ECHELON®

Street Light Bridge Integrator's Guide

SECOND REVIEW DRAFT

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Echelon Corporation
www.echelon.com

Welcome

Intelligent street lighting uses electronic ballasts, power line communications hardware, and local network controllers that are interconnected with specialized control and reporting software. A street lighting network establishes two-way communications with each lighting fixture so that you can control the lighting level of each fixture, turn it on and off, and monitor its condition.

The luminaires in a street lighting network use a LONWORKS® power line communications channel for the network, which is managed by an Echelon *i*.LON® SmartServer, known as the Segment Controller because it controls segments of the street lighting network. To extend the network across low-voltage step-down distribution transformers, Echelon introduces a power line and radio frequency (RF) wireless hybrid device, the Street Light Bridge module.

This document describes the elements of the Echelon street lighting solution, including the Street Light Bridge module and the Segment Controller.

Audience

This document assumes that you understand basic networking and that you have some experience working with an *i*.LON SmartServer. It also assumes that you understand the basics of a low-voltage power distribution network.

Related Documentation

The following manuals are available from the Echelon Web site (www.echelon.com) and provide additional information that can help you manage a street lighting network:

- *i.LON SmartServer 2.0 User's Guide* (078-0345-01E). This document describes how to configure the *i*.LON SmartServer and use its applications to manage control networks.
- *Introduction to the LONWORKS Platform* (078-0183-01B). This manual provides an introduction to the ISO/IEC 14908-1 (ANSI/CEA-709.1 and EN14908) Control Network Protocol, and provides a high-level introduction to LONWORKS networks and the tools and components that are used for developing, installing, operating, and maintaining them.

All of the Echelon documentation is available in Adobe® PDF format. To view the PDF files, you must have a current version of the Adobe Reader®, which you can download from Adobe at: get.adobe.com/reader.

FCC Compliance

If the wide-are network (WAN) Card will be integrated into an American National Standards Institute (ANSI) Internet protocol (IP) Meter, and used within the United States of America, then the complete ANSI IP Meter (including the WAN Card) must comply with United States Federal Communications Commission (FCC) regulations. In addition, the accompanying documentation for the complete product would need to include a notice such as the following:

This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the FCC Rules per sections 15.107 and 15.109. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the manufacturer's instruction manual, may cause interference with radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, you are encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that which the receiver is connected.
- Consult the dealer or an experienced radio/television technician for help.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

RF Statements

This equipment also complies with the limits for wireless devices per FCC sections 15.203, 15.205, 15.207, 15.209 and 15.247. It uses frequency 2.4 GHz per Institute of Electrical and Electronics Engineers (IEEE) standard 802.15.4-2006, and uses a frequency bandwidth from 2400 MHz to 2483.5 MHz.

This equipment complies with the FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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Introduction

This chapter introduces the Echelon Street Lighting Solution.

The Echelon Street Lighting Solution

Energy and maintenance costs are increasing for municipal street lighting. Recent studies show that the electricity used for street lighting can account for up to 40% of municipal electric bills. With an estimated 90 million street lights in Europe and 63 million in North America, efficient use of energy for street lighting is important, both for economic reasons and for environmental reasons. Fortunately, components and systems are now available to manage, monitor, and reduce that electricity demand.

Such a system incorporates several key elements: electronic ballasts, power line communications hardware, and local network controllers that are interconnected with specialized control and reporting software. Together, they create a flexible and powerful control system that simplifies day-to-day operations and facilitates the implementation of cost-cutting strategies. Establishing two-way communications with each lighting fixture in a street lighting network allows you to control the lighting level of each fixture, turn it on and off, and monitor its condition.

Because each luminaire in a street lighting network is already connected to the power grid, defining a power line communications channel for the network is a straightforward way to establish two-way communications with each lighting fixture. However, in many countries, there are a limited number of luminaires per low-voltage service distribution transformer, and, in general, a power line channel cannot maintain communications across a transformer.

Echelon introduces the Echelon *Street Light Bridge module*: a power line and wireless hybrid device that allows communications to bridge the low-voltage service distribution transformers, and manage an extended street lighting network.

Figure 1 on page 11 shows part of a basic street lighting network, with a SmartServer Segment Controller, several street lights, a service distribution transformer, and a pair of Street Light Bridge Modules. The Segment Controller uses power line communications to communicate with the street light luminaires and the Street Light Bridge modules. The Street Light Bridge modules use radio frequency communications to communicate with each other, and thus provide a communications bridge across the service distribution transformer.

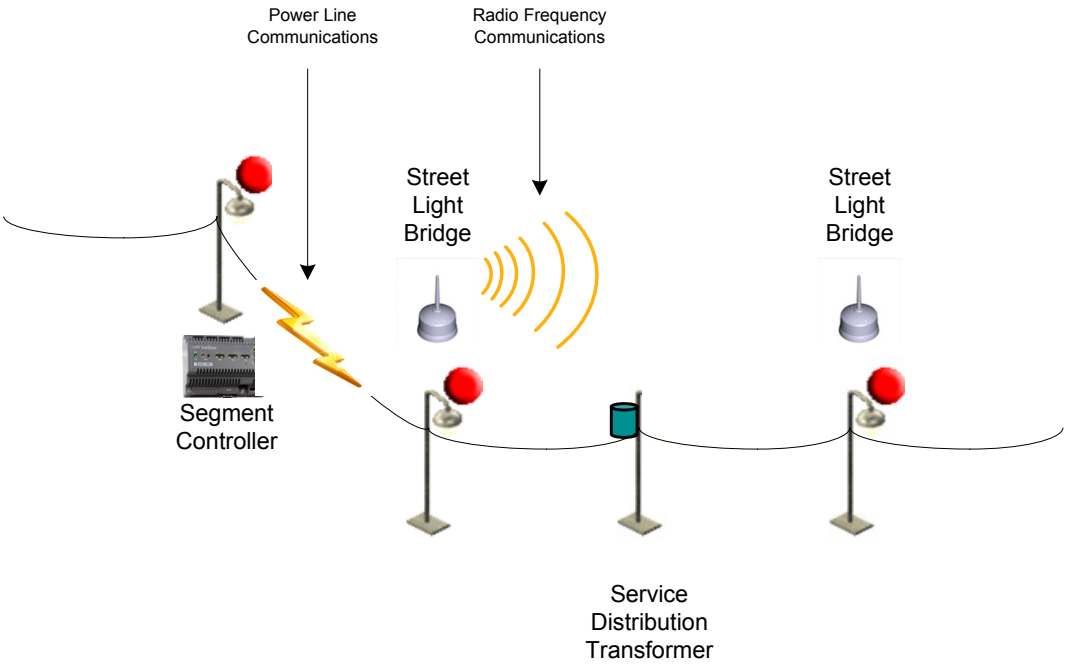


Figure 1. A Basic Street Lighting Network

Because the Street Light Bridge module provides both ISO/IEC 14908-1 Control Network Protocol power line communications and IEEE 802.15.4 (2.4 GHz) radio frequency (RF) wireless communications, the street lighting network can leverage the existing power line circuits to communicate with the luminaires, and create small RF bridges to bypass the service distribution transformers. Each Street Light Bridge module manages RF communications with other Street Light Bridge modules, so that you do not need to set up and manage a complex RF network – you simply install Street Light Bridge modules to extend power line communications for the street lighting network.

You manage and control the street lighting network using an Echelon SmartServer, known as the Segment Controller because it controls segments of the street lighting network. A Segment Controller can consolidate data from half a dozen or more service distribution transformers in a municipal residential environment, allowing you to manage and control up to 200 devices – luminaires and Street Light Bridge modules. For larger street lighting networks, you can install additional Segment Controllers.

The Segment Controller

The Segment Controller is a SmartServer 2.0 (or later) that is configured to manage a street lighting network. You use it to configure the power line channel for repeating, so that each luminaire and Street Light Bridge module can forward messages to luminaires and to Street Light Bridge modules within the network, and you use it to define operational schedules for the luminaires.

See Chapter 3, *Setting Up the Segment Controller*, on page 27, Chapter 5, *Managing a Street Lighting Network*, on page 47, and Chapter 6, *Controlling a Street Lighting Network*, on page 77, for more information about the Segment

Controller. See the *i.LON SmartServer 2.0 User's Guide* for more information about the SmartServer.

Luminaires and Street Light Controllers

Each street light in an intelligent street light network must be able to communicate over a LONWORKS power line communications channel. Thus, each luminaire must include a LONWORKS power line communications chip (such as an Echelon Power Line Smart Transceiver). If the luminaire does not already include power line communications, you can add a street light controller[1] to either the luminaire or the street light pole to provide power line communications.

A luminaire in a street lighting network remains on until it is commissioned by the Segment Controller. After it is commissioned, the luminaire turns on or off based on the schedule defined for it by the Segment Controller.

Street Light Bridge Modules

A Street Light Bridge module is a power line channel device that extends the communications range of the Segment Controller. A Street Light Bridge module uses the Institute of Electrical and Electronics Engineers (IEEE) wireless personal area network standard 802.15.4 for radio frequency (RF) communications to allow it to bypass service distribution transformers and extend the street lighting network.

The primary function of a Street Light Bridge module is act as a repeater for the street lighting network. A Street Light Bridge module can repeat network packets on the power line channel, an RF channel, or both. The Segment Controller determines both the route and channel type that the Street Light Bridge module should use for repeating.

Figure 2 on page 13 shows a simple repeating chain that could be used to relay a network management command from the Segment Controller to a target device (a luminaire in this case, but it could be a Street Light Bridge module). In this example, the repeating chain consists of Repeating Device 1 (a Street Light Bridge module), which relays the message to Repeating Device 2 (a repeating-enabled luminaire), which relays the command to Repeating Device 3 (a Street Light Bridge module), which relays the message to the target device (a luminaire). A luminaire enabled for repeating would use power line repeating. A Street Light Bridge module could use power line repeating or forward the message using an RF channel to another Street Light Bridge module.

[1] Street light controllers that provide power line communications are available from companies such as Superior Electronic Lighting Controllers (SELC Ireland Limited), Koninklijke Philips® Electronics.N.V., ROMlight™ International Inc, SCS StreetLight Control Solutions, S.L., Citylone, Luminext BV, and Siteco Beleuchtungstechnik GmbH.

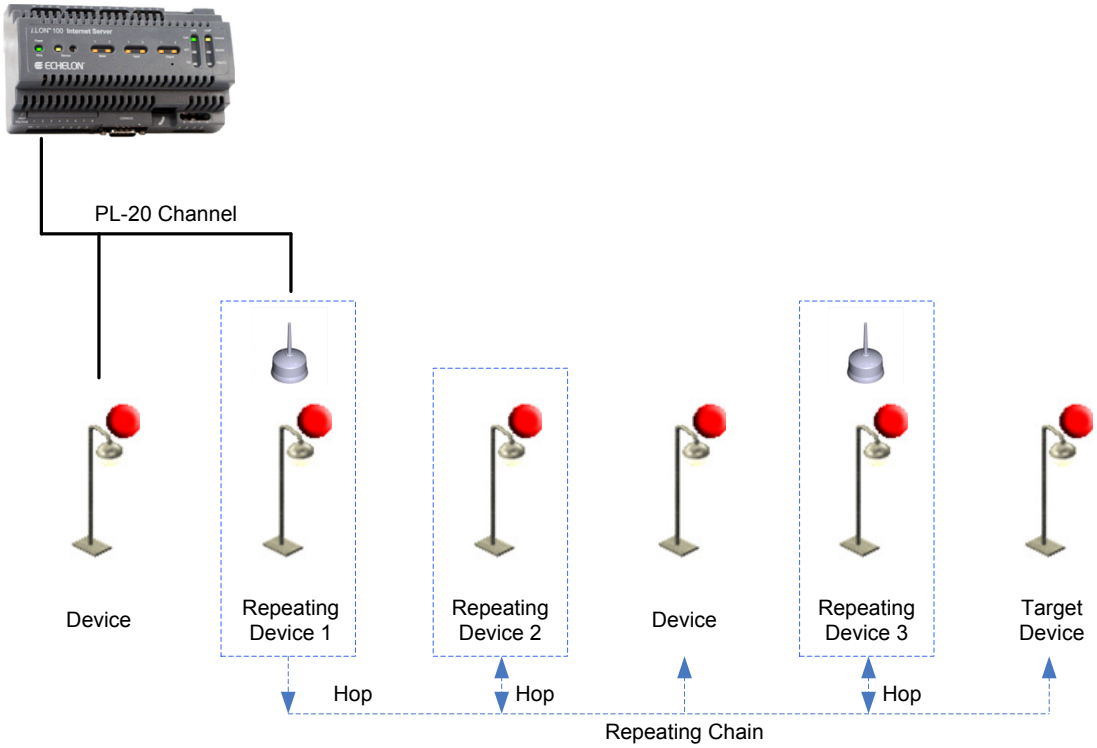


Figure 2. An Example Repeating Network

Each time that a message is repeated, on either channel type, is a *repeater hop*. A message within a street lighting network must be able to reach its destination in eight or fewer hops. That is, there can be no more than eight repeater hops on the path (power line, RF, or both) between the Segment Controller and the luminaire for which a message is destined. **Figure 2** shows three hops between the Segment Controller and the target luminaire.

From a LONWORKS network point of view, a Street Light Bridge module acts like any other power line device: It has a number of network variables that are used to provision the Street Light Bridge module and collect status and statistics.

Installation of a Street Light Bridge module is similar to installation for any power line device. You must add it to the Segment Controller, either by providing the Segment Controller with the Neuron ID for the Street Light Bridge module, or by allowing the Segment Controller to automatically discover and commission the Street Light Bridge module. In either case, power and RF communication LEDs on the Street Light Bridge module provide a visual cue to the installer that the Street Light Bridge module is operational. Additional configuration of the Street Light Bridge module is generally not necessary, but advanced configuration options are available.

Benefits of Managed Street Lighting

A managed street lighting network can offer many benefits, including:

- Electricity use can be reduced – in one installation, by as much as 45%, which in turn resulted in a 30% reduction in streetlight electricity costs (US$ 80 000 per year for this installation).

- Reduction in carbon dioxide (CO_2) emissions – in one installation, by 70 tons per year (corresponding to the 45% reduction in electricity use).
- Lamp failures can be identified within hours, reducing average lamp downtime by as much as 90%.
- Alarms can be triggered when lamp voltage exceeds recommended levels, preventing future lamp failures.
- Reduction in lamp replacement costs – for one installation that uses electronic ballasts that regulate high-pressure sodium lamps, lamp replacement costs were reduced by 20%.
- Because software enables most operations to be performed remotely, the number of onsite maintenance operations can be reduced – in one installation, by at least 30%.

The SmartServer as the Segment Controller can serve as a gateway for a variety of devices types. It provides:

- Universal connectivity for devices attached to it, making data available to a city's IT system.
- Local device monitoring and control through built-in scheduling, alarming, and data logging applications.
- An astronomical clock, which is used to automatically switch lamps on and off, thus reducing lamp burning hours and saving energy (compared to a fixed scheduler or to photocells).

The SmartServer is the streetlight segment controller and logs and reports lamp failures, lamp behavior (dimming level and voltage), energy use, and burning hours. It could also collect information from traffic and weather sensors to adapt lamp dimming levels. The astronomical clock switches lamps off and on depending on the position of the sun. Lamps are dimmed at a fixed time, using the SmartServer's internal scheduler, during low activity hours at night. This highly efficient method of controlling light levels results in significant energy savings. Lamp lifetime is extended due to the way electronic ballasts regulate the lamp.

Examples

Cities, counties, and other local authorities need ways to contain their expenses and limit local taxes while increasing the level of service and security they provide to citizens.

For example, the portion of the United Kingdom budget that is related to streetlight services is estimated at more than UK£ 280 million per year, of which 40 percent is spent on energy. As another example, the electricity costs for the city of Los Angeles, California, with 270 000 streetlights, is estimated at over US$ 17 million per year. Streetlights are the main electricity consumer in a modern city.

In Milton Keynes, U.K., the managed street lighting system includes dimming controls that lower light output by 2 lux between the hours of 10 PM (22h00) and 5 AM (05h00). As a result, the city has reduced its electricity use by 30%. Furthermore, Milton Keynes installed white light lamps that, in addition to

offering far longer operating life, have helped the city improve its closed-circuit television (CCTV) image capturing system for increased public safety.[2]

As stated by the city of Oslo, Norway, in November 2004, cities that take advantage of today's new technologies and solutions can reduce the overall costs associated with streetlight networks by almost 50%, while increasing the quality of service and safety. The city of Oslo and its energy supplier have shown that deploying a solution based on electronic programmable and dimmable ballasts that identify and communicate failures over power lines using a standardized protocol can pay for itself immediately.[3]

Street Lighting Solution Restrictions

The following restrictions apply to a street lighting network:

- Each Segment Controller supports up to a total of 200 devices (luminaires plus Street Light Bridge modules).
- A Street Light Bridge module must be within 85 meters (275 feet) of another Street Light Bridge module and should have direct line of sight in all seasons.
- Each Segment Controller supports up to eight repeating hops to any device (luminaire or Street Light Bridge module). However, during installation, there can be no more than six hops (power line or RF) between any luminaire and the Segment Controller. After installation, it is possible to add hops (power line or RF), up to the maximum of eight, between a luminaire and the Segment Controller.

[2] *Source: HBS Case Study, Netherfield Improved Lighting System, Milton Keynes Council, May 2007.*

[3] *Source: Hafslund presentation, November 2004.*

2

Installation for the Street Lighting Solution

This chapter describes installation for a street lighting network.

Overview

The process for installing a street lighting network includes the following basic tasks:

- Install a Segment Controller
- Install luminaires
- Install Street Light Bridge modules, as needed

For a typical new installation, you install the Segment Controller first. However, you could install luminaires (or have already existing luminaires), and then install the Segment Controller. In either case, you install Street Light Bridge modules, as needed, to enable and extend the network. A single Segment Controller can support up to 200 devices, including both luminaires and Street Light Bridge modules.

For an existing installation, typically the luminaires and the Segment Controller are already installed. In this case, you can add additional luminaires to define additional network segments, or you can install Street Light Bridge modules to enable and extend the communications range for the network.

To decide when to install a Street Light Bridge module, you generally install luminaires and add them to the Segment Controller (or allow the Segment Controller to automatically discover and commission the luminaires), then verify that they were all commissioned. If any of them could not be commissioned, install a Street Light Bridge module near one of the commissioned luminaires (to be sure that the Segment Controller can communicate with the newly installed Street Light Bridge module). Then, you install a companion Street Light Bridge module at the luminaire that could not be commissioned so that the Segment Controller can discover and commission it.

If there are additional uncommissioned luminaires after the installation of the first pair of Street Light Bridge modules, you can add additional Street Light Bridge modules, for example, at the end of the first uncommissioned street light chain and the start of the next chain.

You can repeat these three steps many times to install a complete street lighting solution. Typically, you install hundreds or thousands of luminaires, a small number of Segment Controllers, and dozens or hundreds of Street Light Bridge modules. How many Street Light Bridge modules are required depends on the number of luminaires each service distribution transformer supports, and on the kind of network topology that is required for the street lighting solution.

New Installations

Figure 3 on page 19 shows an overview of the basic process for installing intelligent street lights with Echelon's Street Light Bridge technology. The process includes the following basic steps:

1. Install a Segment Controller
2. Install luminaires
3. Install Street Light Bridge modules, as needed

Alternatively, you can install the luminaires, and then install the Segment Controller. However, this document does not describe details for this alternate installation scenario.

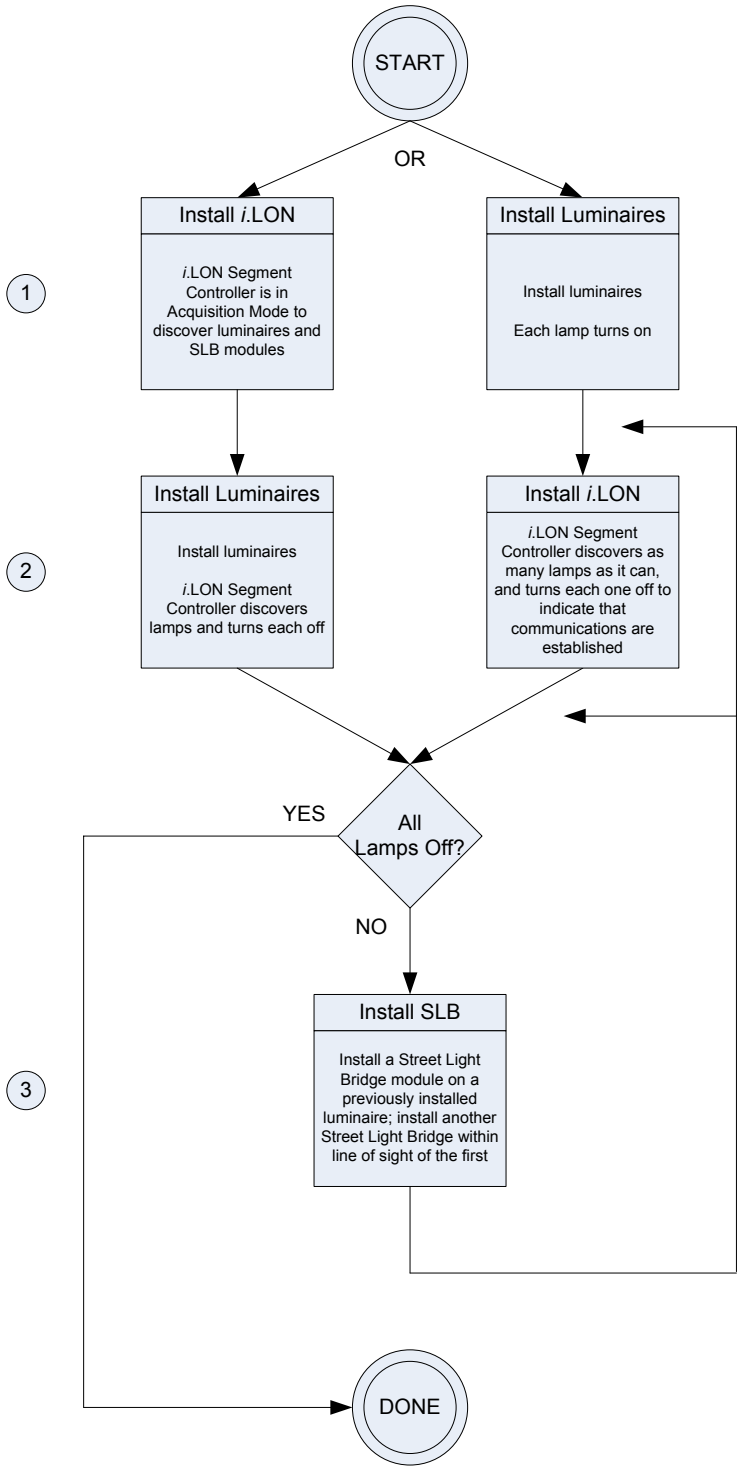


Figure 3. Basic Street Lighting Installation Process

After your initial network of the Segment Controller and luminaires is defined, you can add Street Light Bridge modules to extend the communications range of the network.

Step 1: Install the Segment Controller

Configure the Segment Controller (see Chapter 3, *Setting Up the Segment Controller*, on page 27) and install it at any convenient location for the street lighting solution. For example, you can install it on one of the street light poles or utility poles (typically below the neutral space) within the area for the street lighting solution. Ensure that the Segment Controller has power.

Place the Segment Controller into Acquisition Mode; see *Automatically Discovering Devices* on page 30. While in Acquisition Mode, the Segment Controller continually attempts to discover devices (luminaires and Street Light Bridge modules) on the power line network. In Acquisition Mode, the Segment Controller's Service LED flashes at 4 Hz.

As the Segment Controller establishes communications with each luminaire and commissions it, the Segment Controller turns the lamp off.

Note that if you install luminaires first, all of the lamps within the network stay on until you install the Segment Controller. Some installations might require several days of installation time, so some of the lamps could remain on for one or more days.

Recommendation: For installations in which the luminaires are managed by monitoring software (such as Streetlight.Vision Data Collect) and have group switching established, install the Segment Controller during the day so that the schedule defined by the monitoring software can specify the luminaire's behavior (that is, the schedule should specify that lamps are off during the day) as the Segment Controller establishes communications with each luminaire. Thus, you can receive visual confirmation that the Segment Controller has established communications with each luminaire.

When all of the lamps are off, the installation is complete. For any that do not turn off, proceed to Step 3 to install Street Light Bridge modules; the Segment Controller will discover and commission the installed luminaires through the Street Light Bridge modules.

Step 2: Install Luminaires

Install one or more luminaires. Each luminaire's lamp should turn on to indicate that it has power.

Allow the Segment Controller to discover and commission each installed luminaire. If you install the luminaires before the Segment Controller, record each luminaire's physical location so that you can enter this information into the SmartServer Device Web page for each luminaire. For example, record the luminaire's GPS coordinates, pole ID, or map grid reference.

If you install the Segment Controller before any of the luminaires, the Segment Controller will discover and commission each luminaire as it is installed. If a given lamp does not turn off within approximately two minutes, you should assume that the Segment Controller cannot communicate with the luminaire, and you should proceed to step 3.

If you install the luminaires before the Segment Controller, the Segment Controller will discover and commission all of the luminaires; however, this process could take some time.

After an installed luminaire is discovered and commissioned by the Segment Controller, the lamp should turn off. For any that do not turn off, proceed to Step 3 to install Street Light Bridge modules; the Segment Controller will discover the installed luminaires through the Street Light Bridge modules.

Step 3: Install Street Light Bridge Modules

Install a Street Light Bridge module to extend the communications range of the Segment Controller.

Return to any previously installed luminaire for which the lamp is off (that is, it has communications with the Segment Controller). Install the Street Light Bridge module on the luminaire or on a pole near the luminaire, and record its physical location (GPS coordinates, pole ID, or map grid reference) and its Neuron ID (the barcoded number printed on or attached to the module); or alternatively, let the Segment Controller automatically discover and commission the Street Light Bridge module.

