen

To return to the home screen from any other location, simply select the Home icon in the screen footer. This icon is highlighted in Figure 3, below.

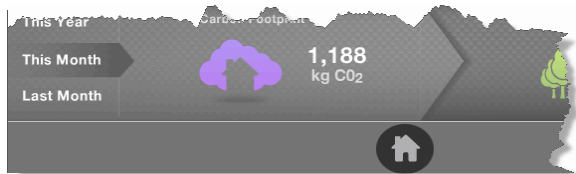


Figure 3 —“Home” icon

Home screen regions

The QNX Smart Energy Reference home screen includes three main regions, arranged in horizontal strips across the entire screen. These regions are the:

- Information strip
- Zone control strip
- Applications strip

The different Home screen strips are shown separately in Figure 4 below.



Figure 4 — Home screen regions

Information

The home screen information strip offers a quick high-level view of key information. As well as the date and time, it shows the weather conditions for the location, and energy data: month-to-date consumption and its cost, current energy prices, and the percent change in cost of consumption from the previous month.



Figure 5 — Weather information screen

This reference application uses Yahoo for its weather data. Figure 5 above shows a sample weather information screen.

The colored lightning bolt on the left part of this strip provides instant information about the current state of the grid. Different colors indicate the level of demand for energy from the grid, as follows: green (low), yellow (medium), orange (high), and red (critical).

A rise in demand would normally include a rise in cost, so a user may wish to defer using high energy consuming devices, such as the water heater or the pool pump, or even change temperature settings to reduce consumption.

In this reference application, costs and thresholds are arbitrarily set through the Reference Control Application running under Windows. A production application could access energy costs directly from the energy suppliers, and, as required to ensure lower consumption during periods of high demand, use algorithms other than the one used in the reference.

For buildings equipped to generate their own electricity, the same data could be used to determine the most profitable time to send energy out to the grid. For example, a small apartment building equipped with solar panels might choose to sell excess generating capacity back to the grid on hot, sunny weekdays, when most apartments are empty and the temperatures for these units can be allowed to rise slightly above the optimal comfort zone.

Zones

The largest part of the home screen is the Zone control strip. The larger display in the center of the screen shows, for the selected zone of the house:

- the desired temperature for the selected zone of the house
- the temperature for the selected zone of the house
- if the temperature control setting is different from the current temperature in the zone, the setting and an indicator of whether the temperature is programmed to rise (red, top) or fall (blue, bottom)
- a light usage indicator (light yellow, right side)
- a humidity indicator (light blue, left side)

Figure 6 below shows the environment controls for the currently selected zone. Note that in Figure 4 temperatures are shown in degrees Celsius, but in Figure 5 they are shown in degrees Fahrenheit.



Figure 6 — Current zone settings

To change the currently selected zone, just touch either the desired zone or the arrows on each side of the Zone control strip. Zones wrap around, so if you go only right or only left through the zones, you will eventually end up where you started.

The current implementation of the reference assumes a building with a single, central heating and cooling unit (or HVAC). Setting the temperature in a zone instructs the HVAC to heat or cool to reach the desired temperature in that zone. Temperatures in other zones are reported, but do not affect operation.

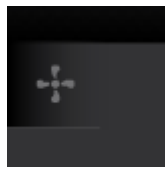
Temperatures on different floors of a house may vary by several degrees, especially during periods of extreme cold or extreme heat. Setting the temperature by zone allows you, for example, to set the temperature in winter on the second floor to 70° Fahrenheit and have the system maintain it regardless of conditions in the rest of the house. Someone baking and heating the kitchen to 78° will not cause the system to stop heating — or even begin cooling.

Buildings with electric heating or HVAC systems that permit heating control of individual rooms could easily implement discrete controls. Each control would set environmental parameters to trigger heating and cooling in its area only.

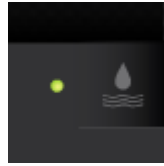
Major energy consumers

On the left and right corners of the Zone control strip, icons indicate the status of major energy consumers, in this case, the heating and cooling fans, the pool pump, and the water heater. The icons for these devices are shown in Figure 7 below.

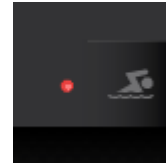
The green light next to the icon indicates that the appliance is currently on. That is, the pump or heater, etc. is currently working and drawing energy. No light means that the appliance is off. A red light indicates that the utility has signaled a spike in demand, and the appliance has been disabled.



Fan (off)



Water heater (on)



Pool pump (alert)

Figure 7 — Some Smart Energy Reference icons

You can use the Reference Control Application, described below in this document, to set values and create events that trigger these indicators and associated behaviors.