You can install the Street Light Bridge module in the luminaire's photocell receptor after removing the photocell. For luminaraires that do not have a photocell receptor, you need to add a locking-type photocontrol receptacle that conforms to the ANSI C136.10 standard.[4] Insert the module into the photocell receptor or locking-type photocontrol receptacle, and turn the module ¼ turn clockwise to lock it into position.

The Street Light Bridge module has a green LED to indicate that it is receiving power. In addition, if this LED is on solid, the Street Light Bridge module has been discovered and commissioned by the Segment Controller; if this LED is flashing slowly, the Street Light Bridge module has not yet been commissioned.

Install a second Street Light Bridge module on a luminaire (or on a nearby pole) for which the lamp is on (that is, the luminaire does *not* have communications with the Segment Controller). This second Street Light Bridge module should have direct line-of-sight with the previously installed Street Light Bridge module. Ensure that the two modules are within 85 meters (275 feet) of one another.

Verify that the newly installed Street Light Bridge module's amber LED is on to indicate that the module has good radio frequency (RF) communication with a previously installed module; see *Verifying Successful Installation* on page 22. If the newly installed Street Light Bridge module does not have a sufficient RF signal with a nearby Street Light Bridge module, reinstall the Street Light Bridge module in a different location (perhaps closer to or within a different line-of-sight of a previously installed Street Light Bridge module).

After you install the second Street Light Bridge module, wait a few minutes for the Segment Controller to discover and commission it. When the Street Light Bridge module's green LED is on solid, the module has been discovered and commissioned. Within a few more minutes, one or more lamps should turn off as

[4] Locking-type photocontrol receptacles are available from companies such as Ripley Lighting Controls (for example, their 5927 or 5926 Receptacle With Cast Housing can accommodate the Street Light Bridge module).

the Segment Controller discovers and commissions the luminaires. If all of the lamps are off, the installation is complete.

For those lamps that do not turn off, install additional Street Light Bridge modules to further extend the communications range of the Segment Controller.

If a newly installed Street Light Bridge module does not cause any lamps to turn off (perhaps because the newly installed module exceeds the maximum hop count or range), it is likely that you need return to step 1 to install a new Segment Controller.

Step 4: Complete Installation

After all of the luminaires, the Segment Controller, and the Street Light Bridge modules are installed, you can establish remote communications with the Segment Controller and can manage the installed network. For example, you can modify the installation information (the Neuron IDs and physical location information) for each of the luminaires and Street Light Bridge modules, and define schedules for the lights within the network. These tasks are typically performed by a network integrator.

Recommendation: For installations in which each luminaire has its photocell removed to allow network communications to manage the luminaires (for example, a typical US installation), install a small number of luminaires (perhaps 20 to 30) and Street Light Bridge modules each day so that you can minimize the amount of time that any luminaire remains on (out of communications with the Segment Controller).

For installations in which the luminaires are managed by monitoring software (such as Streetlight.Vision Data Collect) and have group switching established, normal switching operations control the lamps' behavior (that is, they are off during the day and on at night). Thus, for such preconfigured networks, you can install as many luminaires as required for the project without concern for the amount of time that any luminaire remains on.

Existing Installations

Installation for existing street lighting networks is similar to installation for new networks. In general, you can add new luminaires and Street Light Bridge modules to add new segments to the network, or you can relocate, reassign, or replace existing luminaires or Street Light Bridge modules based on the needs of the network.

If a luminaire or Street Light Bridge module fails, you can use the Segment Controller Web pages to determine which device is bad. You can physically replace the failing device, and then replace it in the Segment Controller by assigning a new Neuron ID to it and recommissioning it. See Chapter 5, *Managing a Street Lighting Network*, on page 47, for more information about these tasks.

Verifying Successful Installation

You can verify a successful Street Light Bridge installation in two ways:

- Verify the states of the power LED and the RF signal LED

- Query the status of the Street Light Bridge module from the Segment Controller

See *Testing Devices* on page 72 for more information about using the Segment Controller to verify Street Light Bridge installation.

Both Street Light Bridge LEDs are off initially, but the green power LED turns on as soon as possible after you supply power to the device. The state of the power LED depends on the state of the Street Light Bridge module:

- If the Street Light Bridge module is configured and running normally, the power LED is on solid.
- If the Street Light Bridge module is not configured, but is otherwise operating normally, the power LED flashes at a ½ Hz rate.
- If there is an error during initialization, or if the cause of reset was a watchdog reset, the power LED flashes at a 4 Hz rate. You can manually reset the device to clear the cause of reset.

Generally, although a rapidly flashing power LED indicates some problem, the Street Light Bridge module operates normally if it can. Thus, you should be able to query the error log and attempt to fix the problem.

The orange RF signal LED is used during installation to indicate whether the Street Light Bridge module can establish RF communications with a nearby Street Light Bridge module. If so, the RF signal flashes in a pattern that represents the signal quality, as shown in **Figure 4**.

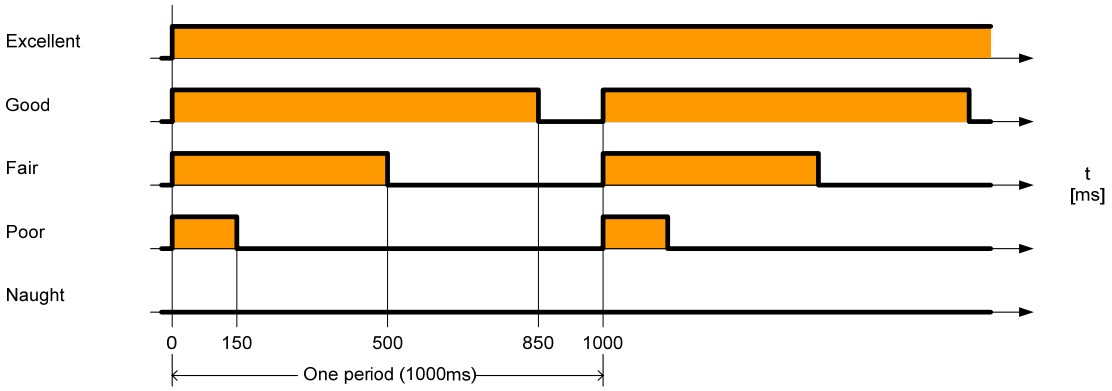


Figure 4. RF Signal Quality as Represented by the RF Signal LED

The flashing pattern of the RF signal LED allows the installer to confirm good RF communications with nearby Street Light Bridge modules without having to return to the Segment Controller.

However, these RF communications could possibly be with an unrelated street lighting network that uses a different Segment Controller than the network into which you installed the Street Light Bridge module. Thus, you should ensure that the Street Light Bridge module can communicate with its Segment Controller.

By default, both LEDs turn off after one hour. You can modify this timeout value by updating the **nciLedTimeout** configuration network variable. Setting this configuration network variable to zero disables LED shutoff (that is, the LEDs remain on or flashing indefinitely).

Example Installations

You can install Street Light Bridge modules in almost any configuration to provide power line and radio frequency communications for street lights within a street lighting solution.

In the figures, the arrows represent RF communications between the Street Light Bridge modules. Although the street lights in the figures are shown in straight lines, they could be in any physical configuration.

Basic Installation

Figure 5 shows a basic installation with a Segment Controller and two Street Light Bridge modules. The Segment Controller uses the power line communications channel for the nearest set of luminaires, and two Street Light Bridge modules provide the communications bridge across the service distribution transformer to cross electrical phases.

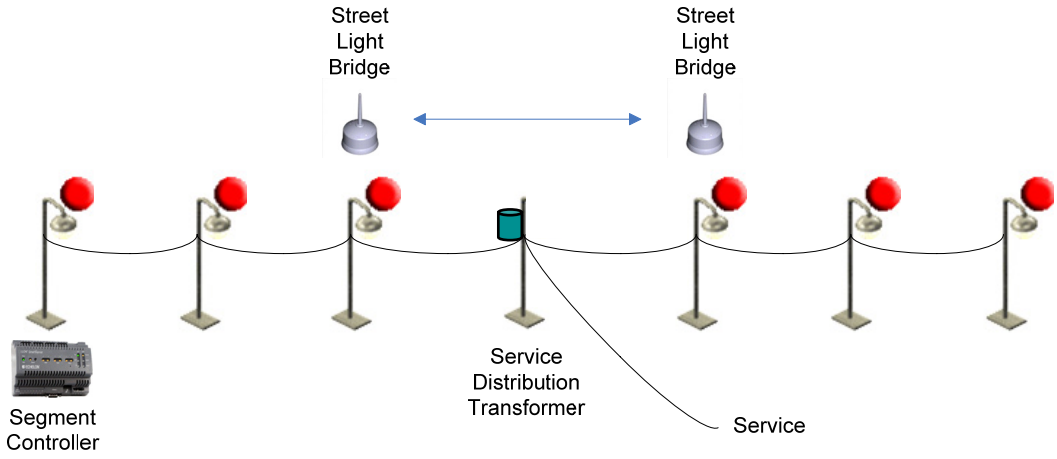


Figure 5. Basic Street Light Bridge Installation

Extending a Basic Installation

A single Street Light Bridge module can communicate with more than one companion Street Light Bridge module to define a more complex configuration. **Figure 6** on page 25 shows an extension to the configuration shown in **Figure 5**. A single Street Light Bridge module communicates with three Street Light Bridge modules to further extend the range of the Segment Controller and provide communications to a greater number of luminaires. **Figure 6** also shows communications with luminaires that do not share a power line connection with the Segment Controller.

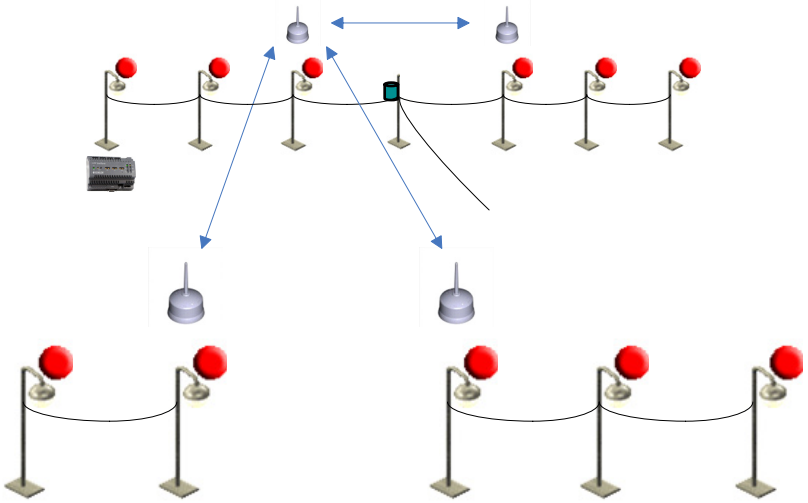


Figure 6. Extending the Street Light Bridge Installation

Adding Multiple RF Hops

Because Street Light Bridge modules provide communications across power line boundaries, you can connect them in a series to provide maximum range extension. **Figure 7** shows such an extension from the configuration shown in **Figure 6**. By adding Street Light Bridge modules in series as shown in the bottom portion of **Figure 7**, you can create complex networks to provide power line and RF communications for almost any physical configuration of luminaires in a street lighting solution.

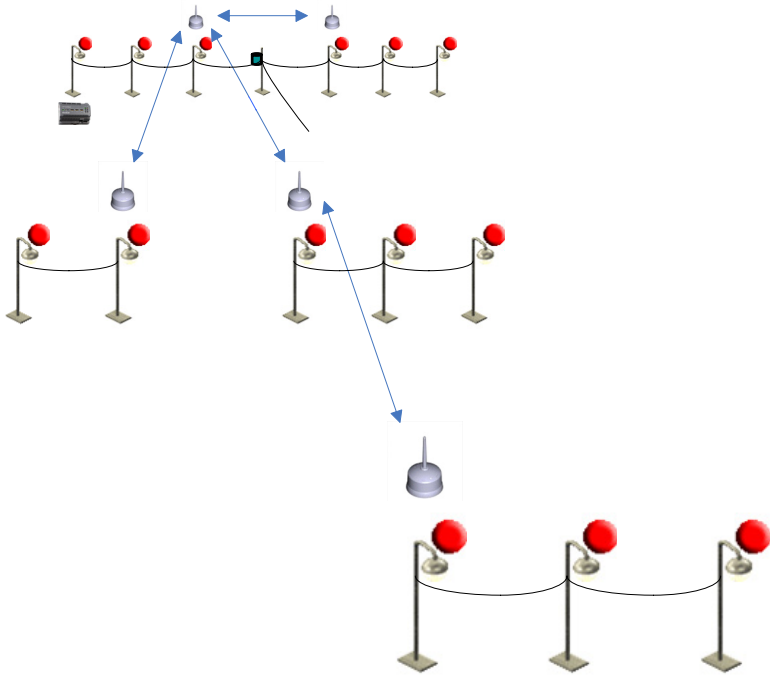


Figure 7. Adding Multiple RF Hops

3

Setting Up the Segment Controller

This chapter describes the tasks required to set up the Segment Controller.

Placing the Segment Controller in Standalone Mode

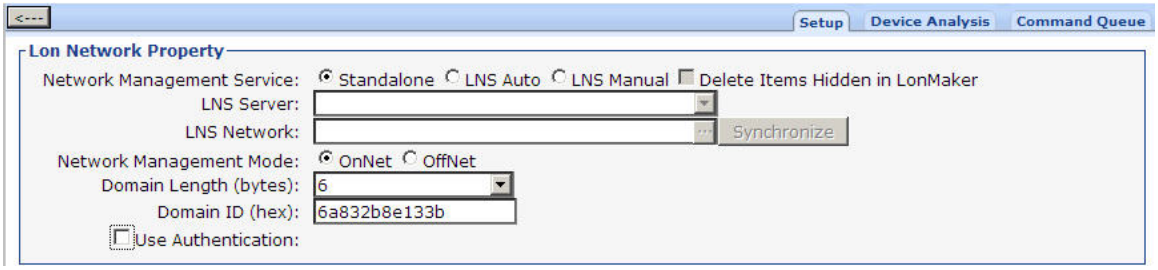
A street lighting network is a power line repeating network, which requires that the Segment Controller operate in standalone mode. This mode allows the Segment Controller to operate as the exclusive network manager of the system, and to establish and maintain the appropriate repeating chains. A *repeating chain* is the path a message must travel on the PL-20 or RF channel from the Segment Controller to one or more repeating devices (luminaires or Street Light Bridge modules) before reaching the target device (a luminaire or a Street Light Bridge module).

In standalone mode, the Segment Controller controls the network management commands sent to the devices attached to its channel (note that for a network operating in LNS mode, LNS would handle these commands). In standalone mode, the Segment Controller can directly download the application image file to the devices and commission, set the application state (online/offline), wink, test, and reset the devices attached to its channel.

Placing a Network in Standalone Mode

To set a network to standalone mode using the SmartServer Web pages, perform the following steps:

1. Open the SmartServer Web pages, as described in Chapter 3 of the *i.LON SmartServer 2.0 User's Guide*.
2. Click the **Net** network to display the Lon Display Property page.
3. From the Setup tab, select **Standalone**.



4. Click **Submit**. A dialog appears informing you that the SmartServer is switching to standalone mode.

It could take several minutes for the SmartServer to switch to standalone mode. After the SmartServer has switched to standalone mode, the dialog closes and you can continue preparing your SmartServer for the network installation.

Network Limitations in Standalone Mode

Managing a power line repeating network in standalone mode has the following restrictions:

- Network is limited to a maximum of approximately 200 devices.
- Network is limited to a single channel.

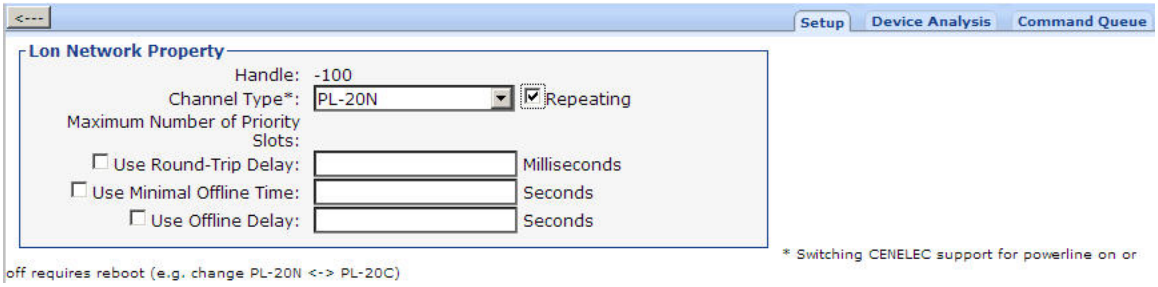
- Network cannot have a router attached to the channel.
- Network does not use LNS management.
- Devices cannot be configured with LNS Plug-ins
- Network cannot be connected to any other network management tool through the network interface or remote network interface.
- LONWORKS network variable connections are not supported. A network in standalone mode functions strictly as a master-slave system. This differs from the standard LNS mode in which the devices attached to the SmartServer's channel can communicate with each other and the SmartServer in a peer-to-peer manner.

Configuring the LonWorks Channel for Power Line Repeating

For a power line repeating network, the LON channel attached to the SmartServer must be configured as a PL-20C or a PL-20N channel and repeating must be enabled on the channel. To configure the channel, perform the following steps:

1. Expand the **Net** network, and then click the **LON** channel to display the Lon Network Property page.
2. From the Setup tab, select the **PL-20C**, **PL-20N**, or other appropriate channel type from the **Channel Type** dropdown listbox.

   Important: The channel type that you select must match the channel type required by local regulations for the area of device deployment. The channel type must also match the channel settings for all devices that will participate in power line communications with the Segment Controller.
3. Select the **Repeating** checkbox to enable repeating on the channel.



4. If a network message fails, a data point and its device are marked offline. You can select the **Use Minimal Offline Time** checkbox so that all the data points on the offline device with pending network messages (read/write requests, polls, or heartbeats) are marked offline and network messages are not sent to them. Thus, network performance is not impacted by an offline device.

   You can also set the minimum period of time (in seconds) that the SmartServer waits before transmitting network messages to offline data points. During this period, an offline device transmits an OFFLINE

status in response to data point requests. After the **Minimal Offline Time** elapses, the SmartServer sends a read/write request to one offline data point. If the read/write request succeeds, the data point and its device are marked online, and all cached read/write requests for the offline data points on the device are executed. If you do not configure this property on a power line repeating channel, it is set to **60** seconds.

5. Optionally, you can set the **Use Offline Delay** property to specify the period of time (in seconds) that the SmartServer waits before marking a data point and its parent device offline (red) in the SmartServer tree after the LON driver detects that the data point is offline.

   For example, if you poll a data point every 5 minutes and you set **Use Offline Delay** to 1 hour, it takes 12 polls for the data point and its parent device to be marked offline—even though the LON driver detected that it could not communicate with the data point after the first poll.

6. Optionally, you can click **Advanced** to set the retry timer and retry counts that determine the frequency in which network messages are re-sent to a device after no confirmation of delivery is received. Although you can change these properties, it is recommended that you use the default transmit timer (**512** ms) and the default retry count (**3**).

7. Click **Submit**.

Copying Resource Files

The Segment Controller needs a copy of the resource files for each device type (luminaire and Street Light Bridge module) in the street lighting network. You can obtain the appropriate resource files for the Street Light Bridge modules from the Echelon Web site; you can obtain the appropriate resource files for each luminaire type from the manufacturer.

To copy these files to the Segment Controller:

1. Open an FTP connection to the Segment Controller. See the *i.LON SmartServer 2.0 User's Guide* for more information about using FTP with the SmartServer.

2. Copy the files from the downloaded (or otherwise provided) resource file to the **/lonworks/Import** and **/lonworks/types** folders in the SmartServer.

   For the **/lonworks/Import** folder, Street Light Bridge module files are copied to the **/Echelon** subfolder. For a luminaire, its files are copied to a folder defined by the manufacturer.

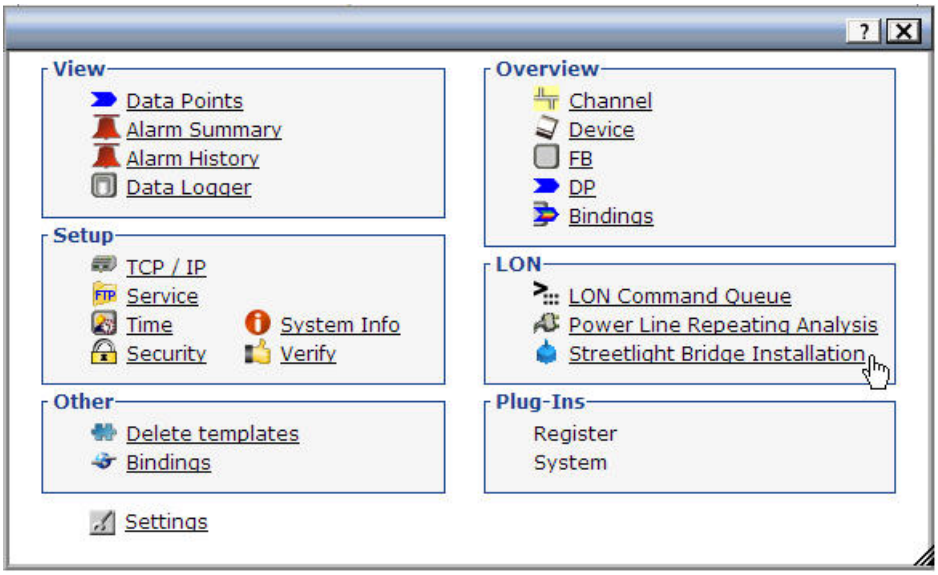
Automatically Discovering Devices

If you want the Segment Controller to automatically discover and commission luminaires and Street Light Bridge modules within the network, you can place the Segment Controller in Acquisition Mode. To enable this mode, perform the following steps:

1. Open the SmartServer Web pages, as described in Chapter 3 of the *i.LON SmartServer 2.0 User's Guide*.

2. Click the Tools icon to open the Tools dialog.

3. From the Tools dialog, click **Street Light Bridge Installation** to open the Lon Devices page.



4. From the Lon Devices page, click the **...** button at the top of the page to open the LON Scan Settings dialog.
5. Select the **Predictive Scanning** checkbox. You can also specify the maximum hop count for repeating chains; the default is 8. Click **OK** to close the dialog and return to the Lon Devices page.
6. Select the **Continuously** checkbox to initiate continuous scanning. Alternatively, click **Scan** to initiate a one-time scan. The SmartServer will discover any unconfigured street light devices or Street Light Bridge modules and commission them.
7. When all street light devices and Street Light Bridge modules have been successfully commissioned, deselect the **Continuously** checkbox to return the Segment Controller to Operational Mode. You can also close the Lon Devices page and return to the main SmartServer page.

All devices that have been commissioned are automatically added to the SmartServer tree, under the LON icon.

While in Operational Mode, if you need to add devices to the street lighting network, you can add them manually and use the SmartServer Web pages to commission them, as described in Chapter 5, *Managing a Street Lighting Network*, on page 47.

4

Planning for the Street Lighting Solution

This chapter includes information needed for planning a street lighting network.

Security Planning

Security planning for a street lighting network must address both of the following concerns:

- Physical security of the luminaires, Street Light Bridge modules, and the Segment Controller
- Network communications security

This document does not describe planning for physical security. The luminaires do not require extra security to participate in a street lighting network. Because the Street Light Bridge modules are typically installed on or near the luminaires, they have minimal physical security requirements. The Segment Controller should be installed in a secure location, within communications distance of the street lighting network.

Network communications security must consider:

- Power line communications between the Segment Controller and the street lighting network (luminaires, Street Light Bridge modules, and possibly other Segment Controllers)
- Power line communications between luminaires
- Power line communications between Street Light Bridge modules
- Radio frequency communications between Street Light Bridge modules

In addition, network communications security must address communications between Segment Controllers and between Ethernet or Internet devices and Segment Controllers. See the *i.LON SmartServer 2.0 User's Guide* for more information about network communications security for the Segment Controller.

General Network Communications Security

Devices within a street lighting network communicate over the power line channel using an open-standard protocol, the ISO/IEC 14908-1 Control Network Protocol. Power line communications are not encrypted; however, messages sent within a general power line network between devices can use authentication to prevent unauthorized access to devices and their applications. Devices within a street lighting network generally do use authentication, as defined by the ISO/IEC 14908-1 Control Network Protocol, for power line communications.

Street Light Bridge modules communicate over an RF channel using a private protocol. RF communications are not encrypted; however, the Street Light Bridge modules always use authentication within the RF channel to prevent unauthorized access to the devices and their applications. For RF-channel authentication, the Street Light Bridge firmware uses a cryptographic hash function, the Secure Hash Algorithm (SHA), described by the National Institute of Standards and Technology (NIST) Federal Information Processing Standards Publication 180-2 (FIPS PUB 180-2). This hash function ensures that a Street Light Bridge module accepts messages only from another Street Light Bridge module.

In addition, Street Light Bridge modules provide the following security measures for the RF channel:

- Each message includes the sender's RF address to detect simple intrusion.
- Each message contains a 32-bit sequence number that allows for duplicate detection and protection against replay attacks.

Network Security for Device Installation

When installing devices within a power line network, you have the following options for managing authentication security:

- No security for the devices
- Security is configured (in a pre-deployment facility) before devices are installed
- Security configured (in the field) after devices are installed

For a street lighting network, having no authentication security is not recommended because the network is generally deployed with minimal physical security. When you configure security for the devices depends on your network, but typically, security is configured after installation.

If you configure security after installation, your network must include two domains: one for device discovery and one for normal communications. In this case, both domains use the same subnet/node address. Domain index 1 would be the discovery domain, which the Segment Controller would use to discover and commission each device (luminaires and Street Light Bridge modules). If security is not required for your network, your network can use a single domain for both discovery and normal communications.

In addition, because ISO/IEC 14908-1 authentication uses distributed authentication keys, you must consider how to manage the number and distribution of the keys:

- Each device (luminaire and Street Light Bridge module) has its own unique key assigned before installation
- Each Segment Controller has a unique key, but the luminaires and Street Light Bridge modules have non-unique keys (different from the Segment Controller's key)
- All devices within the street lighting network have the same key (a city-wide key)

In general, assigning a unique key to each device in the street lighting network before installation is unnecessary. Assigning one key to all devices within the network is a valid option; be sure to document that key so that the network can be expanded over time. For most street lighting networks, assigning a unique key to each Segment Controller, and non-unique keys to all other devices, is the most economical and secure method. From the Segment Controller, you can increment the keys for the other devices so that each one has a unique key if you require additional security.

For a secure network (one in which security is configured before devices are installed), each device must be defined with the configured and authenticated attributes set. That is, each device added to the street lighting network must be a LONWORKS configured device and must use authentication. If security is less

important, the devices can be in the unconfigured state before installation and be configured during commissioning. In both cases, authentication is recommended.

Device Upgrade Planning

To allow your street lighting network to be upgraded over time, you can download an updated Street Light Bridge application (as Echelon releases application updates) over the power line network. The application download uses the standard ISO/IEC 14908-1 download protocol.

The application download process includes the following steps:

- The Street Light Bridge detects the start of a download by a transition to the applicationless state.
- The Segment Controller then downloads the application, which is stored in onboard flash memory.
- After the download is complete, the Street Light Bridge firmware computes a checksum of the downloaded application image to verify that the download was successful. If the checksum fails, the Street Light Bridge firmware sends a failure response to the "go unconfigured" request that follows the computation of the checksum. In this case, you should begin a new download for the application or contact Echelon Support.
- The Street Light Bridge firmware transfers the application image from off-chip to on-chip flash.
- The Street Light Bridge resets and begins running the new application image.

Note that although you can upgrade the Street Light Bridge application over the network, you cannot upgrade the Street Light Bridge firmware over the network.

Network Management Planning

Planning for a street lighting network involves tasks for the luminaires, the Street Light Bridge modules, and the Segment Controller. In addition, you need to plan for both power line channels and RF channels for the Street Light Bridge modules.

Although a Street Light Bridge module provides options for configuring the network, many networks can operate successfully using default settings, without additional configuration.

See Chapter 5, *Managing a Street Lighting Network*, on page 47, for information about network planning for the Segment Controller.

Defining the Networking Channels

A Street Light Bridge module uses the Institute of Electrical and Electronics Engineers (IEEE) wireless personal area network standard 802.15.4 for its radio frequency (RF) communications. The standard defines up to 16 channels in the 2.4 GHz industrial, scientific and medical (ISM) radio band.

A Street Light Bridge module creates a virtual RF channel by using broadcast messages, transmitting and receiving unfragmented packets. To define an RF

channel, all the Street Light Bridge modules within a street lighting network coordinate which frequencies they use. Multiple Street Light Bridge modules can use a single RF channel. In addition, multiple RF channels can exist within a single street lighting network.

A Street Light Bridge module identifies these channels through a pair of configuration network variables (**nciPriChs** and **nciSecChs**), which define three channels in the range 11..26, with default values for the primary channel of 25, 20, and 15, and default values for the secondary channel of 11, 17, and 26. The two configuration network variables represent the primary (normal) and secondary (alternate) LonTalk (ISO/IEC 14908-1) path, which allow the transceiver to define a primary and a secondary channel for communications. If communications fail on the primary channel, the Street Light Bridge module can switch to the secondary channel. The secondary frequency is used when the Segment Controller requests that the alternate path be used.

Important: For all Street Light Bridge modules within the street lighting network, the set of defined primary channels must match for all Street Light Bridge modules, and the set of defined secondary channels must match for all Street Light Bridge modules. In general, the primary and secondary channels should not be the same.

A Street Light Bridge module broadcasts a packet once, followed by a number of repeats (the default number is 1; you can modify the **nciPriRpt** and **nciSecRpt** configuration network variables to specify additional repeats) on each of the configured RF channels. For each path, the product of the number of configured channels and the repeat count plus one should not exceed 12. The default is 6 (three channels with one repeat). Thus, for three configured channels, you should define no more than three repeats.

Signal Strength

The Segment Controller Power Line Repeating Analysis Web page shows device signal strength and margin information. When a Street Light Bridge module is used for power line repeating, the Web page shows power line signal strength and margin information. When the Street Light Bridge module is used for RF repeating (or both power line and RF repeating), you can also retrieve RF signal strength and margin information; see *Analyzing a Power Line Repeating Network* on page 54.

Defining the Media Access Protocol

Each Street Light Bridge module has its media access protocol pre-programmed in the factory. For European street lighting networks, the Street Light Bridge module uses the comité européen de normalisation electrotechnique[5] (CENELEC) EN50065-1 media access protocol for power line networks. For other geographies, the CENELEC protocol is not used.

For device testing, or for power line networks that do not connect to public mains power lines, you can decide to enable or disable the use of the CENELEC protocol for a Street Light Bridge module. From the Segment Controller, you can change

[5] European Committee for Electrotechnical Standardization

the value of the **nciMediaAccess** configuration network variable to specify the power line media access protocol:

- **0** (default): The Street Light Bridge module uses the media access protocol setting defined in the firmware. That is, European models use the CENELEC protocol, and other models do not.
- **1** (normal): The Street Light Bridge module uses the communication parameters of a PL-20N device. That is, the CENELEC EN50065-1 media access protocol is *disabled*. The device program ID reports a PL-20N channel. The XIF file for this mode is **slb-normal.xif**.
- **2** (cenelec): The Street Light Bridge module uses the communication parameters of a PL-20C device. That is, the CENELEC EN50065-1 media access protocol is *enabled*. The device program ID reports a PL-20C channel. The XIF file for this mode is **slb-cenelec.xif**.

Changing the value of this configuration network variable overrides the setting maintained in the device firmware. Changes to this configuration network variable require a device reset, and that all devices (luminaires, Street Light Bridge modules, and the Segment Controller) within the same network use the same media access protocol setting.

Preparing the Segment Controller

To prepare a Segment Controller for a street lighting network, perform the following tasks:

1. Place the SmartServer in standalone mode; see *Placing the Segment Controller in Standalone* Mode on page 28.
2. Enable the SmartServer to manage a power line repeating network; see *Configuring the LonWorks Channel for Power Line Repeating* on page 29.
3. If the network configuration is known, or if device security is configured before the devices are installed (that is, in a pre-deployment facility), enter the Neuron IDs of all of the Street Light Bridge modules and luminaires for the network.
4. If the network configuration is not known, or if device security is configured after the devices are installed (that is, in the field), place the SmartServer in acquisition mode so that it can discover and commission all devices within the network; see *Automatically Discovering Devices* on page 30.
5. Copy the resource files for streetlight devices (luminaires and Street Light Bridge modules) within the network to the **/lonWorks/Import** folder.
6. Back up the SmartServer database; see the *i.LON SmartServer 2.0 User's Guide*. For a remote backup, you could back up just the **/config** folder; for a local backup (for example, in a pre-deployment facility), you should back up all folders within the SmartServer.

Preparing the Street Light Bridge Modules

To prepare a Street Light Bridge module for a street lighting network, perform the following tasks:

1. If the network configuration is known, or if device security is configured before the devices are installed (that is, in a pre-deployment facility), define the authentication key for the device. You can use any 12-byte (96-bit) key.
2. If the network configuration is not known, or if device security is configured after the devices are installed (that is, in the field), note the Neuron ID for the device (printed on the module) so that you can match the installed location of the Street Light Bridge module with its Neuron ID in the Segment Controller.
3. Define which domains the device should use for normal communications. You can use any 1-, 3-, or 6-byte domain, but a 6-byte domain is recommended; for example, you could use the 6-byte Neuron ID of the Segment Controller as the network segment domain. If security is not required for your network, each device can use a single domain for both discovery and normal communications.

Preparing the Luminaires

To prepare a luminaire for a street lighting network, perform the following tasks:

1. If the network configuration is known, or if device security is configured before the devices are installed (that is, in a pre-deployment facility), define the authentication key for the device. You can use any 12-byte (96-bit) key.
2. If the network configuration is not known, or if device security is configured after the devices are installed (that is, in the field), note the Neuron ID for the device (generally printed on or attached to the device) so that you can match the installed location of the luminaire with its Neuron ID in the Segment Controller.
3. Define which domains the device should use for device discovery and for normal communications. You can use any 1-, 3-, or 6-byte domain, but a 6-byte domain is recommended; for example, you could use the 6-byte Neuron ID of the Segment Controller as the network segment domain. If security is not required for your network, each device can use a single domain for both discovery and normal communications.

Device Discovery

Before the Segment Controller can discover and commission luminaires and Street Light Bridge modules within the street lighting network, you must place the Segment Controller in acquisition mode; see *Automatically Discovering Devices* on page 30 for more information.

If you install the Segment Controller before installing any luminaires or Street Light Bridge modules, you can pre-define each luminaire or Street Light Bridge module within the Segment Controller. In this case, the Segment Controller discovers and commissions each device as it is installed. For any devices that the Segment Controller cannot discover, you can install a Street Light Bridge module to extend the communications range so that the device can be discovered.

If you install luminaires or Street Light Bridge modules before installing their corresponding Segment Controller, the Segment Controller must discover and

commission all luminaires and Street Light Bridge module in the entire street lighting network. The Segment Controller discovers and commissions nearby devices first, then discovers additional devices through the Street Light Bridge or luminaire repeaters, and then commissions them. Thus, the discovery and commissioning process is iterative, and could take some time to complete. The process also depends on your having installed Street Light Bridge or luminaire repeaters in appropriate positions within the network.

Both installation methods are supported, and both work well in most cases. The first method is recommended for new installations because it allows you to create and document the network as you install it. For either installation method, you can manually commission any device within the network if you have the device's Neuron ID.

Defining Repeating

The main purpose of a Street Light Bridge module is to act as a repeater for power line communications, for RF communications, or for both. By repeating the communications packets, the Street Light Bridge module can extend the overall range of the street lighting network, or it can bypass obstacles that could otherwise restrict communications within the network.

What kind of repeater the Street Light Bridge becomes depends on the value of the **nciRepeatMode** configuration network variable:

- If **nciRepeatMode** is 0, proxy requests received on the power line channel are repeated onto the RF channel. This is the default value.
- If **nciRepeatMode** is 1, no packets are sent on the RF channel (that is, the Street Light Bridge module acts as a power line repeater only).
- If **nciRepeatMode** is 2, no packets are sent on the power line channel (that is, the Street Light Bridge module acts as an RF repeater only).

Regardless of the Street Light Bridge module's repeating mode, when it receives a message that requires a response, acknowledgement, challenge, or reply, the Street Light Bridge module sends that response, acknowledgement, challenge, or reply on the channel on which the original message was received.

PL/PL Repeater

You can define the Street Light Bridge module as power line repeater to extend the range of power line communications. By default, the Street Light Bridge module acts as power line repeater, but by setting **nciRepeatMode** to 1, you can block RF communications, which might be useful for situations in which RF communications are not used.

Figure 8 shows an example for PL/PL repeating mode. In a multi-phase system with insufficient cross-coupling between the phases, a pair of Street Light Bridge modules in PL/PL repeating mode act as intelligent phase couplers.

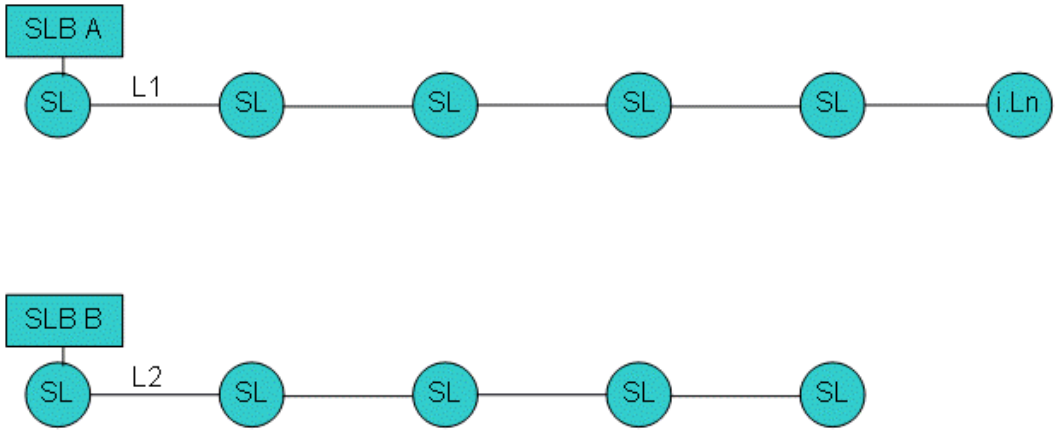


Figure 8. PL/PL Repeating

RF/RF Repeater

You can define the Street Light Bridge module as an RF repeater to extend the range of RF communications. If you set **nciRepeatMode** to 2, you block power line communications, which can be useful if the Street Light Bridge module should act as a repeater for a different Segment Controller than the one with which it has power line communications.

Figure 9 shows an example for RF/RF repeating mode. The street lighting network on the left side of the figure (shown in purple) is installed and running. Then, install the street lighting network on the right side of the figure (shown in blue). If SLB A and SLB B cannot establish RF communications, you can install an RF/RF repeater (SLB X) between them. By defining SLB X as an RF/RF repeater, it does not interfere with power line communications on its own power line network (the purple network).

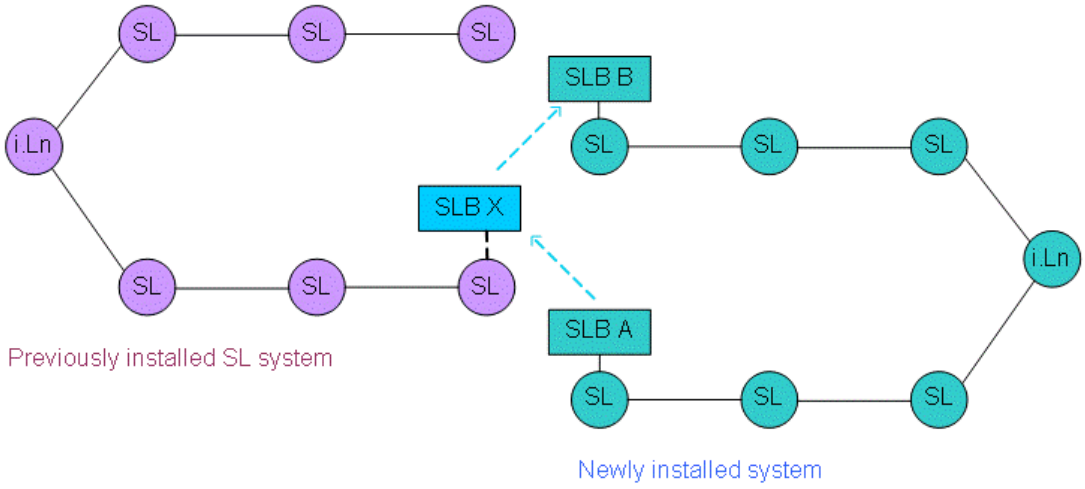


Figure 9. RF/RF Repeating

PL/RF Repeater

In normal mode, the Street Light Bridge module serves both power line and RF channels according to the following rules:

- When receiving a message, the Street Light Bridge module replies only on the channel on which the message was received (PL or RF). In this case, "reply" means response, acknowledgement, challenge, or reply.
- When receiving a proxy request, the Street Light Bridge module forwards the request to both the RF and PL channels.

A Street Light Bridge module does not repeat a packet onto the RF channel unless it receives a request from the Segment Controller to repeat. When directed to repeat onto the RF channel, the receiver waits until all the retries from the originator have completed before repeating onto the same channel. Thus, a Street Light Bridge module attempts to keep the RF channel clear while another module is using it, and does not send responses while the originator is busy sending repeats of the request.

The Street Light Bridge module uses information in each packet header to detect packet duplication, replay attacks, and network intrusion.

Scheduling

The Segment Controller includes an Event Scheduler application that you can use to schedule events. Thus, for example, you can schedule luminaires to turn on at sundown, dim at the end of the evening rush hour, brighten at the start of the morning rush hour, and then turn off at sunrise. In general, you would not define an event schedule for Street Light Bridge modules (they should run continuously).

See Chapter 6, *Controlling a Street Lighting Network*, on page 77, for more information about scheduling.

Device and Network Recovery Planning

The Street Light Bridge module has a watchdog mechanism that covers the main processor, the Smart Transceiver, and the radio communication chip. That is, if LonTalk (ISO/IEC 14908-1) communications are lost, the Smart Transceiver resets; if the radio communications are lost, the radio communication chip resets.

Figure 10 shows a simple street lighting network with two Street Light Bridge modules. This section considers two recovery scenarios: loss of SLB A or loss of SLB B. For any extended outage (generally longer than 15 minutes), the Segment Controller should report the outage so that network management personnel can investigate and repair the outage.

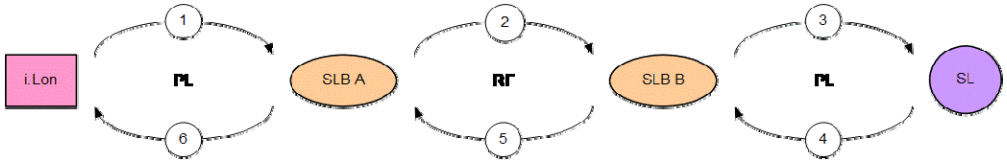


Figure 10. An Example Street Lighting Network

These scenarios assume that both SLB A and B have the same RF channel lists (primary 25, 20, 15 and secondary 11, 17, 26) – an assumption that should apply to nearly all street lighting networks. Also, these scenarios assume that the network has good communications prior to device failure.

Scenario 1: Loss of SLB A

When SLB A fails (for example, it experiences a power outage), any communications initiated by the Segment Controller cannot reach SLB B or the street light (SL).

At this point, SLB B determines that the RF channel is idle. After the channel has been idle for 15 minutes, SLB B tunes to another channel from its configured channel list. If that channel is also idle, SLB B cycles through all of its configured channels to attempt to reestablish communications. SLB B cycles through all of its defined channels until SLB A rejoins the network.

When SLB A becomes active, SLB A and SLB B negotiate a new primary channel for communications. Because the two Street Light Bridge modules are likely not to be using the same channel at the same time when SLB A rejoins the network, both cycle through their defined channels until communications are established. By default, the cycle time is approximately 3 minutes for each channel.

If SLB A had been offline for less than 15 minutes, RF communications would be reestablished immediately because SLB B would not have switched from the original channel and SLB A, after it becomes active, would use the same channel.

Scenario 2: Brief Loss of SLB B

If SLB B experiences a brief outage (less than 15 minutes), communications between the Segment Controller and SLB B or the street light (SL) fail. When SLB B becomes operational, RF communications are reestablished quickly as the devices negotiate the use of the channel.

Scenario 3: Prolonged Loss of SLB B

If SLB B experiences an extended outage (longer than 15 minutes), communications between the Segment Controller and SLB B or the street light (SL) fail. SLB A detects an idle channel, and begins cycling through the channel list. If the Segment Controller continues to attempt to communicate with SLB B, SLB A delays cycling through the channels until the number of failed messages equals the retry count.

When SLB B becomes operational, it uses its last-known-good channel. If the Segment Controller has not switched the path (for example, from normal to alternate), one of the message retries should succeed as SLB A cycles through the configured channel list. Otherwise, SLB A and SLB B negotiate a new primary channel for communications. The channel negotiation for downstream communications (from the Segment Controller) is fairly quick because it alternates between the primary and the alternate path. For upstream communications (to the Segment Controller), message retries guarantee that communications are reestablished.

If the Segment Controller has marked SLB B as “Confirmed Down” (see *Analyzing a Power Line Repeating Network* on page 54), reestablishment of communications could take additional time, depending on the retry timer for Confirmed Down devices.

Simulating Communications Errors

A Street Light Bridge module autonomously determines which frequency to monitor, and then continues using this frequency until some failure condition occurs that makes the frequency unusable. When determining which channel to use, the Street Light Bridge firmware monitors the channel quality and the signal quality for the channel, and chooses the best transmit and receive channel. The firmware considers a receive channel bad if the Street Light Bridge module receives fewer than five valid LonTalk (ISO/IEC 14908-1) packets in a window of 3600 seconds. Street Light Bridge modules send a heartbeat signal periodically to ensure that the channel is not idle within this window.

Before deploying a street lighting network, or for a field trial, you can simulate packet errors for receiving messages, transmitting messages, or both. You can set the simulation mode individually for both the primary and the alternate PL path and for each of the 16 RF channels.

To enable the error simulation mode, write a non-zero value to both the **nviErrMode** and **nviErrRate** input network variables. By default, both network variables have a value of 0 (zero) to disable error simulation. The values of these network variables persist across device reset and power outage.

Writing a non-zero value to the **nviErrMode** network variable initiates the error simulation mode, but only if the corresponding error rate, defined by the **nviErrRate** network variable, also has a non-zero value. Thus, you can start and stop error simulation by writing to the **nviErrMode** network variable.

In addition, error simulation ends after a time period equal to the value of the **nciErrTimeout** configuration network variable (a number of minutes, default of one day, up to a maximum of three days). This timeout value is updated only while the Street Light Bridge module is powered on; any time spent powered off is not included in this timeout value.

Because the Street Light Bridge application writes the remaining error simulation time to onboard flash memory once every 30 minutes, completion of error simulation might be delayed by up to 30 minutes if the Street Light Bridge module is powered off or reset during the simulation.

Updating the **nviErrRate** network variable has the following effect:

- If error simulation is active, the error simulation expiration timer is restarted with the current **nciErrTimeout** value. Note that setting the **nviErrRate** network variable to zero still causes the error simulation expiration timer to restart, even though no errors are simulated.
- If error simulation is not active, the value is stored but has no other immediate effect.

Updating the **nviErrMode** network variable has the following effect:

- If error simulation is active, and if **nviErrMode** is not all zeroes, the error simulation expiration timer is restarted with the current **nciErrTimeout** value.
- Setting **nviErrMode** to all zeroes ends error simulation mode, regardless of how much time remains.

Updating the **nciErrTimeout** configuration network variable has the following effect:

- If error simulation mode is active, error simulation mode is restarted with the new timeout value, regardless of how much time has already passed or how much time would be left in the previous simulation.
- If error simulation mode is not active, the value is stored but has no other immediate effect.

Note that a value of zero (0) is not valid for the **nciErrTimeout** configuration network variable; the Street Light Bridge application rounds a zero value up to 1 (one) to ensure that error simulation mode can eventually end.

Error Codes

The Segment Controller displays the last error code on the Web page for the Street Light Bridge module. You can also use network management tools to send a query status message to the Street Light Bridge module to retrieve the error log. See the *Neuron Tools Errors Guide* (078-0402-01B) for a listing of Neuron firmware error codes. The Street Light Bridge firmware can also post the errors listed in **Table 1**.

Table 1. Street Light Bridge Firmware Error Codes

Error	Description
0x40	Logged when a download fails because the image has a bad CRC, fails to decompress, or is improperly formed in some way.
0x41	Logged when a download fails because an image is incompatible with the target. This error includes image incompatibility (for example, not a Street Light Bridge image), hardware incompatibility, bootrom incompatibility, or feature incompatibility.

5

Managing a Street Lighting Network

This chapter describes how to manage a street lighting network that uses power line repeating.

Manually Installing a Street Lighting Network

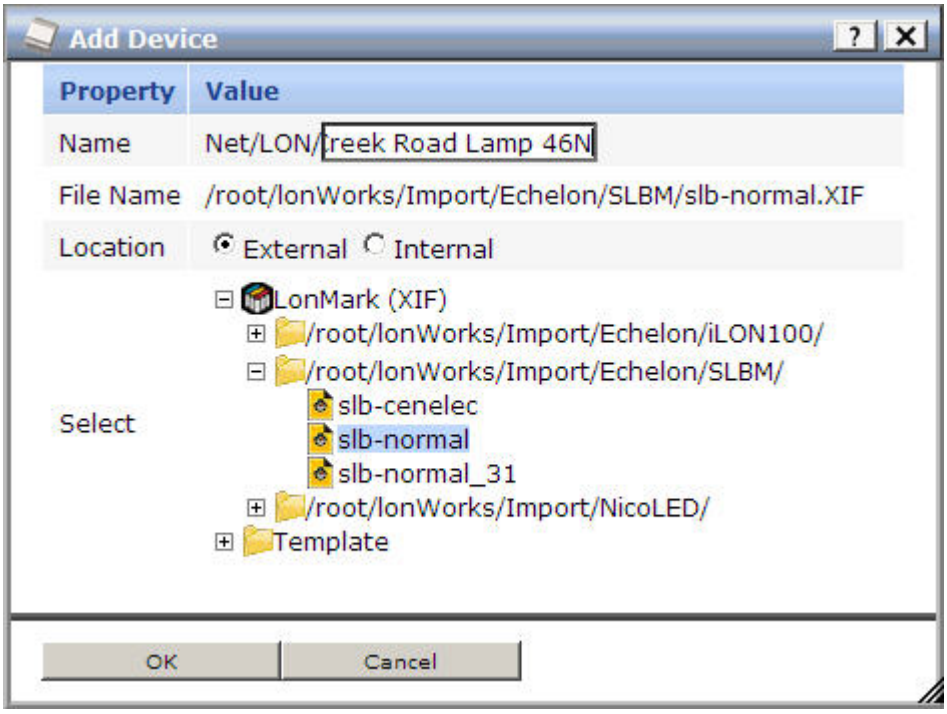
You can manually install a street lighting network using the SmartServer Web pages (see *Automatically Discovering Devices* on page 30 for information about installing devices automatically). The installer should create a device list that accurately records the device location, such as light pole number, and the Neuron ID of the device installed at that location. For example, the installer can peel a bar code sticker off the device and record its location next to the bar code, or just record the device location and the Neuron ID. With the SmartServer Web pages, the network installation includes the following steps, which are each described in the subsequent sections:

1. Create the devices.
2. Manually enter the locations and Neuron IDs of the devices to be installed.
3. Select the devices to be installed.
4. Enable smart network management for the selected devices. After smart network management is enabled, the SmartServer automatically loads, commissions, and sets the devices online. You can then check the installation status using the **LON Command Queue** Web page.