Applications

The Applications strip lists the various applications available in the Smart Energy Reference.

These applications are usually used to change default settings, view energy profile modes and so on. Most day to day monitoring, such as checking the temperature in the zone or turning off some lights, is done through the controls on the Zone control strip.

To use an application on the Applications strip simply touch its icon. For example, to change the energy profile to “Vacation” mode, simply select the Profile icon. See “Modes and Profiles” below for more information.

To change the list of applications, just touch the arrows on each side of the Applications strip. The strip wraps around, so if you go only right or only left, you will eventually end up with the list you started with.

Note that the network, app store and flickr™ applications are not yet implemented.

Using the Smart Energy reference application

If you have tried a few of the buttons on the QNX Smart Energy Reference home screen, you should have no trouble with the rest of the application.

Settings

The Settings screen is used to change global settings, such as units of measure. Currently, the only functionality implemented on this screen is a setting to select the unit of measure for temperature.

Other settings that could be added to this screen in a production system include preferred language selection, currency units, time displays (12-hour, 24-hour, military, etc.) and so on.

Heating and cooling

Heating and cooling are big energy consumers. The QNX Smart Energy Reference provides detailed monitoring, and implements detailed settings to reduce building energy consumption while maintaining comfort levels.

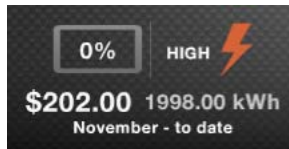


Figure 8 — Energy overview on the home screen

In addition to the basic, zone by zone settings available through the Zone control strip, the reference application offers detailed monitoring of energy consumption for the major consumers. To access this information, select the energy overview area on the information strip. Figure 8 above shows this area.



Figure 9 — Current energy cost and consumption

The first screen in the detailed monitoring and consumption profiles application shows current costs and consumption, comparisons with recent months and with the same month of the previous year, and the carbon footprint of the consumption.

Figure 9 above shows an example of this screen. Note that this example includes a high energy usage warning from the utility. The energy consumption and cost data on this screen is retrieved from a local SQL embedded database, which the reference updates hourly with new data.

Cost and consumption

The cost and consumption portion of this screen provides monthly profiles of costs and energy consumption totals. Estimates based on current usage are shown for the current and next month; these are shown alongside recorded values for the previous months and energy price trend indicators.

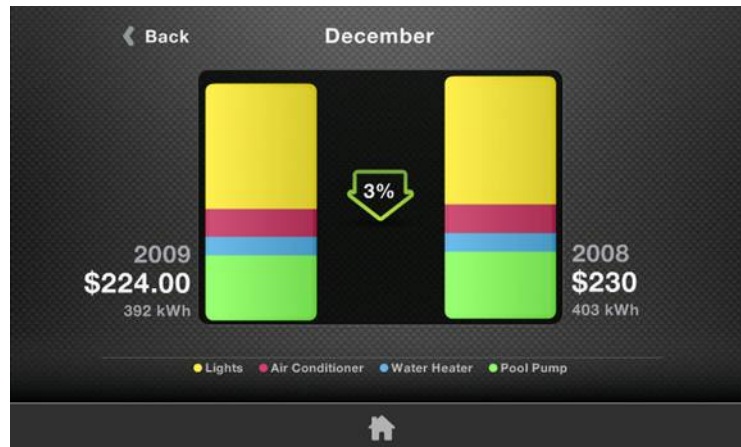


Figure 20 — Energy consumption profiles

Selecting any month opens a screen showing energy consumption breakdowns by major consumers. In Figure 20 above, lighting is clearly the big consumer.

Carbon footprint

The lower portion of the screen shows the building's carbon footprint, and the approximate number of trees required to offset it. As carbon offset markets become more established, these carbon footprint values could of course be connected to these markets for individual trading.

Modes, profile and rules

The QNX Smart Energy Reference uses four configuration levels to facilitate energy-savings: modes, profiles, rules and exceptions.

For this delivery, the reference has been implemented with only the Normal mode. Summer and Vacation are currently for display only. A mode has profiles, which are currently weekday and weekend, but which could be changed to individual days or some other time periods. Profiles are created and modify by adding, removing and changing rules. Rules are set for major individual energy consumers such as the HVAC or major appliances. They specify when energy consumers are enabled or disabled during a day, temperature settings and so on. Rules may also have exceptions, which alter the rules based on variables such as energy prices or demand.

Selecting the Profile icon on the home screen's Applications strip opens the currently active profile. Figure 21 below shows a Vacation mode weekday profile, with three rules.