Creating Devices

To create a device, perform the following steps:

1. Expand the **Net** network, right-click the **LON** channel, and select **Add Device** from the shortcut menu to open the Add Device dialog.

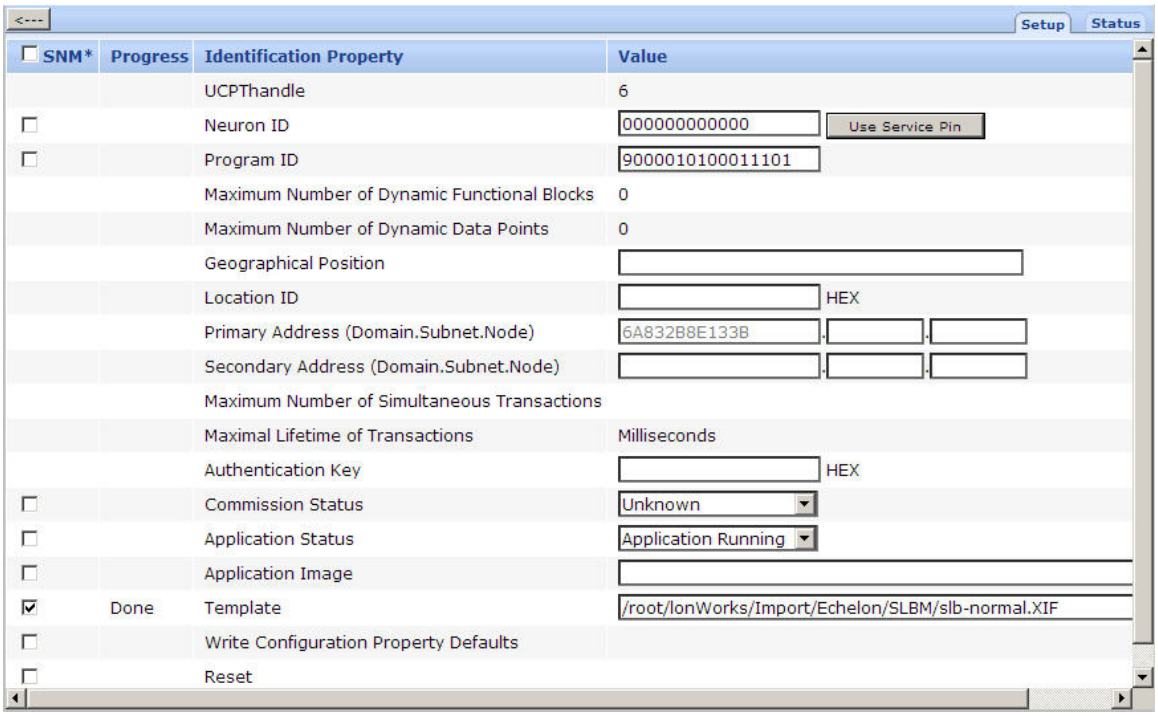


2. Enter the following device properties: the name of the device (for example, "Oak Creek Road Lamp 46N"), the location of the device (select **External**), and the XIF file for the device (for example, "slb-normal").
3. Click **OK** to add the device. It is added to the tree of its parent channel.
4. Click **Submit** on the main SmartServer page to accept the change to the network.
5. Repeat steps 1–4 for each device on the network to be installed.

Entering Device Locations and Neuron IDs

Use the SmartServer Web pages to enter the locations and Neuron IDs of the devices being installed:

1. Select the device from the **LON** device tree to display the device page.



2. From the Setup tab, specify the 12-digit hex string comprising the device's Neuron ID in the **Neuron ID** field.
3. You should also enter a description of the device location such as a light pole number or GPS coordinates that can be associated with the device in the **Geographical Position** field.
4. Click **Submit**. The SmartServer discovers the repeating path for the device and commissions it.
5. Repeat steps 1–5 for each device on the network to be installed.

Selecting Devices

After entering the locations and Neuron IDs of the devices to be installed, you select those devices on the tree:

1. Select one or more devices from the tree to be installed.
   - To select one device, click that device.
   - To select multiple devices, click one device and then either hold down CTRL and click all other devices to be installed or hold down SHIFT and select another device to install the entire range of devices.
2. The device page opens. Proceed to the next section, *Installing Devices with Smart Network Management*, to install the devices.

Installing Devices with Smart Network Management

After you select the devices to be installed, use the Smart Network Management feature to install them. With this option, the SmartServer asynchronously sets the following device properties to the states it determines to be desired:

- Program ID
- Commission status (commissioned or decommissioned)
- Application state (online or offline)
- Application image
- Device template (external interface)
- Configuration property default values

Enabling Smart Network Management

You can enable smart network management for a device by selecting the checkbox at the top of the **SNM** column of the device page (setup tab), and then clicking **Submit**. You can also enable smart network management for specific device properties by selecting the checkbox in the SNM column for the specific property, and then clicking **Submit**. Which checkboxes you should select depends on whether you are installing devices pre-loaded with the current application image files:

- If you are installing pre-loaded devices, select the Smart Network Management checkboxes for the following properties: **Commission Status**, **State**, **Template**, **Write Configuration Property Defaults**, and **Reset**. Verify that all other checkboxes are cleared to ensure that the SmartServer does not update the application image currently on the devices.
- If you are installing devices that need to be loaded with an application image file, select the checkbox at the top of the **SNM** column to enable smart network management for all device properties. Note that the application image to be downloaded to the devices must be in the **/LonWorks/Import** folder on the SmartServer flash disk for the SmartServer to install the devices successfully.

After smart network management is enabled for a device property, the SmartServer attempts to perform the corresponding network management command. The current statuses of the network management commands appear in the **Progress** column.

Installing Devices

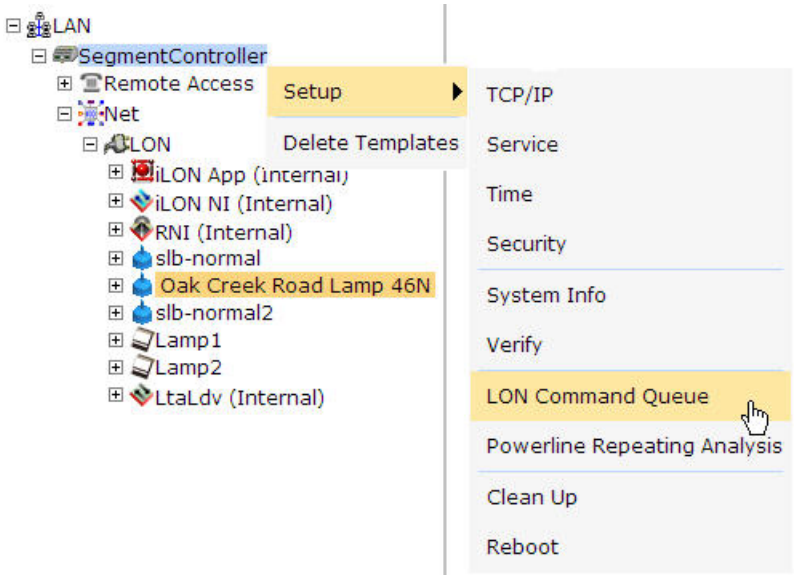
After enabling smart network management for all the applicable device properties, click **Submit**. The SmartServer performs the following tasks for each device that you are installing:

1. Fetches the program ID of the device (if the Smart Network Management checkbox is selected for the **Program ID** property).
2. Downloads the application image file to the device (if the Smart Network Management checkbox is selected for the **Application Image** property). The SmartServer downloads the application image file that has a program ID matching that of the device application; the application image file must be in the **/LonWorks/Import** folder.
3. Loads and instantiates the device interface (if the Smart Network Management checkbox is selected for the **Template** property):
    a. The SmartServer first attempts to load the device template (.XML file) that has a matching program ID; the device template must be in the **/config/template/lonworks** folder on the flash disk.
    b. If the SmartServer cannot find a matching device template, the SmartServer loads the device interface (XIF) file that has a matching program ID; the XIF file must be in the **/LonWorks/Import** folder.
    c. The SmartServer creates all the functional blocks and data points defined by the device interface.
4. Re-commissions the device. Commissioning downloads network configuration data and application configuration data to the device.
5. Writes configuration property default values defined in the XIF file to the device.
6. Resets the device, which starts the device application.
7. Sets the device application online.

Checking Device Installation Status

You can use the **LON Command Queue** Web page to check the status of the management commands you have submitted for one or more devices:

1. Right-click the local SmartServer icon, select **Setup**, and select **LON Command Queue** from the shortcut menu. Alternatively, you can click the **Tools** icon and select **LON Command Queue**.



2. The LON Command Queue page opens.

	Name	Position	Unique ID	Command	Status	Last Update
0	Net/LON/slb-normal1	- - -	0501A2B5A500	UpdateCpDefaults	STATUS_DONE	2010-09-21 16:10:34
1	Net/LON/slb-normal1	- - -	0501A2B5A500	GetTemplate	STATUS_DONE	2010-09-21 16:10:28
2	Net/LON/slb-normal1	- - -	0501A2B5A500	ChangeApplicationStatus	STATUS_DONE	2010-09-21 16:10:27
3	Net/LON/slb-normal1	- - -	0501A2B5A500	ChangeCommissionStatus	STATUS_DONE	2010-09-21 16:10:27
4	Net/LON/iLON NI	- - -	030000294204	ChangeApplicationStatus	STATUS_DONE	2010-09-20 17:21:21
5	Net/LON/iLON NI	- - -	030000294204	ChangeCommissionStatus	STATUS_DONE	2010-09-20 17:21:21
6	Net/LON/iLON App	- - -	030000294202	GetTemplate	STATUS_DONE	2010-09-20 17:22:10

3. The management commands submitted for all devices and their statuses appear in a table. By default, the names of the first 20 devices listed in the tree in the left frame are listed in descending alphabetical order and the commands executed on them are listed in descending chronological order (most recent to earliest). You can sort the management commands by clicking the column headers.

   To view multiple additional devices, click a device in the tree, and then either hold down CTRL and click all other additional devices to be viewed, or hold down SHIFT and select another device to view the entire range of additional devices.

   To view the status of a specific device, click one of the 20 blue-highlighted devices in the tree to clear the pre-selected devices and then click the device to be viewed. To view the statuses for a set of specific devices, click one of the 20 blue-highlighted devices in the tree to clear the pre-selected devices, click a device in the tree, and then either hold down CTRL and click all other devices to be viewed, or hold down SHIFT and select another device to view the entire range of devices.

4. You can right-click the header, a table entry, or an empty space in the application frame and select one of the following options from the shortcut menu:

Clear Table	Clears all entries in the **LON Command Queue** table. The table automatically re-lists pending commands (STATUS_REQUEST) and updates their statuses after the commands successfully complete or fail.
Configure Device	Opens the **Driver** or **General** properties page for the selected device.
Cancel Command	Cancels the selected command and deletes it from the table. You can select multiple commands by clicking one, holding down CTRL, and clicking the other commands to cancel. You can also use this option to delete inactive commands from the table.

Troubleshooting Street Lighting Network Installation

If a device is not installed by the SmartServer even after the entire network installation has been completed, it is likely that the device has failed or the SmartServer cannot reach it through a repeating device. In this case, you can do the following:

1. Add another device (such as a Street Light Bridge module) at an intermediate spot on the network that will serve only as a repeater. See *Adding Devices* on page 64 for more information about adding devices to an installed power line repeating network.
2. Replace the device to determine if it has failed. See *Replacing Devices* on page 67 for more information about replacing devices on a power line repeating network.

Maintaining a Street Lighting Network

You can perform routine maintenance to update, repair, and optimize an installed street lighting network. You can use the SmartServer to maintain the network and its devices. For example, if a device fails, you can replace it on the physical network and then logically replace it on the SmartServer, preserving the device's configuration.

This section describes the following network maintenance tasks that you can perform with the SmartServer:

- Analyze the power line repeating network using the **Power Line Repeating Analysis** Web page
- Adding devices
- Upgrade devices
- Replace devices
- Decommission devices

- Set devices offline
- Test (query and wink) devices
- Delete devices

Analyzing a Power Line Repeating Network

When running on a PL-20 repeating network, the SmartServer transmits network messages to the repeating devices with which it can directly communicate, and those repeating devices in turn relay the messages to repeating devices located further down the power line, and so on until the message reaches the target device. The following figure illustrates a repeating chain that could be used to relay a network management command from the SmartServer to a target device. In this example, the repeating chain consists of Repeating Device 1 (a Street Light Bridge module), which relays the message to Repeating Device 2 (a repeating-enabled luminaire), which relays the command to Repeating Device 3 (a Street Light Bridge module), which relays the message to the target device (a luminaire). A luminaire enabled for repeating would use power line repeating. A Street Light Bridge module could use power line repeating or forward the message using an RF channel to another Street Light Bridge module.

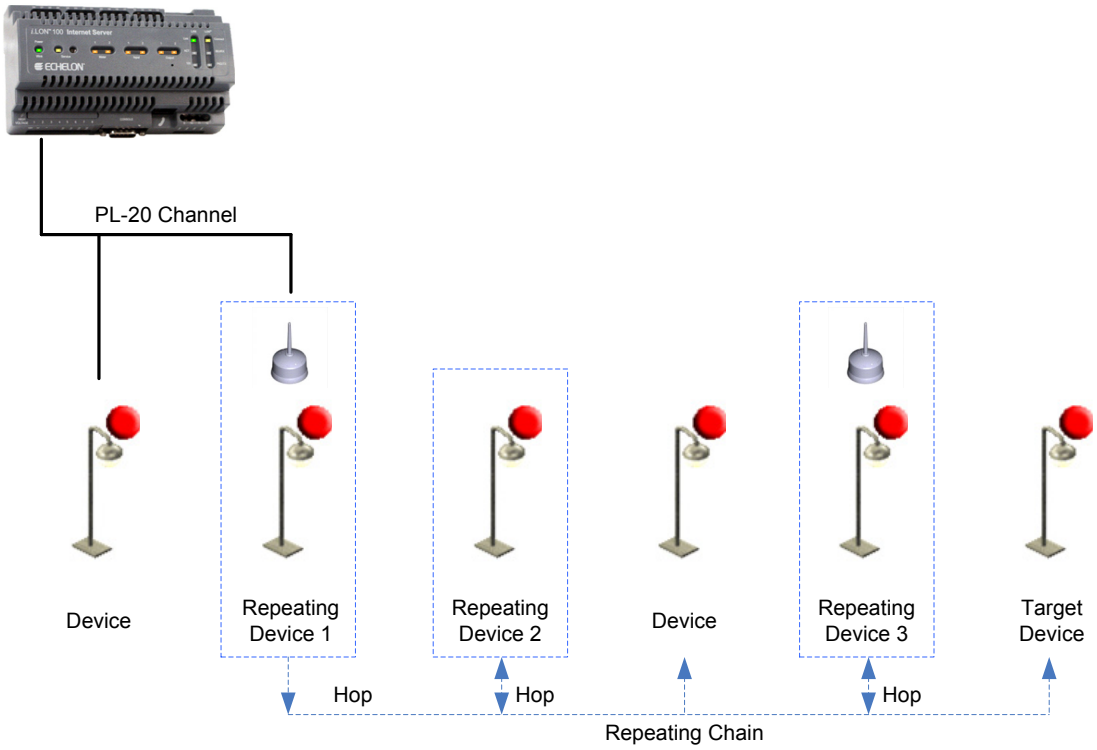
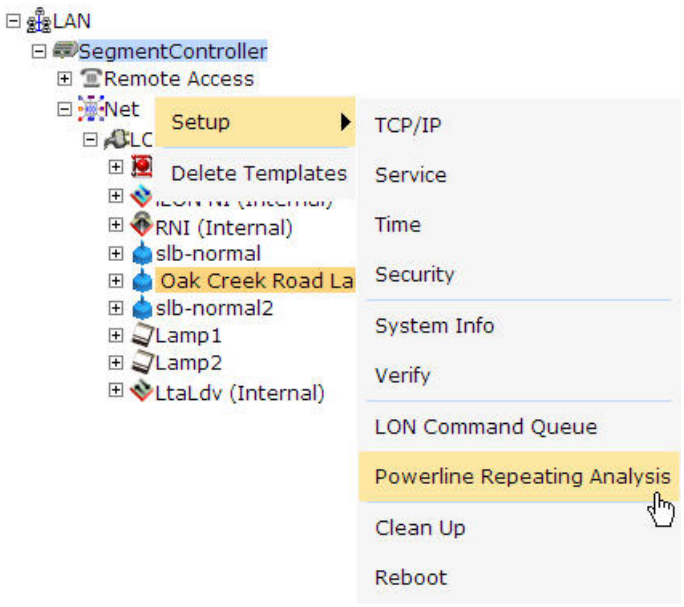


Figure 11. Repeating Network

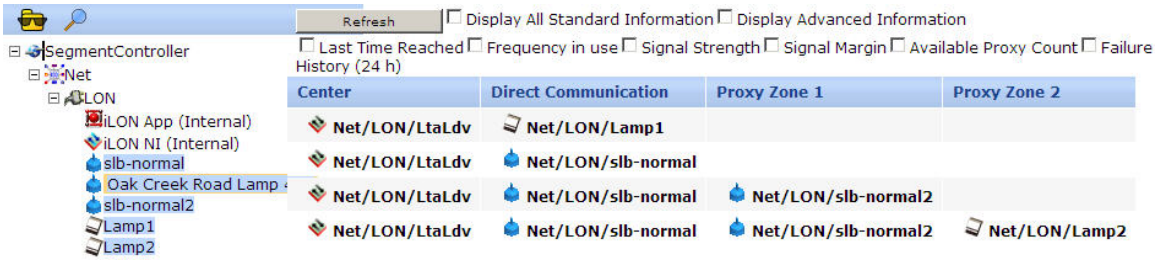
You can use the **Power Line Repeating Analysis** Web page to view the repeating chain a device is using to communicate with the SmartServer. In addition, you can use this Web page to analyze and debug the power line repeating network.

To open and use the **Power Line Repeating Analysis** Web page, perform the following steps:

1. Right-click the **SmartServer** icon, select **Setup**, and select **Power Line Repeating Analysis** from the shortcut menu. Alternatively, you can click the Tools icon and select **Power Line Repeating Analysis**.



2. The **Power Line Repeating Analysis** Web page opens.



The rows in this Web page represent established repeating paths between the listed devices. The target device in a repeating chain is listed furthest to the right. The current chain of repeating devices used to relay messages to the target device are listed to the left of the target device. The repeating chains lead back to the SmartServer, which is listed furthest to the left, in the column titled **Center**.

The SmartServer is always listed in the column titled **Center** because all network messages originate from its local LonTalk (ISO/IEC 14908-1) device (Net/LON/LtaLdv).

The repeating chains of the first 20 repeating devices listed in the tree view are displayed in this Web page. Devices that have been installed successfully are marked black, devices in the process of being installed are marked orange, and devices with communication failures or other errors are marked red.

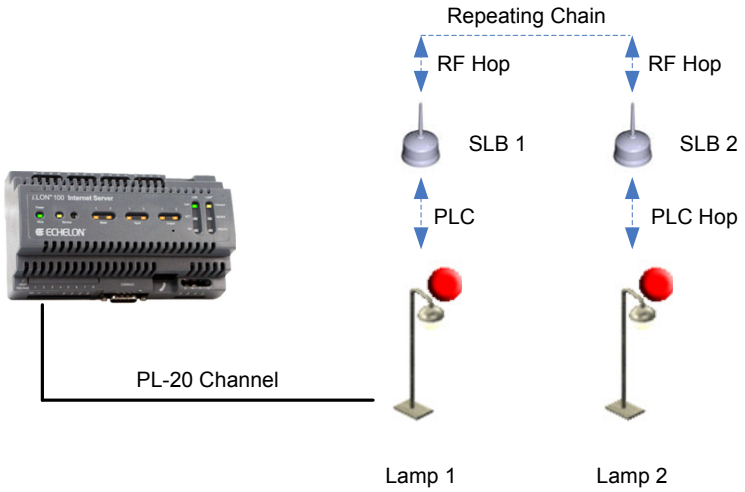
To view the repeating chain of another device, click that device in the tree. To view multiple additional devices, click a device in the tree, and then either hold down CTRL and click all other additional devices to be viewed, or hold down SHIFT and select another device to view the entire range of additional devices.

To view the repeating chain of a specific device, click one of the 20 blue-highlighted devices in the tree to clear the pre-selected devices and then click the device to be viewed. To view the repeating chains for a set of specific devices, click one of the 20 blue-highlighted devices in the tree to clear the pre-selected devices, click a device in the tree, and then either hold down CTRL and click all other devices to be viewed, or hold down SHIFT and select another device to view the entire range of devices.

3. You can identify proxies (repeating devices that can relay messages to devices located further down the channel) and target devices (the destination device in a repeating chain) by observing whether there is a device listed in the column to the right. If there is no device listed in the column to the right, that device is a target device.

Center	Direct Communication	Proxy Zone 1	Proxy Zone 2
Net/LON/LtaLdv	Net/LON/Lamp1		
Net/LON/LtaLdv	Net/LON/slb-normal		
Net/LON/LtaLdv	Net/LON/slb-normal	Net/LON/slb-normal2	
Net/LON/LtaLdv	Net/LON/slb-normal	Net/LON/slb-normal2	Net/LON/Lamp2

The simple power line repeating network shown in the figure above corresponds to the following physical configuration:



The direct communication devices (proxies that can directly receive messages from the SmartServer without any repeating) are listed in the **Direct Communication** column (in the example above, the SmartServer can reach both Lamp 1 and SLB 1 directly). The direct communication devices can relay messages to proxies and target devices further down the power line (in the example above, SLB 2 and Lamp 2).

The proxies and target devices are listed under the **Proxy Zone** columns (in the example above, SLB 2 is Proxy Zone 1, and Lamp 2 is in Proxy Zone 2). The last repeating device in the chain before the target device is referred to as the "proxy agent".

For example, if a target device uses four hops to receive a message, you would observe:

a. The proxy in the repeating chain that directly communicates with the SmartServer is listed in the **Direct Communication** column.

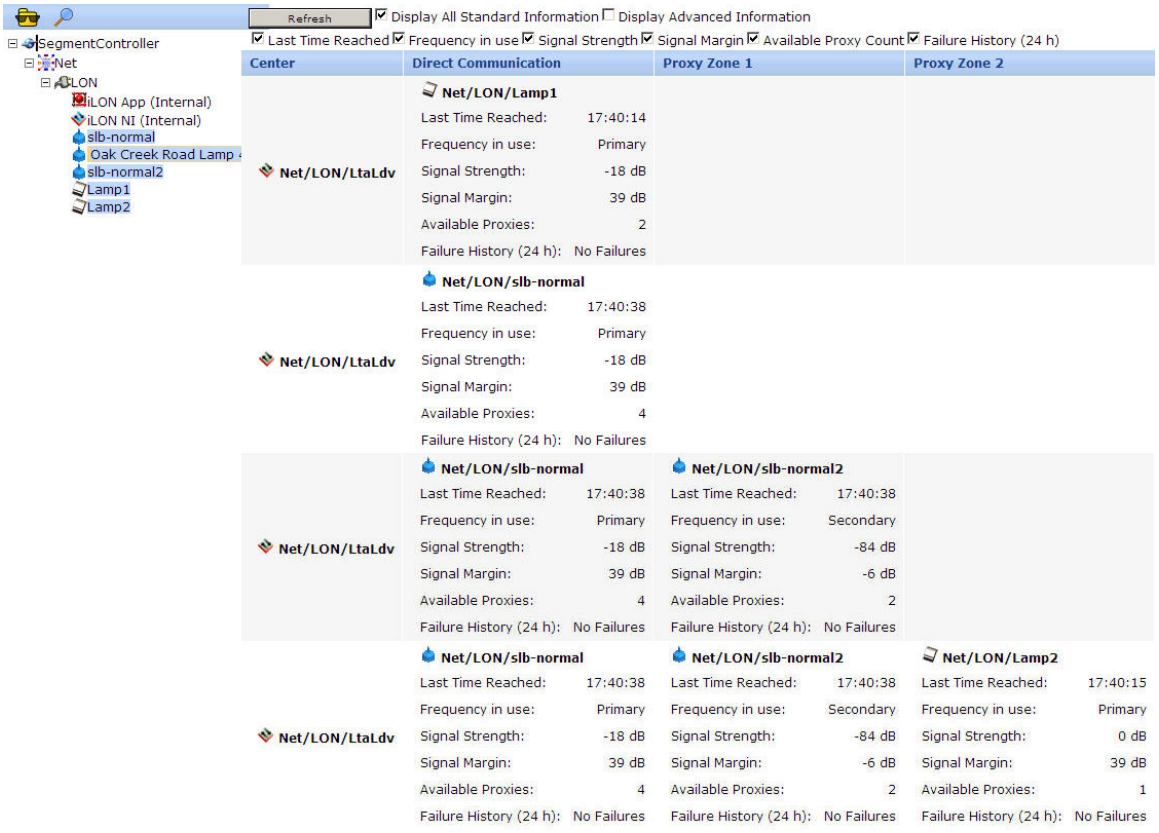
b. The next proxy in the repeating chain, which does not have direct communication with the SmartServer, is listed in the **Proxy Zone 1** column.

c. The proxy that can directly communicate with the target device (the proxy agent) is listed in the **Proxy Zone 2** column.

d. The target device is listed in the **Proxy Zone 3** column.

If a target device requires the maximum of eight hops, you can scroll to the right to **Proxy Zone 7** column to view the target device and its repeating chain to the left.

4. You can display statistics related to the power line signal at the hop between a device and its proxy by selecting the following checkboxes at the top of the Web page (you can view all the statistics by clicking the **Display All Standard Information** checkbox).



Last Time Reached — The time at which the device last responded to a network message.

Frequency in use — The frequency carrier of the signal at the hop (**Primary** or **Secondary**). For more information on the use of these frequency carriers on a LONWORKS power line channel, see the *LonWorks PLT-22 Power Line Transceiver User's Guide (110kHz - 140kHz Operation)*.

Signal Strength	**Direct Communication Devices:** The reduction in signal strength measured at the device in decibels (dB). **Proxies and Target Devices**: The reduction in signal strength at the hop in decibels (dB). This value is the minimum of the signal strengths measured at the device and its proxy.
Signal Margin	**Direct Communication Devices:** The amount that the signal is greater than the noise level at the device in decibels (dB). **Proxies and Target Devices**: The amount that the signal is greater than the noise level at the hop in decibels (dB).
Available Proxies	The approximate number of repeating devices that can directly communicate with the device, including the current proxy. The signal strength at the repeating device and the number of hops required to reach it determine whether a repeating device can serve as a proxy for a given device.
Failure History (24h).	Lists the 45-minutes intervals within the current 24-hour period in which a device failure (if any) was reported.

Note: The data displayed in the Web page are cached values (not real-time measurements). You can click **Refresh** to get the latest cached values.

Repeating devices marked offline (red) in the tree view might not be marked as such in the **Powerline Repeating Analysis** Web page; likewise, devices marked offline (red) in the **Powerline Repeating Analysis** Web page might not be marked as such in the tree view. Furthermore, there could be a significant delay for a device in this Web page to show the offline state if you have not configured the **Use Offline Delay** property in the **Setup – LON Channel Driver** Web page. See *Configuring the LonWorks Channel for Power Line Repeating* on page 29 for more information about setting this property.

5. You can display the following advanced diagnostic statistics for a given target device by clicking the **Display Advanced Information** checkbox:

Commission Status

Indicates whether the device has been commissioned. The values that can appear in this field and their colors depend on whether the device has successfully been installed (black), is being installed (orange), or has an error (red).

Black (Installed)

- **Commissioned**. The device has successfully been installed.

Orange (Installation in Progress)

- **Pending Commission**. The SmartServer has identified that it needs to commission the device.
- **Pending Download**. The SmartServer has been instructed to download an application image to the device.
- **Never Reached**. During the initial installation attempt, the device has not received messages from the SmartServer.

Red (Error)

- **Commission Error**. The device has not been commissioned. Most likely this state is a result of a communication failure, but it could also be caused by a device failure.
- **Download Error**. An application image has not been downloaded to the device. Most likely this state is a result of a communication failure, but it could also be caused by issues such as the device having the wrong

model number, or the device and the application image file (.apb extension) on the SmartServer (to be downloaded to the device) having mismatching program IDs.

- **Message Error**. The SmartServer cannot communicate with the device after the calculated number of retries (this state is classified as a hard message error). The SmartServer regularly attempts to communicate with the device over an approximate 5-minute period. If the device does not respond during this time, its **Online Status** is changed from "Down" to "Confirmed Down".

Online Status

Indicates the current device state. The values that can appear in this field and their colors depend on whether the device has successfully been installed (black), the device is being installed (orange), or the device is not running because of an error (red).

Black (Installed)

- **Up**. The device has been commissioned, it is communicating with the SmartServer, and it does not have any hard message failures.

Orange (Installation in Progress)

- **Nul**. The SmartServer has not yet communicated with the device.

Red (Error)

- **Down**. The SmartServer cannot communicate with the device after the calculated number of retries. This error is called a hard message error.
- **Confirmed Down**. After the device has had a hard message error and is marked as "Down", the SmartServer attempts to communicate with the device using degraded messages (no retries) over an approximate 5-minute period. If the SmartServer fails to communicate with the device during this period, the device is marked as "Confirmed Down". In addition, the data points on the device are marked offline in the tree.
- **No Agent**. No proxy can communicate with the device.
- **Invalid Neuron State**. The SmartServer has determined that the device is applicationless.

Communication Attempts

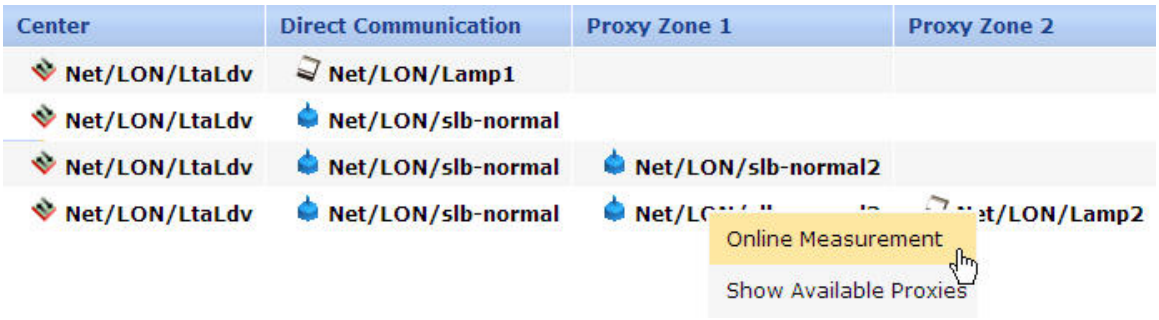
The number of times that a device (either the SmartServer or a proxy agent) has attempted to communicate with the target device.

For direct communication target devices, this field lists the number of communication attempts made by the SmartServer. For all other target devices, this field lists the number of communication attempts made by a proxy agent.

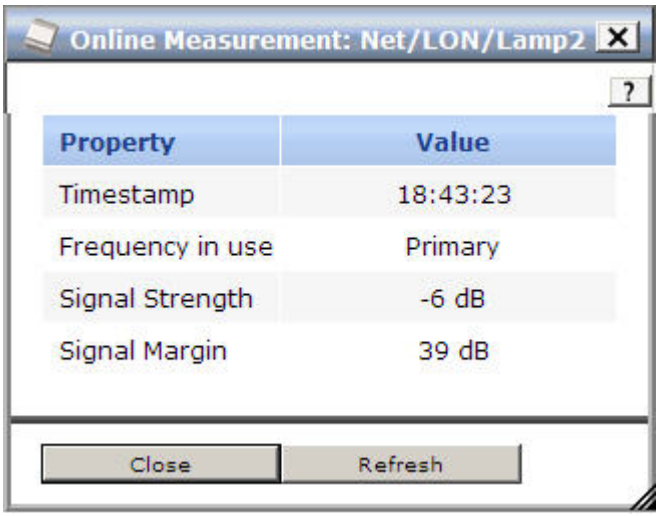
Communication Failures	The number of times that a device (either the SmartServer or a proxy agent) has failed to communicate with the target device. For direct communication target devices, this field lists the number of communication failures that have occurred with the SmartServer. For all other target devices, this field lists the number of communication failures that have occurred with a proxy agent.
Communication Agent Switch	The number of times that the proxy agent used by a target device to receive a message from the SmartServer has been switched because of a communication failure with a previous proxy agent.
Communication Skipped	The number of times that a proxy agent has not attempted to send a message to the target device because the **Online Status** of the target device was not "Up".

6. Optionally, you can obtain the real-time signal strength and signal margin measurements at the hop between a device and its proxy by performing the following steps:

    a. Right-click the device and select **Online Measurement** from the shortcut menu.



    b. The **Online Measurement** dialog opens.



This dialog displays the following statistics:

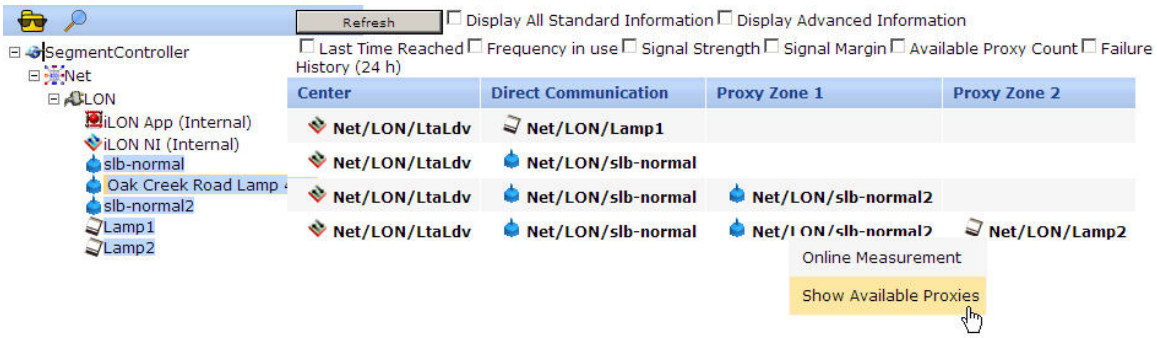
Time Stamp	Displays the time at which the device last responded to a network message.
Frequency in Use	Displays the frequency carrier of the signal at the hop (**Primary** or **Secondary**). For more information on the use of these frequency carriers on a LONWORKS power line channel, see the *LonWorks PLT-22 Power Line Transceiver User's Guide (110kHz - 140kHz Operation)*.
Signal Strength	**Direct Communication Devices:** Displays the real-time measurement in dB of the signal strength at the device. **Proxies and Target Devices**: Displays the real-time measurement (in dB for power line hops; in dBm for RF hops) of the signal strength at the hop. This value is the minimum of the signal strengths measured at the device and its proxy.
Signal Margin	**Direct Communication Devices:** Displays the real-time measurement in dB of the signal margin (the amount that the signal is greater than the noise level) at the device. **Proxies and Target Devices**: Displays the real-time measurement (in dB for power line hops; in dBm for RF hops) of the signal margin at the hop.

c. You can click **Refresh** to get updated real-time values.

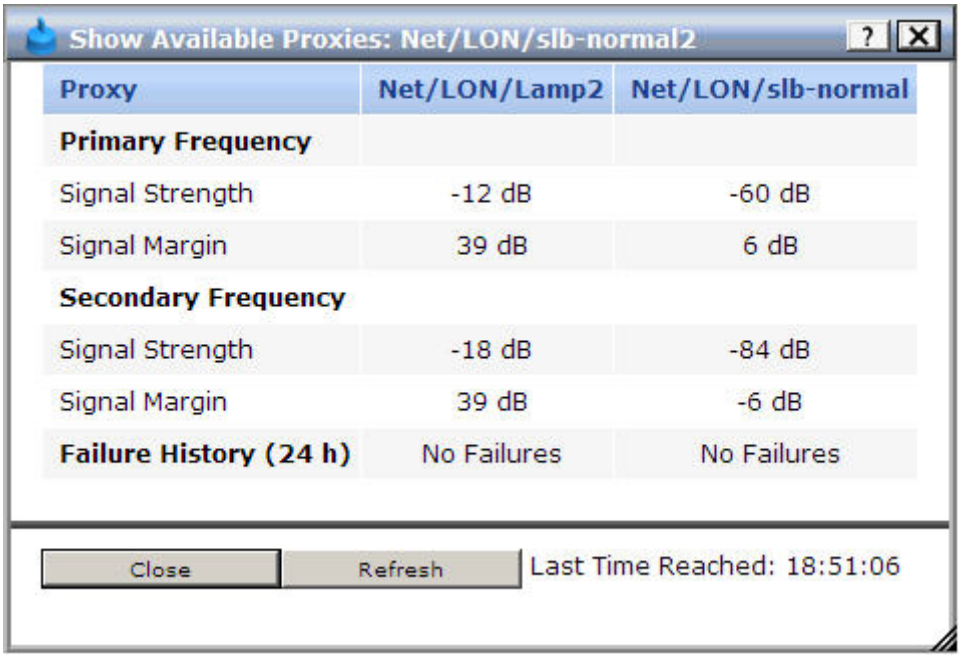
d. Click **Close** to return to the **Power Line Repeating Analysis** Web page.

7. Optionally, you can view statistics related to signal at the hop between the selected device and all the proxies (repeating devices) that can be used to relay messages to that device, including the current proxy. To view the available proxies for a given device, perform the following steps:

   a. Right-click the device and select **Show Available Proxies** from the shortcut menu.



   b. The **Show Available Proxies** dialog opens.



c. All the proxies (repeating devices) that can directly communicate with the selected device, including the current proxy, are listed in columns. For each proxy, the following statistics are listed:

Primary Frequency — The cached signal strength and signal margin measurements at the hop between the selected device and the proxy on the primary frequency.

Signal Strength — **Direct Communication Devices:** Displays the reduction in signal strength at the device in decibels (dB).

Proxies: The reduction in signal strength at the hop in decibels (dB). This value is the minimum of the signal strengths measured at the selected device and the proxy.

Signal Margin — **Direct Communication Devices:** The amount that the signal is greater than the noise level at the device in decibels (dB).

Proxies: The amount that the signal is greater than the noise level at the hop in decibels (dB).

Secondary Frequency — The cached signal strength and signal margin measurements at the hop between the selected device and the proxy on the secondary frequency.

Signal Strength — **Direct Communication Devices:** Displays the reduction in signal strength at the device in decibels (dB).

Proxies: The reduction in signal strength at the hop in decibels (dB). This value is the minimum of the signal strengths measured at the selected device and the proxy.

Signal Margin	**Direct Communication Devices:** The amount that the signal is greater than the noise level at the device in decibels (dB). **Proxies**: The amount that the signal is greater than the noise level at the hop in decibels (dB).
Failure History	Provides a historical list of the 45-minutes intervals since the SmartServer was rebooted in which a device failure (if any) was reported. For example, if failures are recorded for the device on Monday at 14:30, Tuesday at 15:00, Wednesday at 16:00, and Saturday at 16:15, this property would display the following text: **Failure 14:15-15:00** **Failure 15:45-16:30** The device failure history is cleared when a device has no failures during a 7-day period.
Last Time Reached	Displays the time at which the device last responded to a network message.

Note: The number of proxies displayed in this dialog might differ from the number shown in the **Power Line Repeating Analysis** Web page as the SmartServer updates cached data. To view an updated list of available proxies in this dialog, close this dialog, click **Refresh** in the **Power Line Repeating Analysis** Web page, right-click the device, and then select **Show Available Proxies** in the shortcut menu.

d. You can click **Refresh** to get the latest cached signal strength and signal margin measurements.

e. Click **Close** to return to the **Power Line Repeating Analysis** Web page.

Adding Devices

After you install a power line repeating network, you can use the SmartServer to add new devices to the network. The process for adding new devices to an existing network is the same as initially installing the network. See *Manually Installing a Street Lighting Network* on page 48 for more information about installing devices with the SmartServer.

When you add the device to the network, the SmartServer attempts to commission the new device. The commissioning succeeds if the SmartServer can communicate with the device either directly or though a repeating chain.

Upgrading Devices

You can use the SmartServer to upgrade a Neuron-hosted device that has writeable application memory (EEPROM or flash). An upgrade might be needed to improve the device's capabilities or to repair a damaged device application. You can upgrade devices one at a time, or you can perform a batch upgrade.

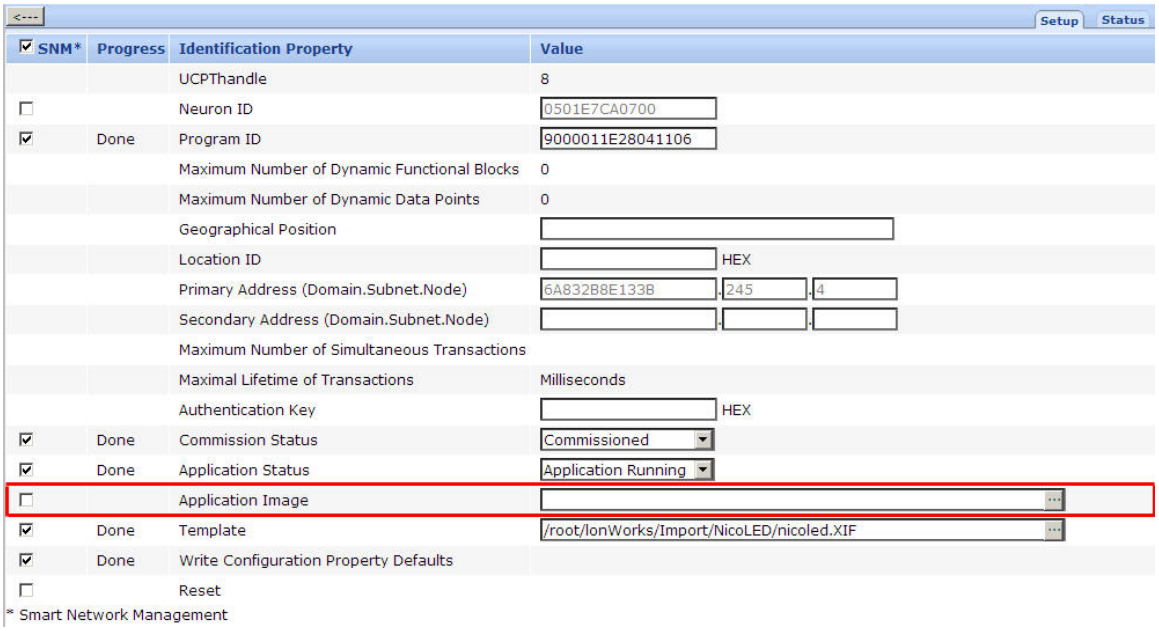
To perform an upgrade, you need to obtain from the device manufacturer the binary application image file (.apb extension) and related files for the new application to be used to upgrade the device. The system image in the application image file must have the same firmware version as the Neuron Chip on the device. If the device interface has changed, you also need to obtain a new device interface (XIF) file for the device, upload it to the SmartServer, and activate it on the SmartServer.

The SmartServer takes the application image file that has program ID matching that of the device from the **/LonWorks/Import** folder on the SmartServer flash disk and then downloads it to the device. Note that the device to be upgraded must be online and be reachable (directly or through a repeating device) in order for the upgrade operation to succeed.

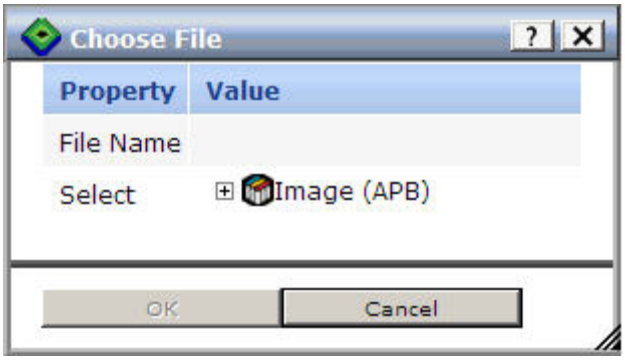
Note: Upgrading a device can affect the performance of the power line repeating network and the repeating chain.

To upgrade a device, perform the following steps:

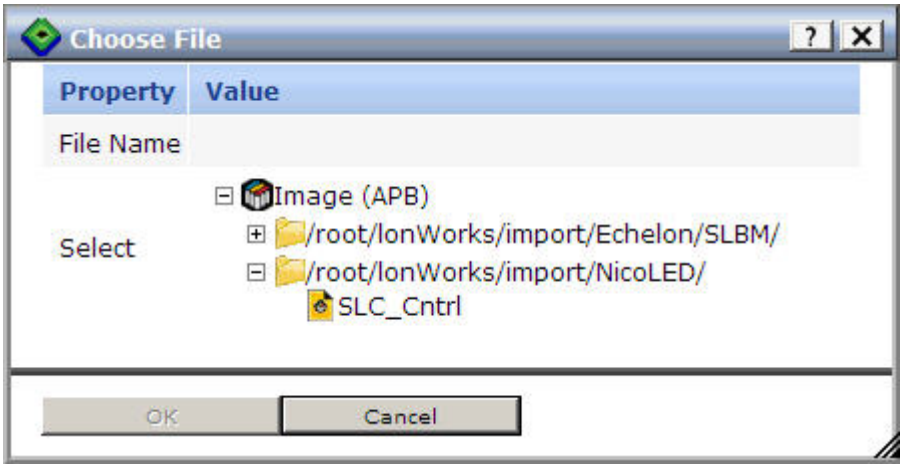
1. Follow the upgrade instructions from the manufacturer (such as copying the .apb file of the new application and the .xif file of the new external interface, if required) to the **/LonWorks/Import** folder on the SmartServer flash disk.
2. Select one or more devices from the tree to be upgraded:
   - To select one device, click that device.
   - To select multiple devices and perform a batch upgrade, click one device and then either hold down CTRL and click all other devices to be upgraded or hold down SHIFT and select another device to upgrade the entire range of devices.
3. From the Setup tab, select the .apb file to be downloaded to the device, and perform the following steps:
   a. In the **Application Image** property, click the **...** button to the right.



b. The **Choose File** dialog opens.



c. Expand the LONMARK **Image (APB)** icon to show the appropriate **/lonworks/import** folder. Expand the folder to show the application image files.



d. Select the application image to be downloaded to the devices.

e. Click **OK** to return to the device Web page.

4. If the external device interface has changed, you need to load a new XIF file for the device onto the SmartServer:

   a. In the **Template** property, click the **...** button to the right.

   b. The **Choose File** dialog opens.

   c. Expand either the **LonMark (XIF)** or **Template** folder depending on whether you are using a .xif or .xml file for the external device interface. If the device being upgraded is located in the LNS tree, the **Template** folder is not available.

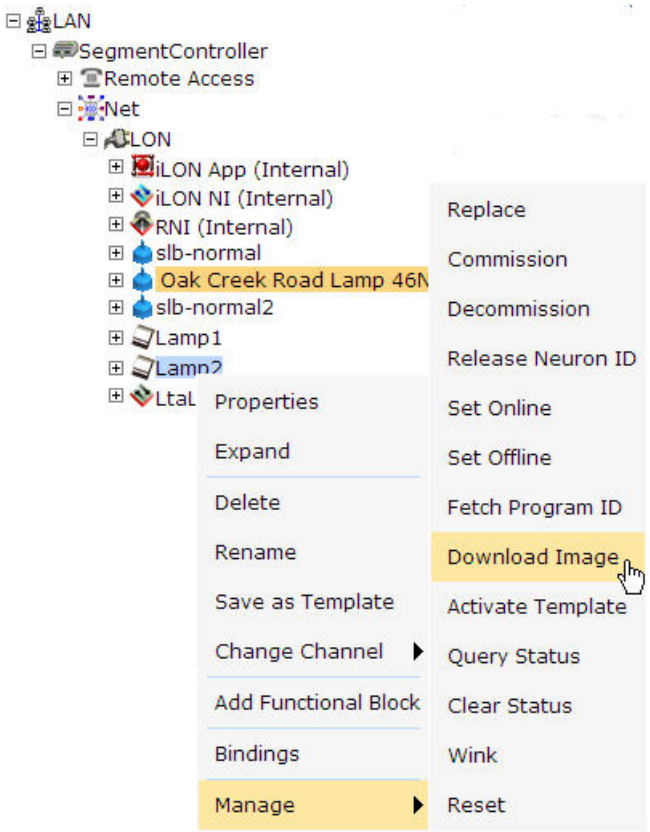
   d. For an XIF file, expand the subfolders containing the XIF file to be loaded onto the SmartServer, and then click the XIF file.

   e. Click **OK** to return to the device Web page.

5. Click **Submit**.

6. Download the application image to the selected devices: Right-click one of the selected devices in the SmartServer tree, select **Manage**, and click **Download Image** in the shortcut menu. Alternatively, you can clear and

then select the Smart Network Management checkbox to the left of the **Application Image** property in the device Web page and click **Submit**.



7. Activate the XIF files for the devices (if necessary): Right-click one of the selected devices in the SmartServer tree, select **Manage**, and click **Activate Template** in the shortcut menu. Alternatively, you can clear and then select the Smart Network Management checkbox to the left of the **Template** property in the device Web page and click **Submit**.

8. To check the status of the device upgrade, open the **LON Command Queue** Web page: Right-click the **SmartServer** icon, select **Setup**, and select **LON Command Queue** from the shortcut menu. Alternatively, you can open the **Tools** menu and click **LON Command Queue**. See *Checking Device Installation Status* on page 51 for more information about using this Web page.

Replacing Devices

You can use the SmartServer to replace a device if the device fails or a newer version of the device becomes available. Note the following requirements when replacing a device:

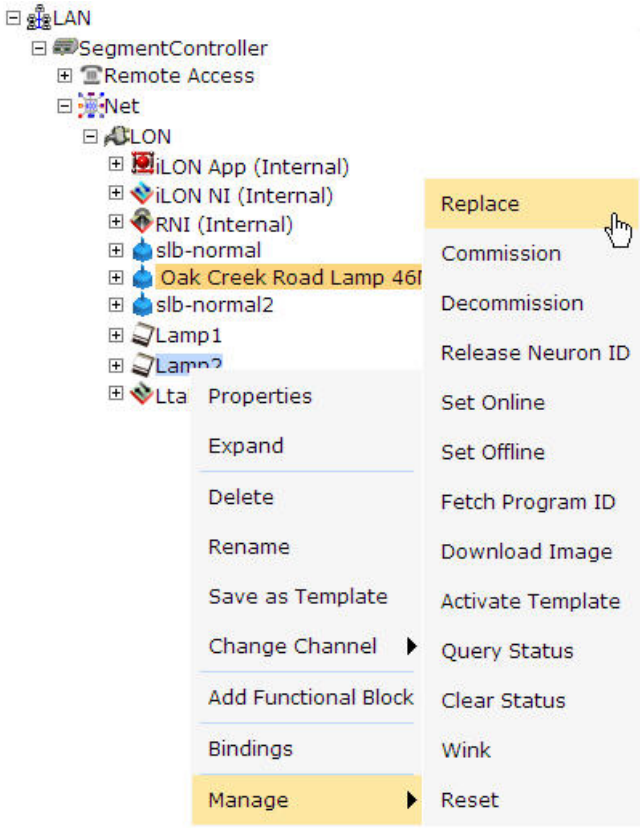
- The replacement device must have the same program ID as the original device.
- The application image file and device interface should match the original device; otherwise, you might have to upgrade the replacement device as well.