Figure 21 — Energy consumption profiles

Each rule sets the operational parameters for a major energy consumer based on the day of the week and the time of day. The colored background provides a visual clue to help users set profiles to reduce energy consumption during periods of high demand. Currently these periods are fixed, but a production implementation could adjust them based on trend data supplied by the utility company over the network.

To add, remove or change rules, simply select the appropriate label or icon on the screen. Note, for example, that you can specify the days on which a Profile applies. Figure 22 below shows a sample rule creation screen.

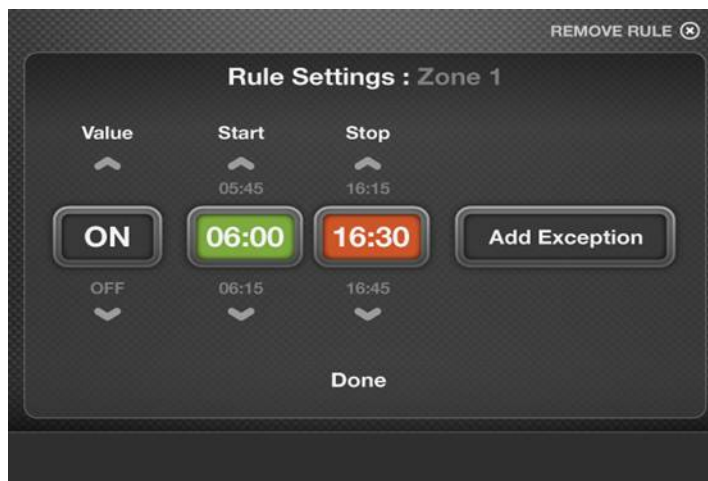


Figure 22 — Energy consumption profiles

Exceptions

Exceptions override behaviors defined by rules. You can set exceptions that use external variables to determine special behaviors in exceptional circumstances, such as when the grid load is critical. For example, you can add an exception to a rule for a pool pump to disable it if the grid load is high. Similarly, in Summer mode, you could add an exception to increase the desired room temperature and reduce air conditioning when the grid load is critical. Currently the reference can use high and critical grid load for exceptions; it is designed, however, to easily extend to use other variables, such as energy cost, and other thresholds.

To try some exceptions, configure them, then use the control application to change the grid load.

Lighting

The QNX Smart Energy Reference implements lighting controls to adjust lighting manually or according to timer settings via an Insteon power-line based communication network. To access the lighting controls for a specific zone, simply go to the zone in the home screen's Zone control strip, then select the lighting icon shown in Figure 23 below.



Figure 23 — Lighting icon

Zones

As described in the description of the Home screen above, the QNX Smart Energy Reference divides a building — or buildings — into separately monitored and controlled zones. You can set lighting controls and parameters for these zones, just as you do for temperature.

Figure 24 below shows a sample lighting control screen. Note that the menu on the left lets you select:

- an individual light in the current zone
- all the lights in the current zone
- all the lights in the building



Figure 24 — Lighting controls with time set

Note that this menu allows you to control overall building lighting from any zone's lighting control screen.

To adjust lighting, select a light or lights from the menu, then use the slider to set the light intensity.

Timers

In Figure 24 above, the clock face beside the name indicates that Sun Room Light 1 has an active timer set. Because this light is currently selected, the clock face to the right of the screen is lit, with the timer parameters below: at 4:00 PM, the light will be switched off.

To change time settings for a light or group of lights, select it then select the clock icon to the right of the screen. On the timer configuration screen, set the desired on and off times and intensity.

Security

The QNX Smart Energy Reference includes a simple security application that displays streaming MPEG-4 video from IP cameras from two different locations. For configurations that do not have IP cameras connected to the system, the system can be configured to play video from saved sources. This saved source can be MPEG-4 video, which is used for the standard streamed video, or flash video (.flv files) for boards that do not support the MPEG-4 decoder.

To receive live video, it is a simple matter of adding cameras to the system, and changing the URL where the application looks for the streamed source from these cameras.



Figure 25 — View from a security camera

The possibilities offered by this application are limited only by the camera capabilities. In the reference, ringing the doorbell triggers the relevant camera and switches the display to the video from that camera. Voice- and/or motion-activated cameras can easily be added inside or outside to do anything including monitor a child's crib.

Smart Energy Reference architecture

The QNX Smart Energy Reference implements Flash Lite HMI applications running on a Flash Lite 3 player, running on the QNX Neutrino RTOS.