If you replace a device that was serving as a repeating agent, the SmartServer automatically identifies alternate repeating devices to relay network messages to those target devices that were using the old device in their repeating chains. When you add the replacement device to the network, the SmartServer attempts to commission the replacement device. The commissioning succeeds if the SmartServer can communicate with the device either directly or though a repeating chain.

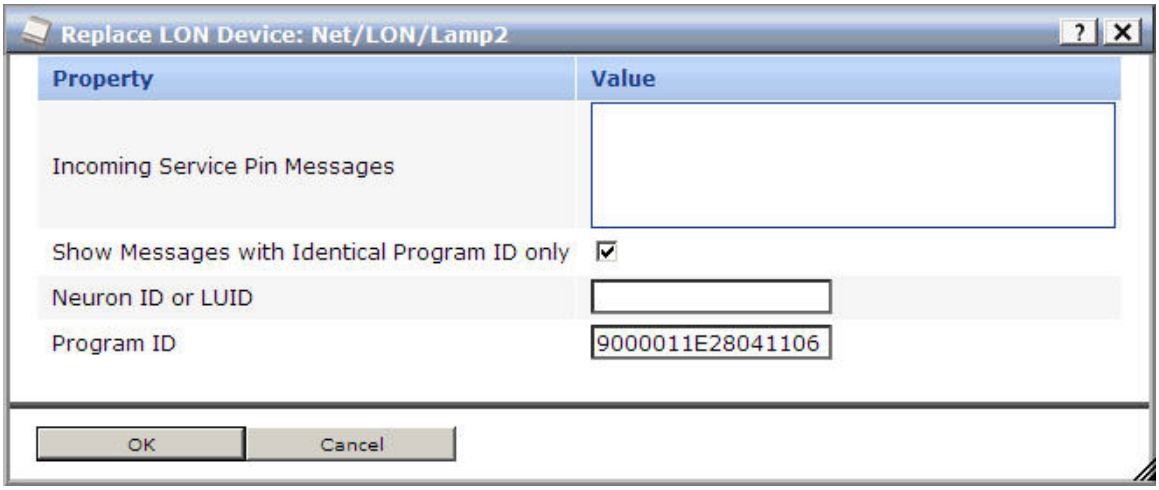
Note: If the original device still functions, leave the old device connected to the network (if physically possible) until the device replacement has been completed. Thus, the SmartServer can decommission the old device so that you can easily reuse it in a new network. This step is not required if the device has failed.

To replace a device with the SmartServer, perform the following steps:

1. Attach the replacement device to the network by applying power to the device and attaching its network connection as documented by the device manufacturer.
2. Right-click the original device, point to **Manage**, and then select **Replace** from the shortcut menu.



3. The **Replace LON Device** dialog opens.



4. You can acquire the Neuron ID of the replacement device using a service pin or you can enter it manually:
   - If you are using the service pin method, press the service pin of the device. The Neuron ID and program ID of the device are both entered into the **Incoming Service Pin Messages** box and they are input into the **Neuron ID or LUID** and **Program ID** boxes, respectively.
   - If you are using the manual entry method, enter the 12-digit hex string of the device in the **Neuron ID** or **LUID** box.
5. Click **OK**.
6. Click **Submit**. The SmartServer downloads the application and the configuration data of the original device to the replacement device, decommissions the replacement device, begins repeater discovery, and then commissions the replacement device.
7. To check the status of the device replacement, open the **LON Command Queue** Web page: Right-click the **SmartServer** icon, select **Setup**, and click **LON Command Queue** on the shortcut menu. Alternatively, you can open the **Tools** menu and then click **LON Command Queue**. See *Checking Device Installation Status* on page 51 for more information about using the **LON Command Queue** Web page.

Decommissioning Devices

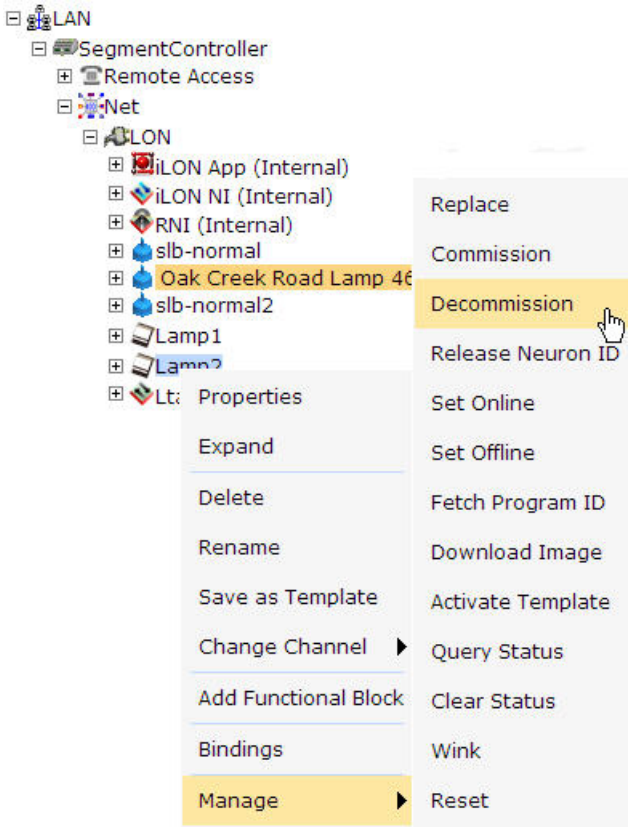
You can use the SmartServer to decommission a device if you are no longer using it or if you are moving it to a new network. In addition, you can temporarily decommission a device to optimize, troubleshoot, or repair your network. Decommissioning logically removes the device from the network. When you decommission a device, its Neuron ID is preserved so that you can subsequently recommission the device without having to re-acquire its Neuron ID. In addition, the configuration properties of the device are preserved in the SmartServer's internal database. You can then later recommission the same or different devices without having to load configuration property files to the device.

Note: Decommissioning a device can affect the performance of the power line repeating network, particularly if the device is being used as a repeating agent in

a repeating chain. If a repeating agent is decommissioned, it could cause communication failures for multiple devices.

To decommission a device, perform the following steps:

1. Select one or more devices from the tree to be decommissioned:
   - To select one device, click that device.
   - To select multiple devices and perform a batch upgrade, click one device and then either hold down CTRL and click all other devices to be decommissioned or hold down SHIFT and select another device to decommission the entire range of devices. The device Web page opens.
2. From the Setup tab, right-click a selected device, select **Manage**, and select **Decommission**.



   Alternatively, you can change the **Commission Status** property to **Uncommissioned** from the Setup tab of the device Web page, which appears when you select devices in step 1.
3. The SmartServer places the devices in the soft-offline state (the device has an application loaded and is configured, but it is offline) and then unconfigures the devices. The offline devices are highlighted red in the SmartServer tree and in the **Power Line Repeating Analysis** Web page.
4. To recommission an unconfigured device and place it back online, select one or more devices to recommission, right-click a selected device, select **Manage**, and select **Commission** from the shortcut menu. You then select

the devices again, right-click a selected device, select **Manage**, and select **Set Online** from the shortcut menu.

Alternatively, you can select the Smart Network Management check boxes for the **Commission Status** and **Application Status** properties from the Setup tab of the device Web page, and click **Submit**. You can also change the **Commission Status** property to **Commissioned** and change the **Application Status** property to **Application Running (Online)**, and then click **Submit**.

Note: Changing the domain ID of the SmartServer causes all the devices on the network to be recommissioned automatically and reconfigured to the new domain ID.

Setting Devices Offline

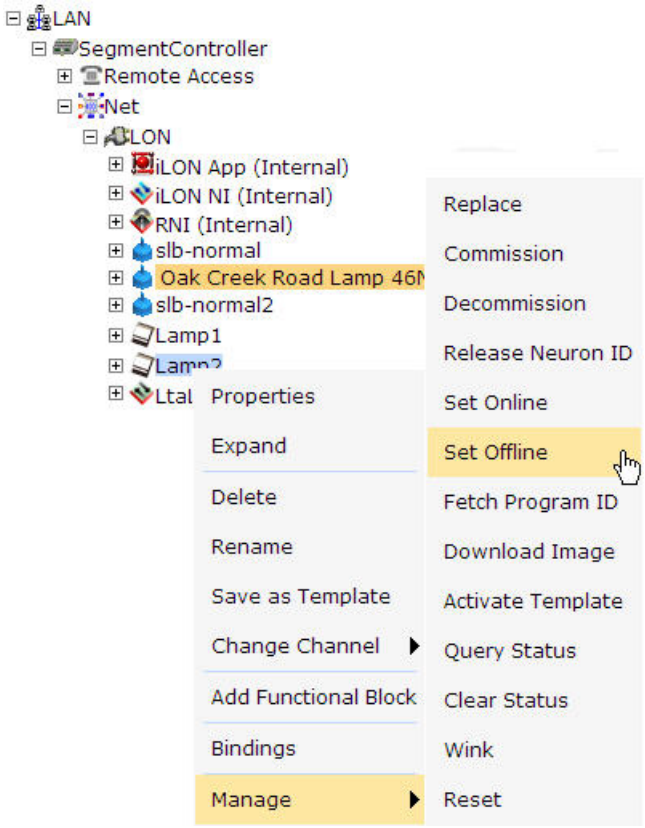
You can set a device on a power line repeating channel to the offline state in order to stop running its application. You might want to set a device offline to test the behavior of other devices on the network. An offline device still receives data point updates; however, it does not process them. Instead, the offline device transmits the default values for its data points. In addition, an offline device can still process commission, decommission, set online, query status, clear status, wink, and reset commands.

Note: Setting a device offline can affect the performance of the power line repeating network, particularly if the device is being used as a repeating agent in a repeating chain. If a repeating agent is placed offline, it could cause communication failures for multiple devices. In addition, setting a device offline can affect network performance if the device was polling prior to its being set offline.

Street Light Bridge modules continue to forward messages when offline.

To set a device offline, perform the following steps:

1. Select one or more devices to place offline. To select one device, click that device. To select multiple devices, click one device and then either hold down CTRL and click all other devices to be installed or hold down SHIFT and select another device to place the entire range of devices offline.
2. From the Setup tab, right-click a selected device, select **Manage**, and select **Set Offline**.



Alternatively, you can change the **Application Status** property to **Application Stopped (Offline)** in the from the Setup tab of the device Web page, which appears when you select devices in step 1.

3. The SmartServer places the devices in the soft offline state (the device has an application loaded and is configured, but it is offline). The offline devices are highlighted red in the SmartServer tree and in the **Power Line Repeating Analysis** Web page.

4. To place a device back online, select one or more devices to set online, right-click a selected device, select **Manage**, and select **Set Online**. Alternatively, you can select the Smart Network Management checkbox for the **Application Status** property from the Setup tab of the device Web page and then click **Submit**, or you can change the **Application Status** property to **Application Running (Online)** and click **Submit**.

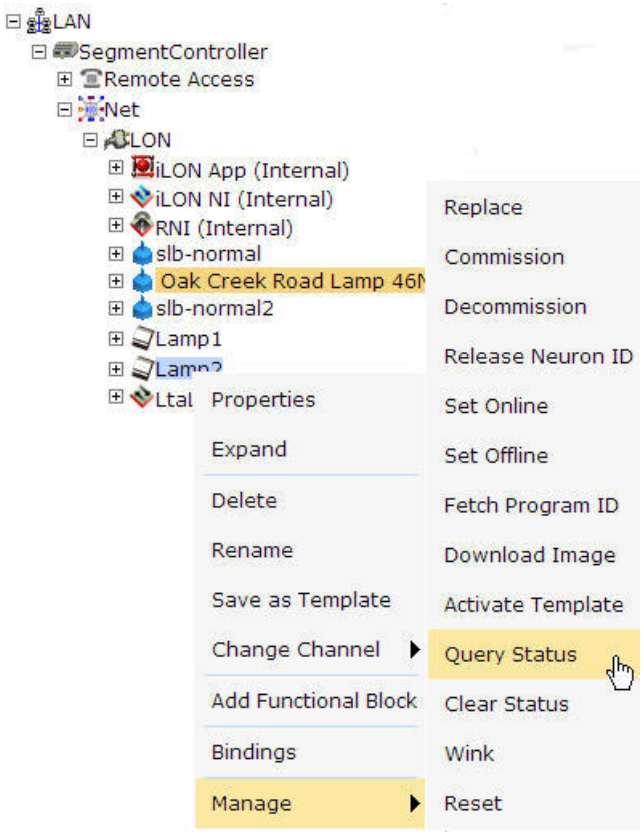
Testing Devices

You can use the SmartServer to query the status of a device and to wink a device. You can query the status of a device to ensure that it is operating and that it is configured correctly. Querying a device opens a dialog that lists network traffic statistics that you can use to evaluate the performance of the device. Winking a device enables you to identify the device on the network and verify that it is communicating properly.

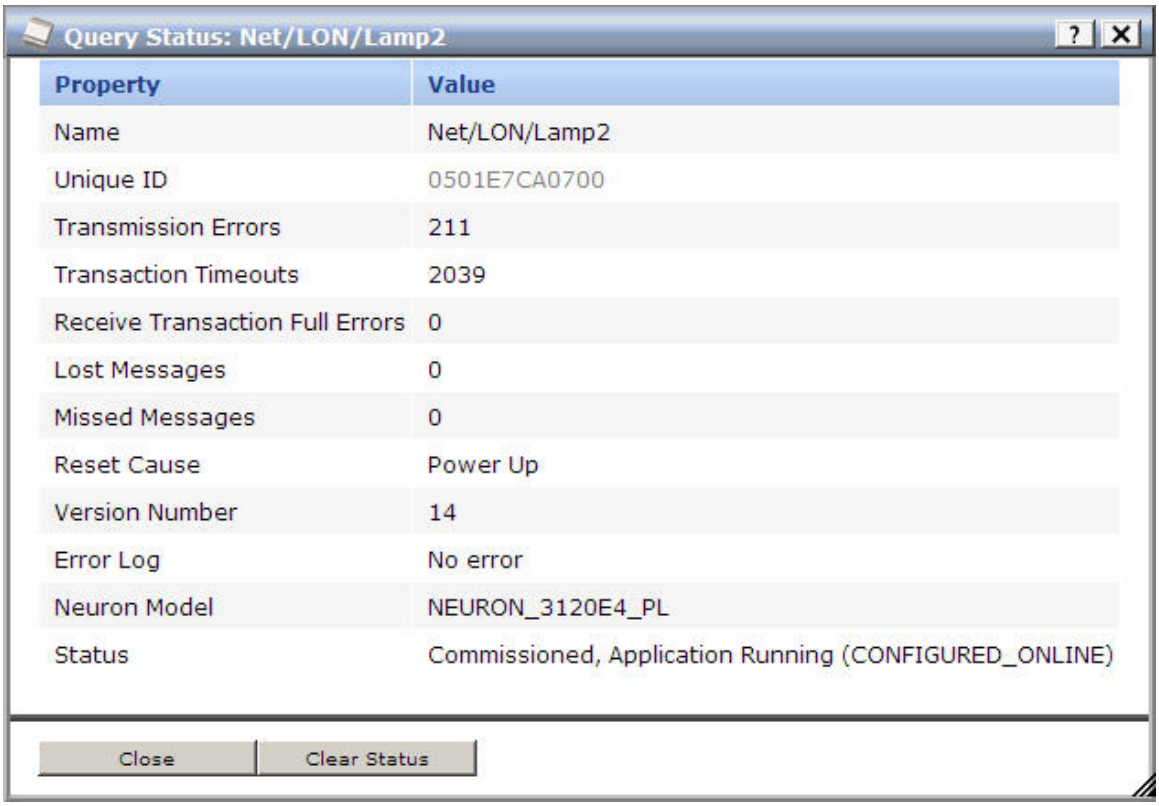
Querying Devices

You can query a device to evaluate its performance and diagnose problems. It is recommended that you query devices under both normal and peak conditions. To query a device, perform the following steps:

1. Right-click the device, select **Manage**, and select **Query Status**.



2. The **Query Status** dialog opens.



3. This dialog lists the following network statistics. Non-zero values indicate that the device was unable to receive or respond to a message. Small values are expected; rapidly increasing values could indicate a problem. If the device is consistently reporting failures and new errors are being logged, the device could have a configuration problem or the network could be overloaded.

Name	The name of the device in the following format: <*network*>/<*channel*>/<*device*>.
Unique ID	Displays the Neuron ID of the device as a 12-digit hex string. The Neuron ID is a unique 48-bit number persistently stored in the device's Smart Transceiver.
Transmission Errors	Transmission errors typically indicate cyclical redundancy check (CRC) errors. CRC errors are commonly caused by electromagnetic interference (EMI) on the channel.
Transaction Timeouts	Transaction timeouts occur when an acknowledged message times out after the last retry without the receiving device's sending a confirmation that the message was delivered.
Receive Transaction Full Errors	Transaction full errors occur when the device's transaction database, which is used to detect duplicate message packets, overflows. This error could indicate excessive network traffic or transaction timers that are set too high.

Lost Messages	Lost messages occur when a device's application buffer overflows. This error could indicate excessive network traffic or a busy device application. If the incoming message is too large for the application buffer, an error is logged but the lost message count is not incremented.
Missed Messages	Missed messages occur when a device's network buffer overflows or network buffers are not large enough to accept all packets on the channel, whether or not addressed to this device.
Reset Cause	Displays an error code that indicates the cause for the device's most recent reset. Check the LonMaker Turbo Editions Help file to locate a description of the error.
Version Number	Specifies the firmware version used by the device hardware.
Error Log	Indicates whether errors have been logged for the device.
Neuron Model	Displays the model number of the device's Smart Transceiver (3120®, 3150®, or 3170) or generic.
Status	Indicates the status of the device (configured or unconfigured) and the device application (online or offline).

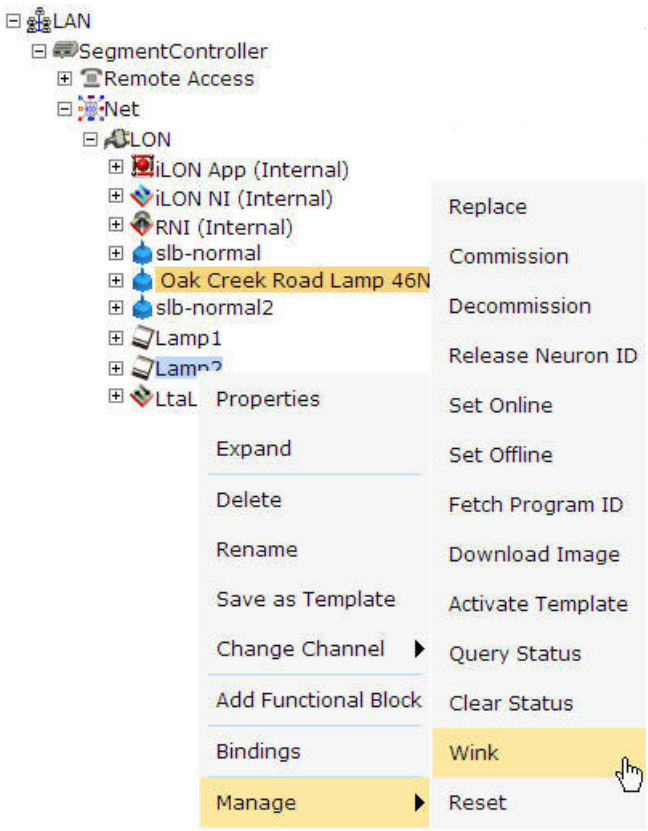
4. Click **Close** to exit this dialog.
5. Optionally, you can clear the log in the **Query Status** dialog: Click **Clear Status** in the **Query Status** dialog, or click **Close** to return to the SmartServer Web interface, right-click the device, select **Manage**, and select **Clear Status**.

Winking Devices

Winking a device enables you to identify the device on the network and verify that it is communicating properly. A device that supports the Wink command generates an application-dependent audio or visual feedback, such as a beep or a flashing service LED, when winked. For a Street Light Bridge module, the Wink command causes the module to flash its orange RF LED for approximately five seconds before returning the RF LED to its normal operational state.

To wink a device, perform the following steps:

1. Select one or more devices to wink. To select one device, click that device. To select multiple devices, click one device and then either hold down CTRL and click all other devices to be winked, or hold down SHIFT and select another device to wink the entire range of devices.
2. From the Setup tab of the device, right-click one of the selected devices, select **Manage**, and select **Wink**.



Deleting Devices

You can delete a device to logically remove it from the network: Right-click the device, and select **Delete**. The device is removed from the SmartServer. If you delete a device that was serving as a repeating agent, the SmartServer automatically identifies alternate repeating devices to relay network messages to those target devices that were using the deleted device in their repeating chains.

6

Controlling a Street Lighting Network

This chapter describes how to use the Scheduler application on the SmartServer to control the devices on a street lighting network.

Scheduling Overview

The SmartServer contains an Event Scheduler application that you can use to schedule data point updates (called events) to occur at sunrise and sundown, or at a configured amount of time before or after. For example, you can schedule luminaires to turn on at sundown, dim at the end of the evening rush hour, brighten at the start of the morning rush hour, and then turn off at sunrise.

Each Event Scheduler includes day-based daily schedules and date-based exception schedules. To create a daily schedule, you specify the days for which the schedule occurs (for example, Monday–Friday or Saturday–Sunday) and then create the events to be executed by the schedule. To create an exception schedule, you select a range of dates for which an exception occurs and specify how frequently the exception recurs, such as every weekday or weekend day. After you create the exception schedule and define when and how often it occurs, you create events in the exception schedule.

The events you create in the daily and exception schedules change the state and values of the luminaires on the network. In the daily schedule, you create events that turn on, brighten, and dim the streetlights based on the times at which the morning and evening rush hours start and end. In the exception schedule, you create events that turn on and turn off the light based on the sunrise and sundown times.

You can create a single Event Scheduler that handles multiple street lighting network scenarios. For example, you could create an Event Scheduler that turns the luminaires on at sundown while the evening rush hour is ongoing, and then dims them at the end of the evening rush hour. If the evening rush hour ends before sundown, the same Event Scheduler can just turn on the lights in the dimmed state at sundown. Or if sundown occurs before the start of rush hour, it can turn on the lights in the dimmed state at sundown, brighten them at the beginning of the evening rush hour, and dim them back at the end of the evening rush hour.

Before you can schedule events based on sunrise and sundown, you need to configure the Real-Time Clock on the SmartServer. The Real-Time Cock maintains the current date and time on the SmartServer. It also includes an astronomical position sensor application that takes the time stored on the SmartServer and its location (geographic coordinates), and determines the position of the sun (elevation and azimuth) relative to the SmartServer, calculates the sunrise and sundown times based on the position of the sun, and then passes the calculated sunrise and sundown times to the Event Scheduler.

Tip: You can use a data logger to verify that your Event Scheduler is updating the data points at the appropriate times. For more information on using the Data Logger and using the Scheduler application, including for network applications other than street lighting, see the *i.LON SmartServer User's Guide*.

To create a schedule for a street lighting network, perform the following general steps:

1. Configure the Real-Time Clock on the SmartServer. See *Configuring the Real-Time Clock* on page 79.
2. Create an Event Scheduler. See *Creating Event Schedulers* on page 83.

3. Select the data points to be updated by the Event Scheduler. See *Selecting Data Points* on page 88.
4. Create the daily schedules: set the days for which the daily schedules are used and creating events. See *Creating Scheduled Events* on page 90.
5. Create the exception schedules: set the range of dates and recursions for which the exception schedules are used and creating events. See *Creating Exception Schedules* on page 92.

Configuring the Real-Time Clock

The real-time clock on the SmartServer provides the Event Scheduler with calculated sunrise and sundown times. To configure the real-time clock, you specify an existing SNTP time server to add to the LAN on which the SmartServer resides or you manually specify the time. After you store the time of day on the SmartServer, you enter the geographic coordinates of the SmartServer.

Based on this information, the astronomical position sensor application on the SmartServer calculates the position of the sun relative to the SmartServer and stores this information in **nvoElevation_005** and **nvoAzimuth_005 SNVT_angle_deg** data points. The SmartServer then uses the data points to calculate the sunrise and sundown times and stores the results in **nvoSunrise** and **nvoSunset SNVT_time_stamp** data points. The information in these data points is then passed to the Event Scheduler so that you can create events based on the calculated sunrise and sundown times.

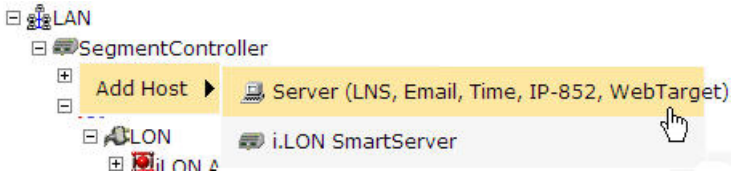
Setting the SmartServer Time

For the SmartServer to calculate the position of the sun, you need to store the time of day on it. You can add an SNTP time server to the LAN on which the SmartServer resides, or you can manually configure the time.

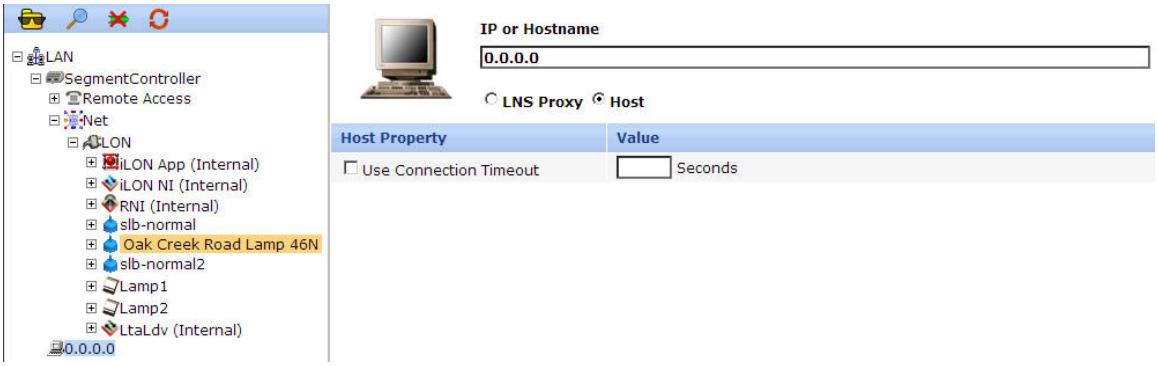
Adding an SNTP Time Server

To specify an SNTP server to add to the LAN, perform the following steps:

1. Right-click the **LAN** icon or a dial-out connection icon, select **Add Host**, and select **Server (LNS, Email, Time, IP 852, WebTarget)** from the shortcut menu, or if are you adding the time service to an existing server on the LAN, skip to step 4.

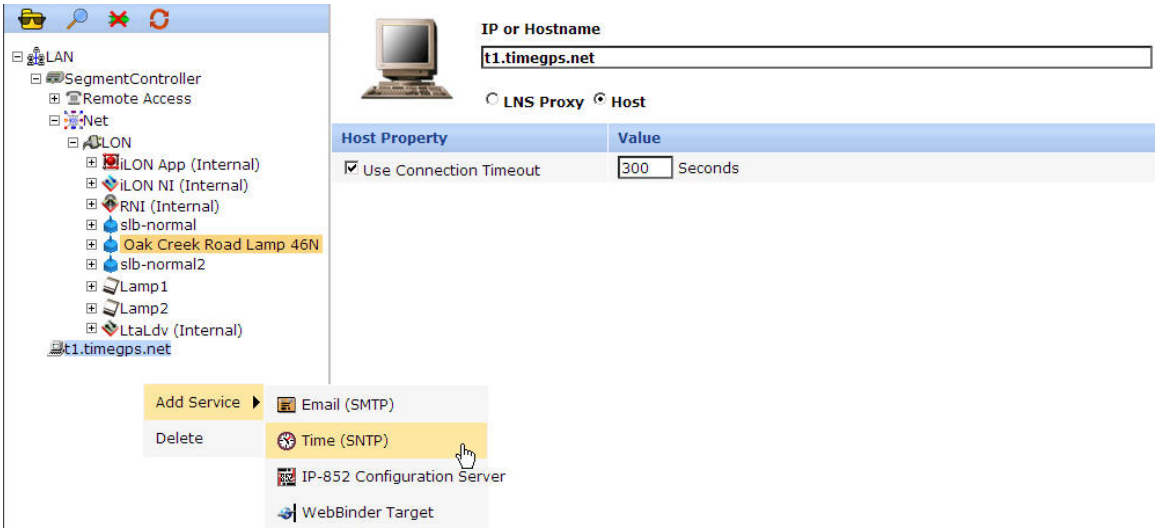


2. The Setup Host Web page opens, and a server icon is added one level below the LAN icon at the bottom of the navigation pane or one level below the dial-out connection icon.



3. Enter the IP address or hostname[6] of the SNTP server and click **Submit**. The server icon in the tree is updated with the IP address or hostname that you entered.

4. To specify that the SNTP server that you added supplies time service for your network, right-click the server icon, select **Add Service**, and select **Time (SNTP)** from the shortcut menu.



5. The Set Up Time Service Web page opens.

[6] Your corporate or municipal network might already include one or more SNTP servers. If not, you can find a public-access SNTP server from the Internet; for example, see support.ntp.org/bin/view/Servers/WebHome.

Property	Value
Time Server Port	123 (not configurable)
Time Synchronization Mode	Automatic
Time Synchronization Interval	12 Hours
Use as	Default Backup

6. Configure the following time (SNTP) server properties:

Time Server Port — The port used by the SmartServer to receive time data. The default value is **123**, and it cannot be changed. Contact your IT department to make sure that your firewall is configured to allow you to access the time server on this port.

Time Synchronization Mode — Select the frequency in which the SmartServer is synchronized to the SNTP server:

- **Automatic**. The SmartServer is synchronized every 1 to 15 minutes and remains within 100 ms of the SNTP server. This is the default, and it can be used for both LAN and dial-out (modem and GPRS) connections.
- **Sync when Dial-Up is active**. The SmartServer clock is synchronized when a dial-out connection is established. This option can only be used for dial-out connections (modem and GPRS).
- **Fixed Interval**. The frequency in which the SmartServer is synchronized is based on the value in the **Synchronization Interval** property. This option can only be used for Ethernet connections.
- **Disabled**. The SmartServer is not synchronized with the SNTP server.

Time Synchronization Interval — Set how often the SmartServer clock is synchronized with the SNTP server. This option is only available if **Fixed Interval** is the selected synchronization method. The default synchronization interval is **12 hours**.

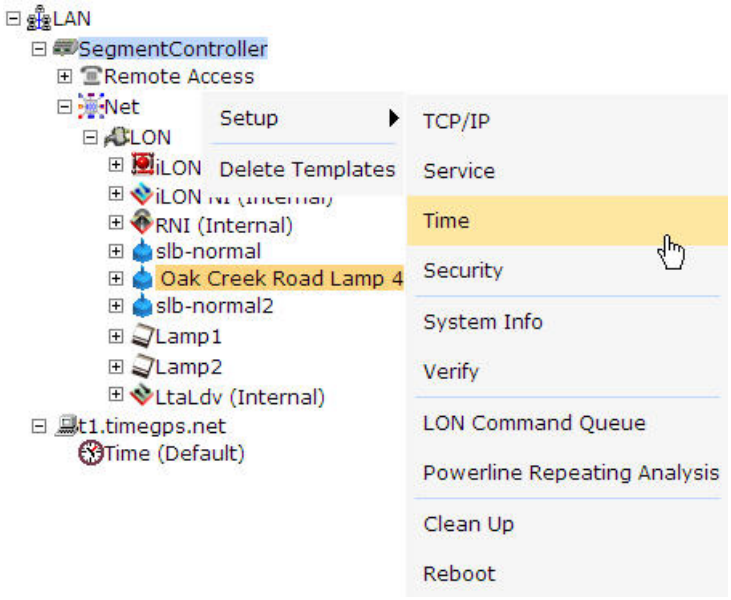
Use As — Select whether this time server is the **Default** or the **Backup** time server. If this is the first time service created on the SmartServer, this option is set to **Default**. If another time service is currently designated as the default and you select **Default**, the default designation will be removed from the other time server when you click **Submit**.

7. Click **Submit** to save the changes.

Manually Configuring the Time

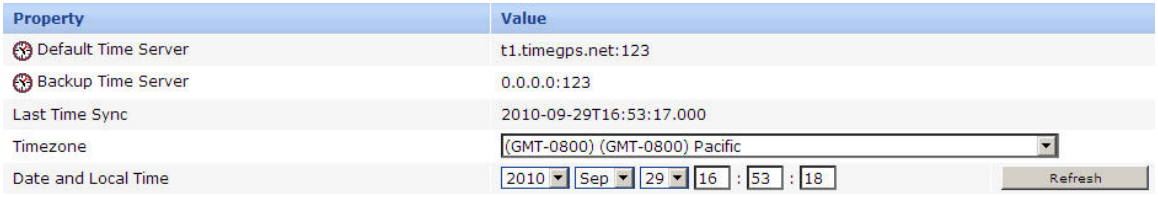
You can manually configure the SmartServer's real-time clock:

1. Right-click the **SmartServer** icon, select **Setup**, and select **Time** from the shortcut menu.



   Alternatively, you can click **Tools** and then select **Time** to configure the time settings on the local SmartServer.

2. The Setup Time Web page opens.



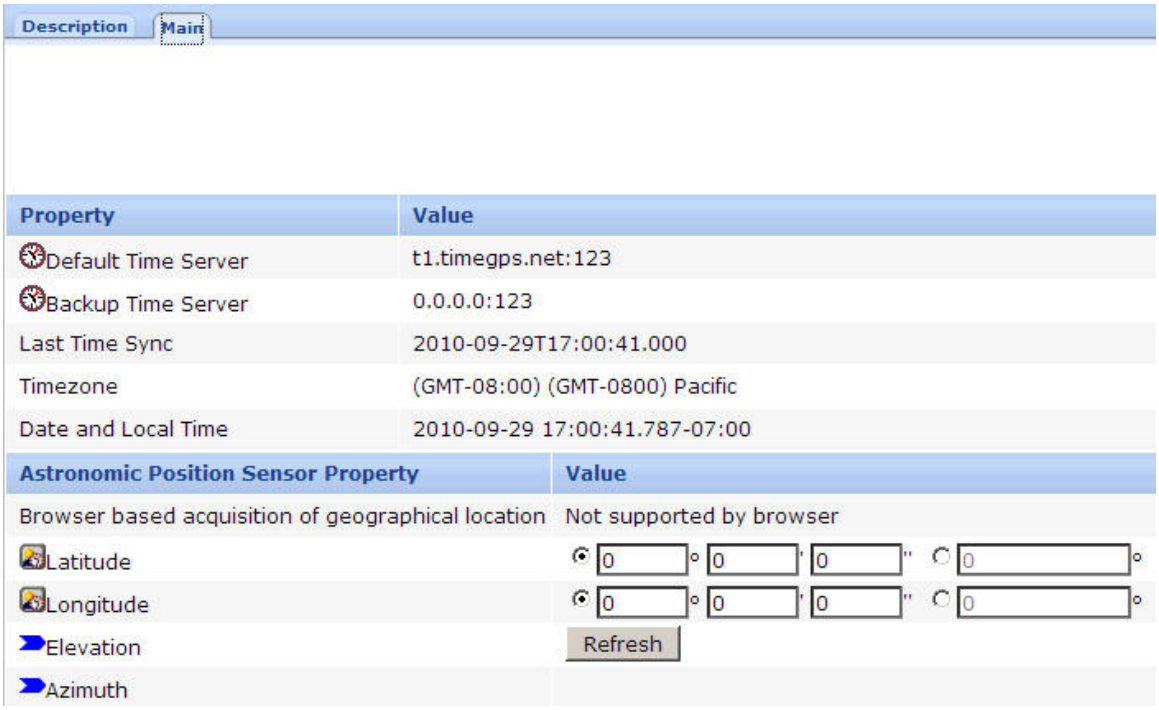
3. In the **Timezone** property, select the time zone in which the SmartServer is located.
4. In the **Date and Local Time** property, enter the time and date to be stored in the SmartServer's real time clock. You might need to refresh the Web page to view the current time.
5. Click **Submit** to save the changes.

Note that if the **Last Sync Time** property does not show a valid timestamp for the SNTP server's most recent synchronization (for example, if it shows "Unknown"), it is likely that the configuration for the SNTP server is incorrect. Check that the server name is correct and that port 123 is available.

Entering the Location of the SmartServer

You can enter the geographic coordinates of the SmartServer:

1. Open the Real-Time Clock application on the SmartServer: Expand the **Net** network icon, expand the **LON** channel, expand the **i.LON App (Internal)** device, and then click the **Real-Time Clock** functional block.
2. The Real Time Clock Configure Web page opens.



3. Configure the following properties for the real-time clock and astronomical position sensor on the SmartServer:
   - In the **Latitude** property, enter the north-south location of the SmartServer relative to the equator. Select the first radio button to enter the latitude in sexagesimal notation (degrees, minutes, and seconds); select the second radio button to enter the latitude as a decimal fraction. If the SmartServer is located south of the equator, enter a negative value between 0 and –90. If it is located north of the equator, enter a positive value between 0 and 90.
   - In the **Longitude** property, enter the east-west location of the SmartServer relative to the Prime Meridian. Select the first radio button to enter the longitude in sexagesimal notation (degrees, minutes, and seconds); select the second radio button to enter the longitude as a decimal fraction. If the SmartServer is located west of the Prime Meridian, enter a negative value between 0 and –180. If it is located is located east of the Prime Meridian, enter a positive value between 0 and 180.
4. Click **Submit**.

Creating Event Schedulers

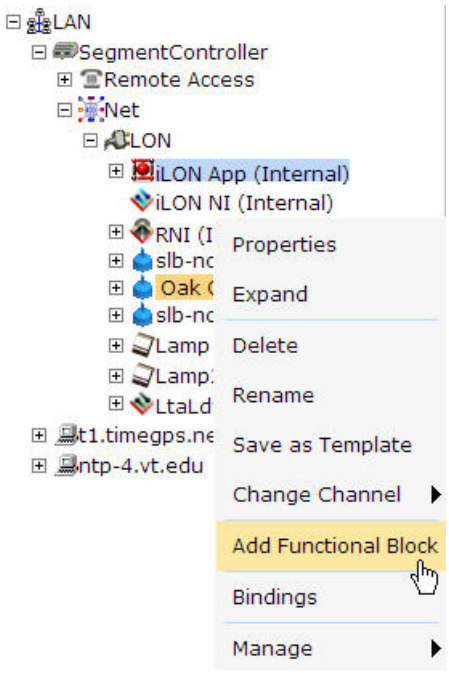
You can create a single Event Scheduler with multiple exception schedules to control a street lighting network. For example, you can create one exception that turns off the lights at sunrise, a second exception that turn the lights on or fully

illuminates them at the beginning of the morning and evening rush hours, and a third exception that dims the lights at sunrise and sundown.

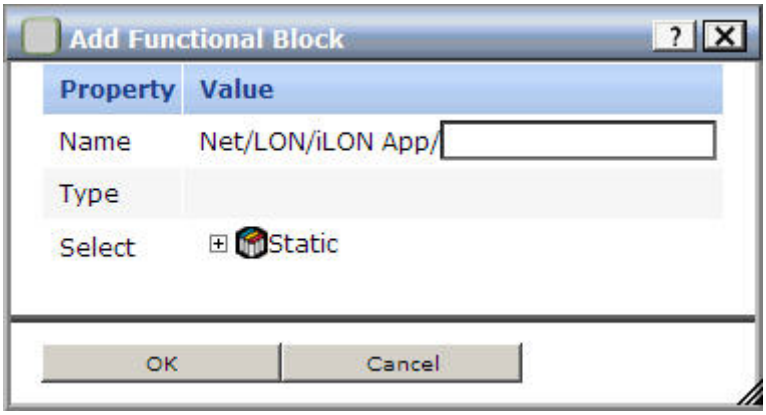
To open an Event Scheduler application, you must first create a **Scheduler** functional block, if the available functional blocks are not already displayed in the tree view for the **i.LON App (Internal)** device. After you create the **Scheduler** functional block, the functional block appears on the SmartServer tree below the **i.LON App (Internal)** device. You can then click the functional block and begin configuring the Event Scheduler application.

To create a **Scheduler** functional block and open the application, perform the following steps:

1. Expand the **Net** network icon in the SmartServer tree, and expand the **LON** channel to show the **i.LON App (Internal)** device.
2. Right-click the **i.LON App (Internal)** device, and select **Add Functional Block** from the shortcut menu.

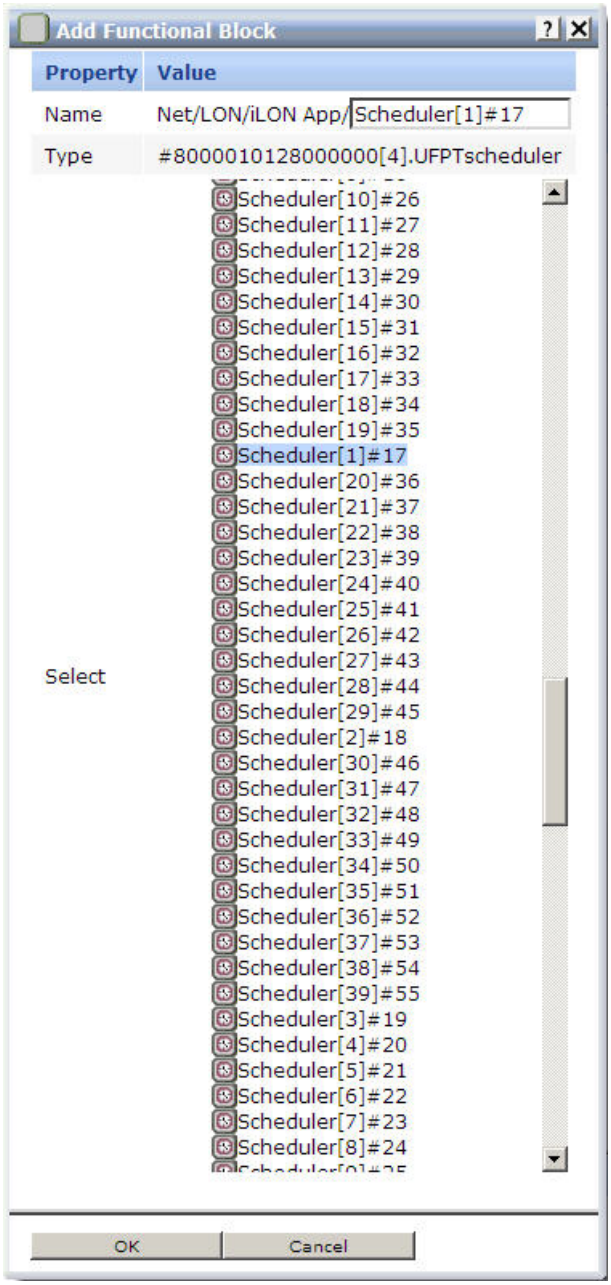


3. The **Add Functional Block** dialog opens.



4. Select the Scheduler functional block from the **Static** or **Dynamic** LONMARK folder. The folder available in the dialog depends on whether the SmartServer is using the static v12 external interface (XIF) file or the dynamic v40 XIF file.

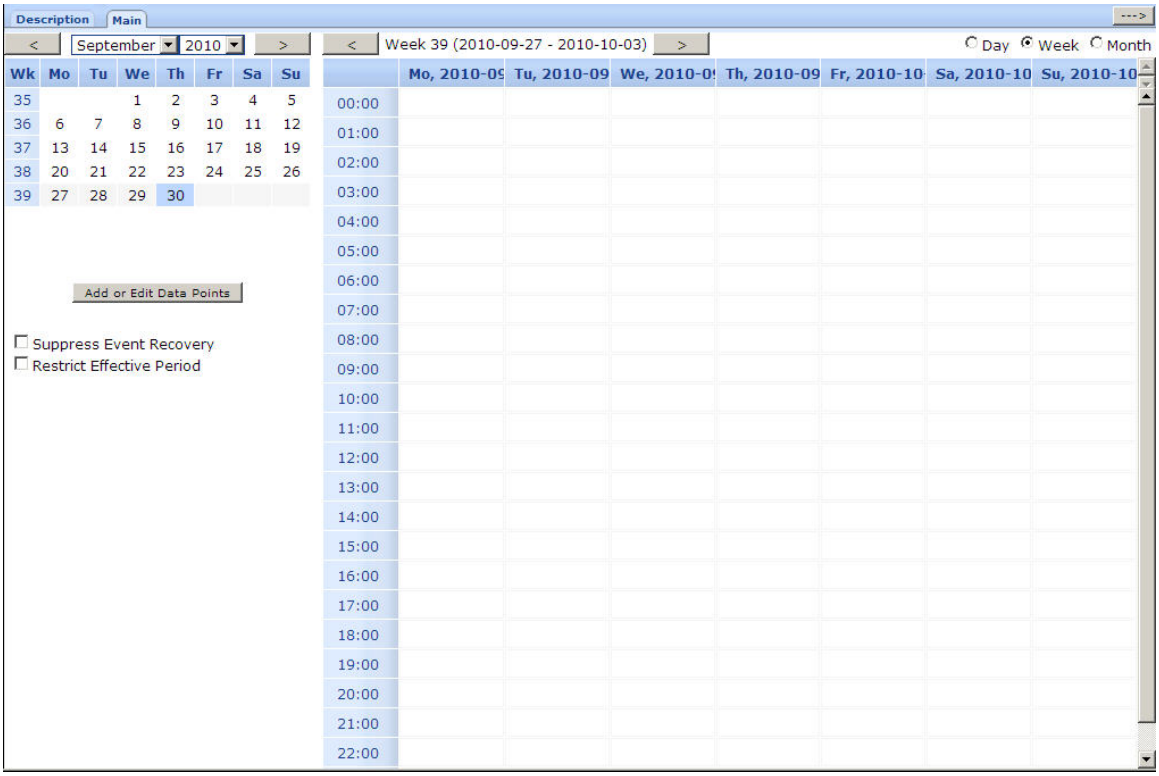
   - If the SmartServer is using the static v12 XIF file (the default), expand the **Static** icon, select the **Scheduler** functiona1 block, optionally enter a different name than the default programmatic functional block name, and then click **OK**.



   - If the SmartServer is using the dynamic v40 XIF file, you can select the Scheduler functional block from either the **Static** or the **Dynamic** folder. To select the Scheduler functional block from the **Dynamic** folder, expand the **Dynamic** icon, expand the

root/lonworks/types folder, expand the **bas_controller** folder, select the user-defined functional profile template (UFPT) for the Scheduler, enter a name for the functional block such as "Scheduler 1", and then click **OK**.

5. A calendar view for the current date opens.



6. Optionally, you can select the **Restrict Effective Period** checkbox to configure the period of time for which the Event Calendar and Event Scheduler are active, respectively. By default, both are active for a 37-year period starting on January 1, 2000 and ending December 31, 2037. To configure a different effective period, specify the Start Date and Stop Date. If you clear the checkbox, the default 37-year effective period is used.

7. By default, the **Suppress Event Recovery** checkbox is cleared. Clearing this checkbox means that the Scheduler executes the next scheduled event when the SmartServer reboots, the system time changes, or a data point's priority is reset at the end of a one-time exception. This option enables the SmartServer to maintain the current value stored in the data point if the data point is overridden by another application. Selecting the checkbox allows the Scheduler to attempts to restore the values and priorities of the selected input points by searching for the most recent past event and executing it.

   The Scheduler exclusively determines the value of each selected input point (as long as it has the highest priority assigned to the data point).

8. Click **Submit**.

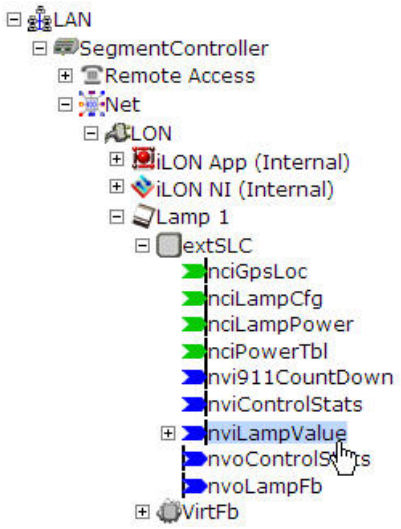
To open the Scheduler application from an existing Scheduler functional block, perform the following steps:

1. Click the Scheduler functional block representing the Scheduler to be opened. The Scheduler Web page opens in the application frame to the right.

Adding Data Point Preset Values

You can select and configure the input points to be updated by the Event Scheduler application. To select a data point, perform the following steps:

1. Expand the **Net** network icon, expand the **LON** channel, expand the tree view for the lamp or other device (for example, **Lamp 1**), expand the device's primary functional block and click the data point for which you want to set a preset. For example, to select a luminaire's control data point, select **nviLampValue** (or similar data point for your device).



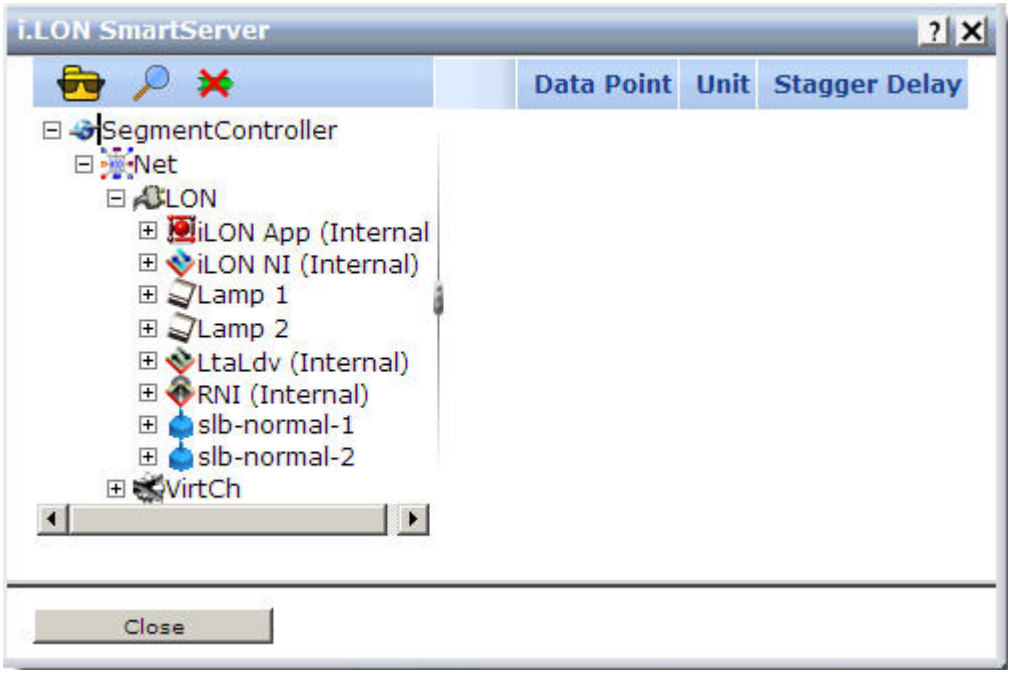
2. The **Data Point Property** Web page opens.
3. Click **Add Preset** to add a preset value for the data point: a new row is added to the preset area. Give each preset a name and a value. You can add as many presets for the data points as needed. For example, for a luminaire, you might define an on value (100% on), an off value, and a dim value (say, 60% on).