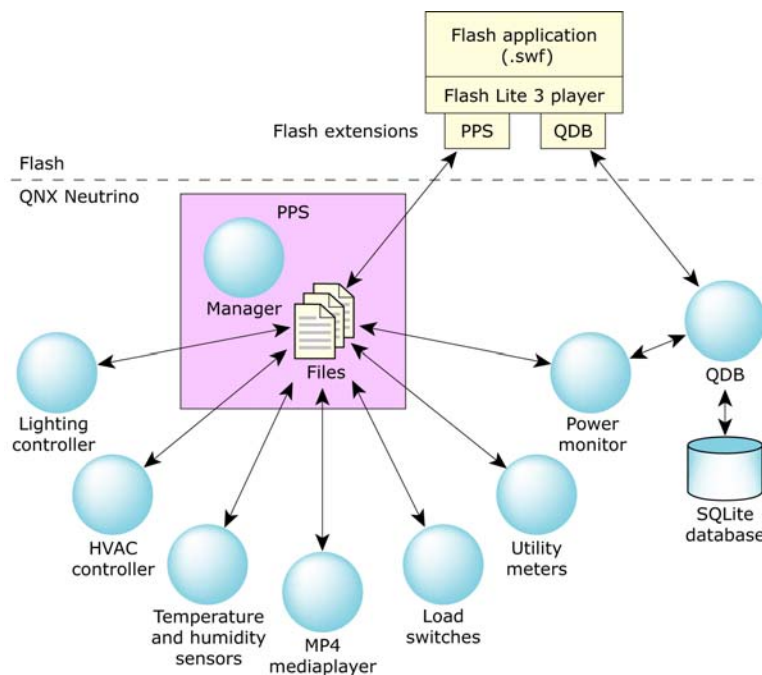


Figure 26 — QNX Smart Energy Reference architecture

The QNX HMI Suite provides the Action Script extensions that permit the Flash applications to interface with QNX Neutrino RTOS services and device drivers. Figure 26 shows a high-level view of the reference architecture, with a sample of applications.

The QDB (QNX data base) resource manager provides access to an SQLite database, which stores data such as energy usage and prices, and system settings. The PPS (Persistent Publish/Subscribe) service provides communication between the HMI, the various applications, and the sensors and devices (real or simulated) on the system.

For more information about PPS and QDB, see the PPS Developer's Guide and the QDB Developer's Guide, which are part of the standard QNX Neutrino documentation.

QNX Smart Energy Reference Control Application

The Reference Control Application provided with the QNX Smart Energy Reference allows you to generate specific events to trigger and test how the reference behaves, as well as monitor processor use during operation. Figure 27 below shows the control application screen controls.

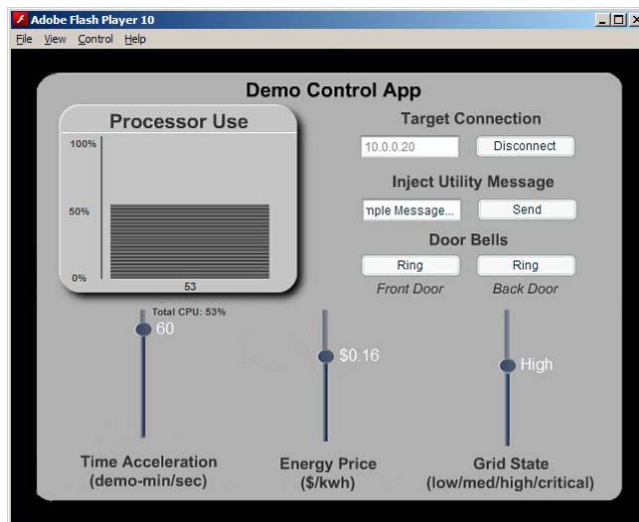


Figure 27 — QNX Smart Energy Reference Control Application

You can use the control application to, for example, ring door bells and trigger a security camera; or increase energy prices or the grid load to trigger exceptions to profile rules.

Time accelerator

The time accelerator increases the demo clock speed. You can use it to speed through a 24 hour day or even a week in a few minutes to view the effects produced by changes to settings.



About QNX Software Systems

QNX Software Systems, a Harman International company, is the leading global provider of innovative embedded technologies, including middleware, development tools, and operating systems. The component-based architectures of the QNX® Neutrino® RTOS, QNX Momentics® Tool Suite, and QNX Aviage® middleware family together provide the industry's most reliable and scalable framework for building high-performance embedded systems. Global leaders such as Cisco, Daimler, General Electric, Lockheed Martin, and Siemens depend on QNX technology for vehicle telematics and infotainment systems, industrial robotics, network routers, medical instruments, security and defense systems, and other mission- or life-critical applications. The company is headquartered in Ottawa, Canada, and distributes products in over 100 countries worldwide.

www.qnx.com