4. Click **Submit**.

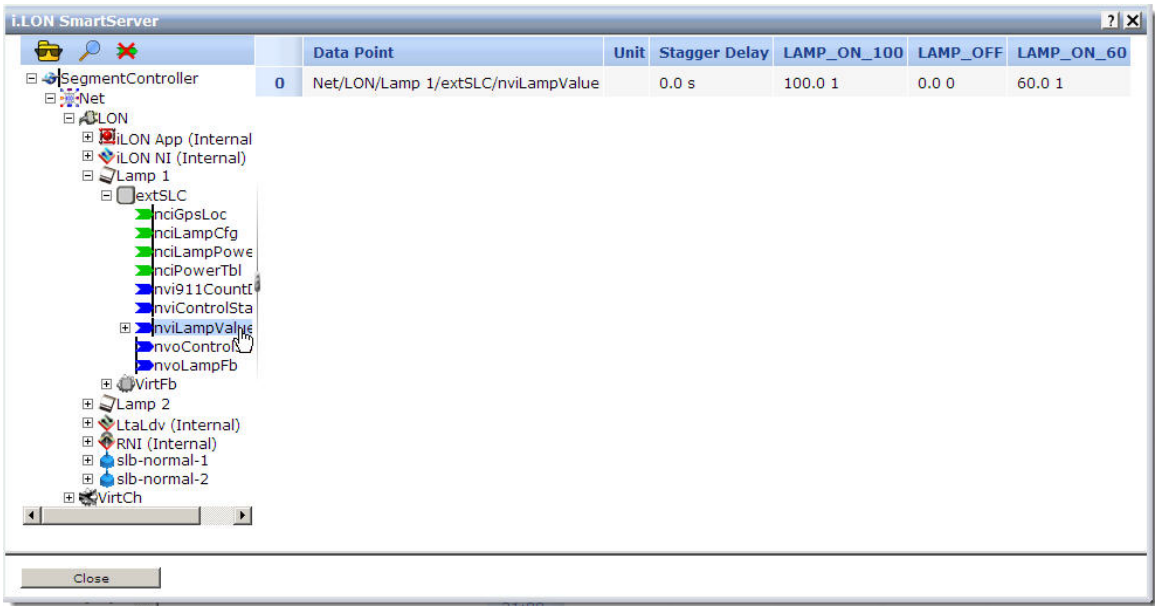
Selecting Data Points

You can select and configure the input points to be updated by the Event Scheduler application. To select a data point, perform the following steps:

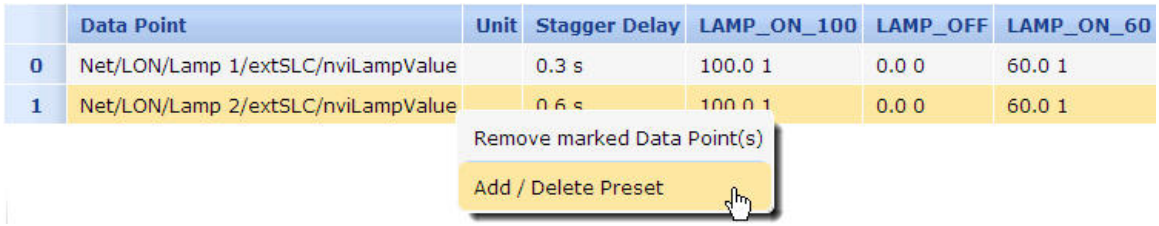
1. Expand the **Net** network icon, expand the **LON** channel, expand **i.LON App (Internal)**, and select the scheduler for which you want to select data points. See *Creating Event Schedulers* on page 83 to create an event scheduler.
2. The calendar view for the current date opens. Click **Add or Edit Data Points** to open the Add or Edit Data Points dialog.



3. Expand the tree view for the device for which you want to add a data point, and expand its primary functional block.
4. Select the data point to add it to the scheduler.



5. Repeat steps 3 and 4 for each data point that you want to add.
6. Optionally, you can click the **Stagger Delay** column to specify the period of time (in seconds) that the Event Scheduler waits before updating the specified data point at each schedule interval. This setting enables you to ramp up or wind down a system. Click **Submit**.
7. Optionally, you can add new presets to a data point or delete existing presets:
    a. Right-click the data point and select **Add/Delete Preset** from the shortcut menu.



    b. The **Add/Delete Preset** dialog opens.

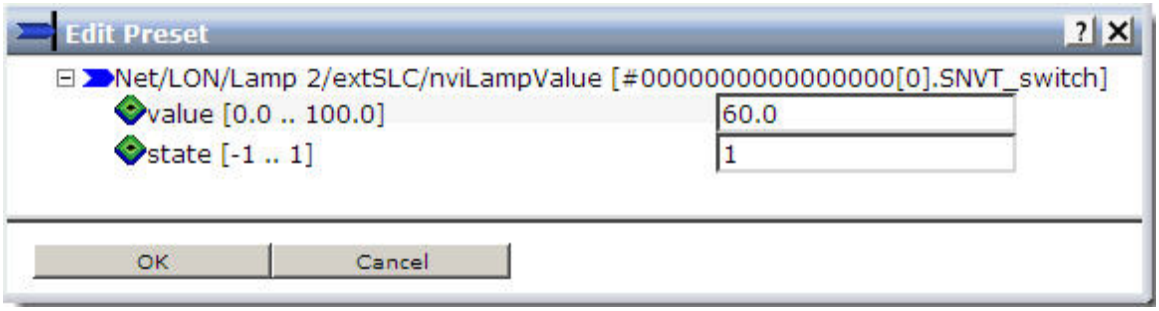
- To create a new preset, select the **Add** radio button, enter the name of the new preset in the field, and click **Add**. The new preset appears without a value in the **Scheduler: Data Points** Web page.

- To delete an existing preset, select the **Delete** radio button, select the preset to be deleted from the dropdown list box, and click **Delete**. The preset is removed from the **Scheduler: Data Points** Web page.

c. Click **Close**.

8. Optionally, you can edit the values of existing presets:

a. Click the preset to be edited. The **Edit Presets** dialog opens.



b. Enter the value (or values, if you are editing the preset of a structured data point) for the preset.

c. Click **OK**.

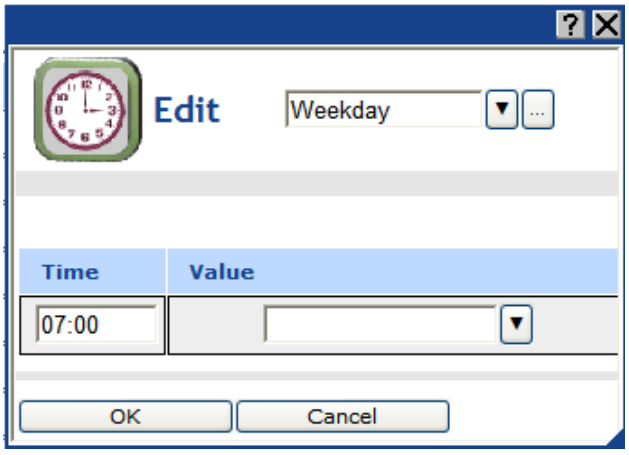
9. Click **Submit**.

Creating Scheduled Events

You can create scheduled events for the Event Scheduler.

1. Open the scheduler so that the calendar view for the current date opens. See *Creating Event Schedulers* on page 83 to create an event scheduler.

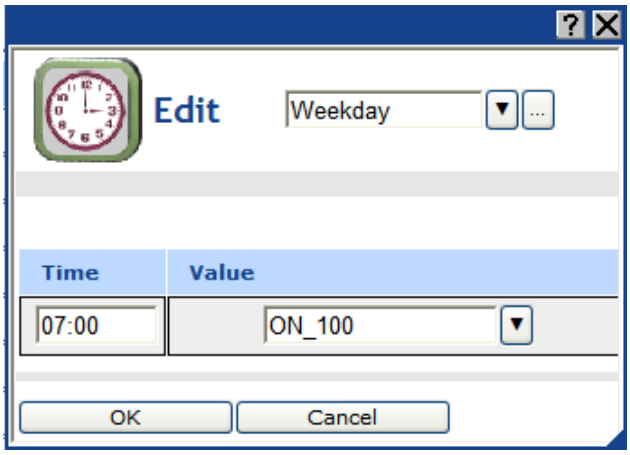
2. Left-click in the calendar (or right-click anywhere in the calendar view page and select **Add** → **New Event**) to open the Edit Event dialog.



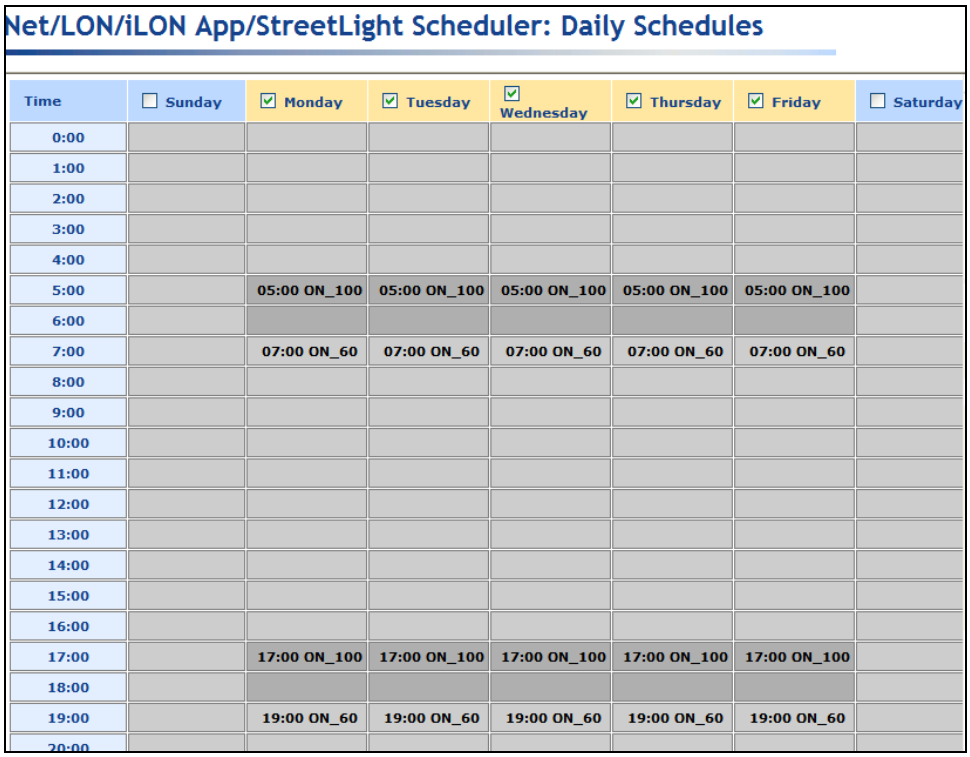
3. By default, the daily schedule in which the selected day is a member is displayed at the top of the dialog (for example, **Weekday**, **Weekend**, or some other user-defined daily schedule). You can select a different daily schedule from the list to add events to that daily schedule. In addition, you can click the box to the right of the daily schedule list to open the

Edit Daily Schedules dialog and configure the scope of the daily schedules. See ***Error! Reference source not found.*** on page **Error! Bookmark not defined.** for more information about configuring the daily schedules.

4. In the **Time** box, enter the exact time that the event is to occur (if it is different than the default time, which is on the hour of the selected time). For example, to create an event that occurs at 7:15 A.M. instead of the default 7:00 A.M, enter **07:15**. Note that you can create up to one event per minute.
5. In the **Value** box, perform one of the following tasks:
   - Select the preset to be used to update the values of all the data points added to the Scheduler that have that preset defined for them. Alternatively, you can enter a new preset and then go back to the **Scheduler: Data Points** Web page and define the value (or values) for the preset.



   - Enter a valid value to be written to all the data points. To enter a value, all the data points added to the Scheduler must have the same network variable type (for example, **SNVT_switch**).
6. To create additional events in the daily schedule, right-click anywhere in the **Time** or **Value** boxes, and select **Add** from the shortcut menu. A new row for the event is added to the **Edit** dialog. Repeat steps 3–4 to specify the **Time** and **Value** properties of the new event.
7. Click **OK** to save your events and return to the **Scheduler: Daily Schedules** Web page. Click **Cancel** to delete all changes and return to the **Scheduler: Daily Schedules** Web page.
8. The **Scheduler: Daily Schedules** Web page is updated to reflect the events that you created, which are listed under each day of the selected daily schedule. For example, if you created events for Monday, and Monday is in the default Monday–Friday **Weekday** schedule, the events that you created are listed under the Tuesday, Wednesday, Thursday, and Friday schedules. If you scheduled multiple events within an hour, an arrow appears to the right of the time under the **Time** column. You can click the arrow to show all the events under that time.



Note: To edit an event, click the event in the **Scheduler: Daily Schedules** Web page, change the time or value, and click **OK**. To delete an event, click the event in the **Scheduler: Daily Schedules** Web page, right-click the event, select **Delete** from the shortcut menu, and click **OK**.

9. Repeat steps 1–6 to create events for other Daily Schedules in the Scheduler.
10. Click **Submit**.
11. Click **Back** to return to the **Scheduler: Configure** Web page.

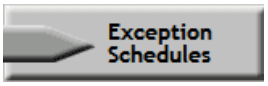
Creating Exception Schedules

You can use the exception schedule to select a range of dates for which an exception occurs and specify how frequently the exception recurs, such as every weekday or weekend day. After you define when and how often an exception occurs, you can create events for that exception.

Creating One-Time Exceptions

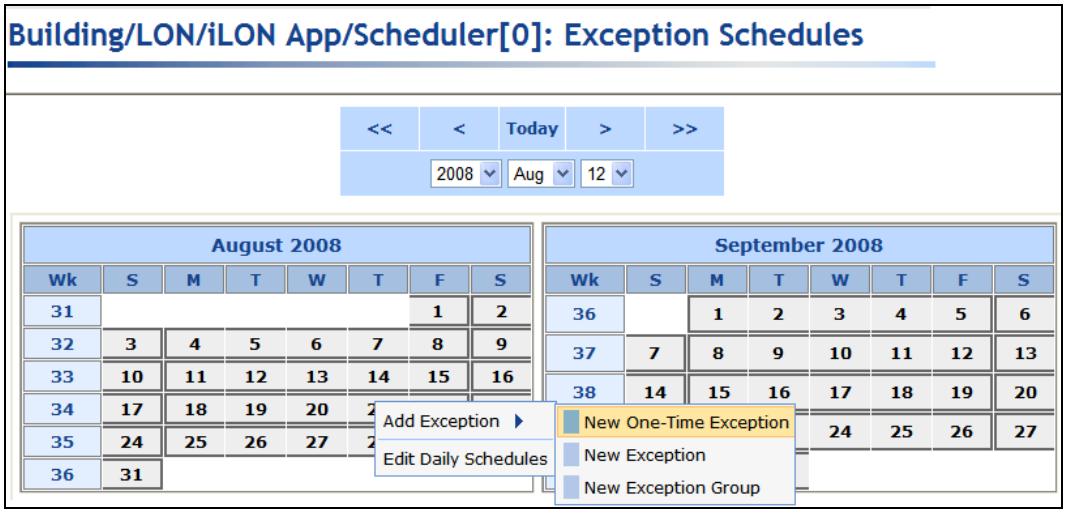
You can create a one-time exception to apply an alternate schedule for some period of time on a single calendar date such as May 20, 2011 or December 21, 2011. For a street lighting network, you might need to create one-time exceptions to overlap multiple exceptions to create a single solution that addresses all possible scenarios. To create a one-time exception, perform the following steps:

1. Click the Exception Schedules icon in the **Scheduler: Configure** Web page.

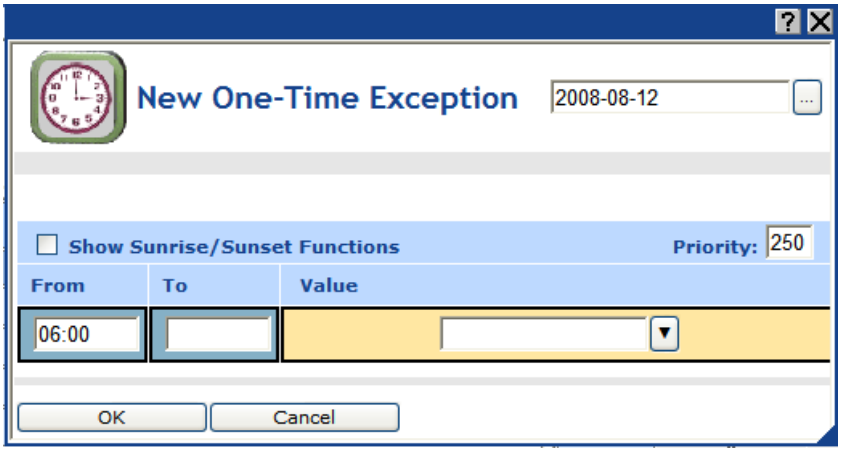


The **Scheduler: Exception Schedules** Web page opens.

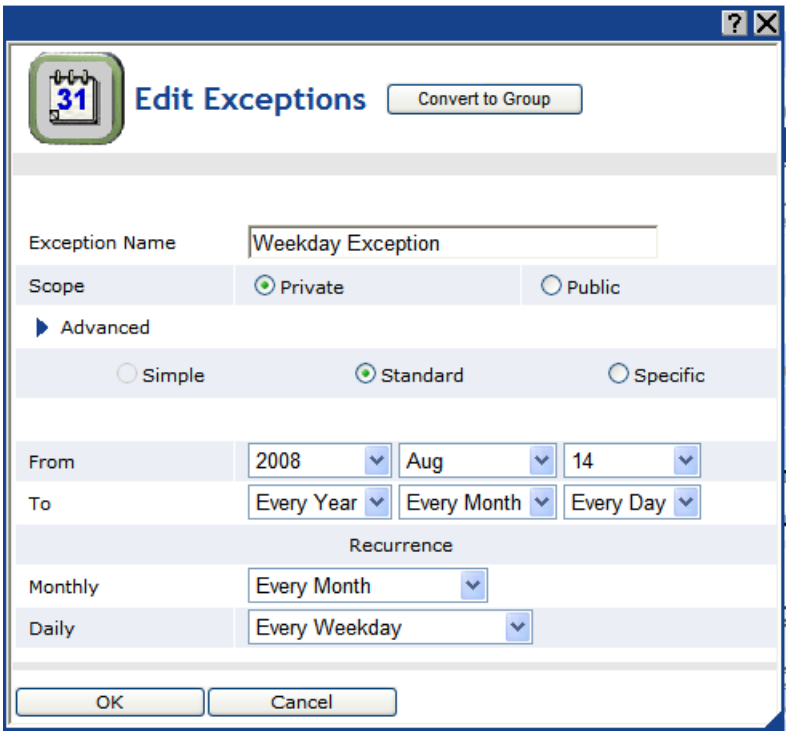
2. Right-click the date on which the one-time exception schedule is to be used, point to **Add Exception**, and select **New One-Time Exception** from the shortcut menu.



3. The **New One-Time Exception** dialog opens.



4. By default, the name of the one-time exception is the date for which it is being created. You can enter a different (perhaps more descriptive) name in the box at the top of the dialog. Additionally, you can click the box to the right of the one-time exception name to open the **Edit Exception** dialog and change the scope, dates, and recursions of the exception. See *Defining Exception Dates and Recursions* on page 96 for more information about the properties in this dialog.



5. Select the **Show Sunrise/Sunset Functions** checkbox to create events based on sundown and sunrise times. In the **Function** box, select the Sunrise ( ) or Sundown ( ) icon. The calculated sunrise or sundown time appears in the **Time** box, which becomes read-only, and an **Offset** box is added to the right of the **Time** box. In the **Offset** box, you can enter the time before or after sunrise or sundown that the event is to occur.

6. Specify the start and end time of the one-time exception by performing the following steps:

    a. In the **Time** box under the **From** property, enter the exact time that the event is to start.

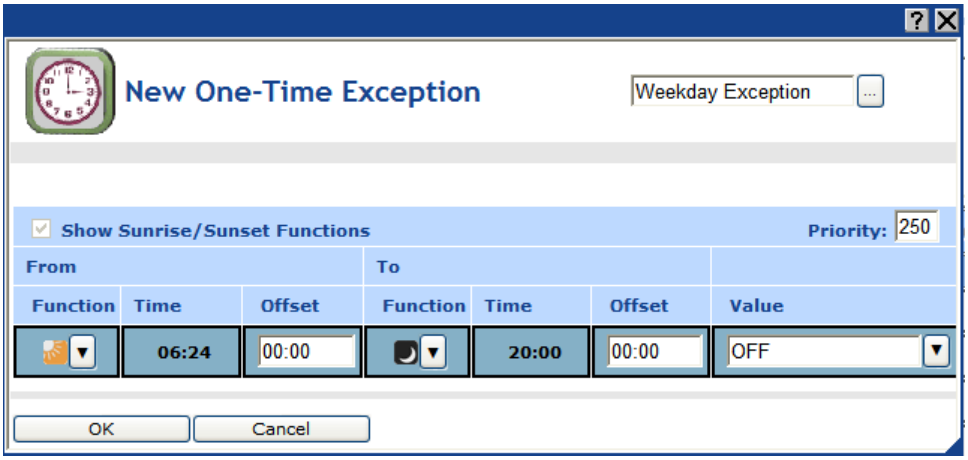
    b. In the **Time** box under the **To** property, enter the exact time that the event is to end.

    c. In the **Value** box, perform one of the following tasks:

    - Select the preset to be used to update the values of all the data points added to the Scheduler that have that preset defined for them. Alternatively, you can enter a new preset and then go back to the **Scheduler: Data Points** Web page and define the value (or values) for the preset.
    - Enter a valid value to be written to all the data points. To enter a value, all the data points added to the Scheduler must have the same network variable type (for example, **SNVT_switch**).

    d. In the **Priority** box, enter a priority for the event between 0 to 255 (highest to lowest priority). The default priority for an event in an exception schedule is five more than the priorities of events in the daily schedule. For example, if you created an event with a priority of 255 in the daily schedules, the events in the exception

schedule have a priority of 250. This priority essentially locks out events with lower priorities so that they cannot update the data points written to by this event. When the event ends, lower-priority events can update the data points.



e. To create additional events in the one-time exception, right-click anywhere in the **Time** or **Value** boxes, and select **Add** from the shortcut menu. A new row for the event is added to the dialog. Repeat steps a–c to specify the **Time** and **Value** of the new event in the one-time exception.

f. Click **OK** to save your events and return to the **Scheduler: Exception Schedules** Web page Web page. Click **Cancel** to delete all changes and return to the **Scheduler: Exception Schedules** Web page.

7. The date on which the one-time exception is to occur is highlighted teal (or dark blue) in the calendar.
8. Click **Submit**.
9. To edit the one-time exception, click the teal-highlighted date in the calendar. The **Edit: <***exception name***>** dialog opens. This dialog lists the events that are scheduled to occur on the selected date.

   The intervals specified by the events in the one-time exception are highlighted teal, and the events in the daily schedule are highlighted grey. When events in the one-time exception end, their priority is reset to 255 and the schedule reverts to the regular daily schedule. Thus, the highest priority event in the applicable daily and exception schedules that was supposed to occur prior to the event in the one-time exception is executed. If there are no such events, the next highest-priority event executes at its regularly scheduled time.

Creating Exceptions

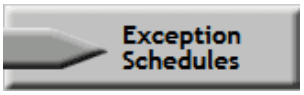
You can create an exception or recurring exception in the Event Scheduler. An exception is an alternate daily schedule that is used over a range of dates. A recurring exception is an alternate daily schedule that is used over a range of dates in a specific pattern (such as every third Sunday). To create an exception or recurring exception, you set the dates of the exception and then create the events in the exception.

Note: This section generally describes how to define the exception schedules. See *Demonstrating a Street Lighting Schedule* on page 105 for specific exception schedules that you can create for scheduling a street lighting network.

Defining Exception Dates and Recursions

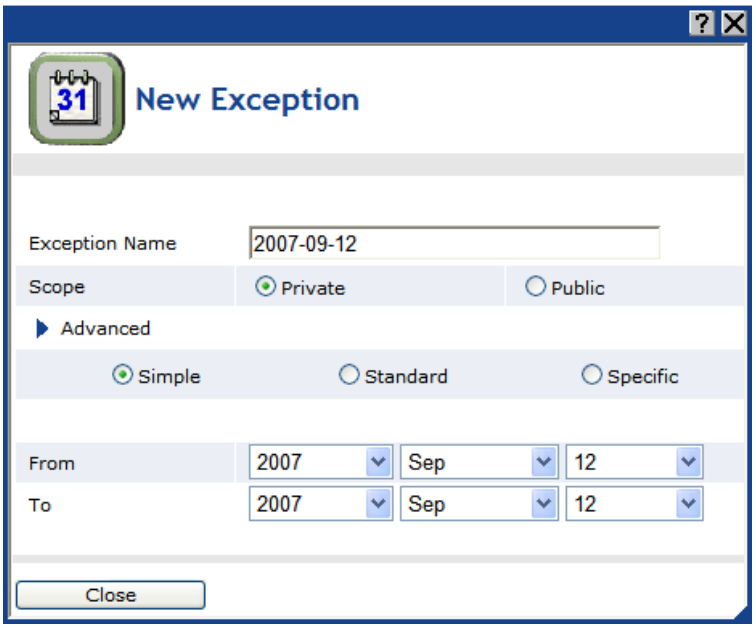
To define the dates and recursions of an exception in the Event Scheduler, perform the following steps:

1. In the **Scheduler: Configure** Web page, click the **Exception Schedules** icon.

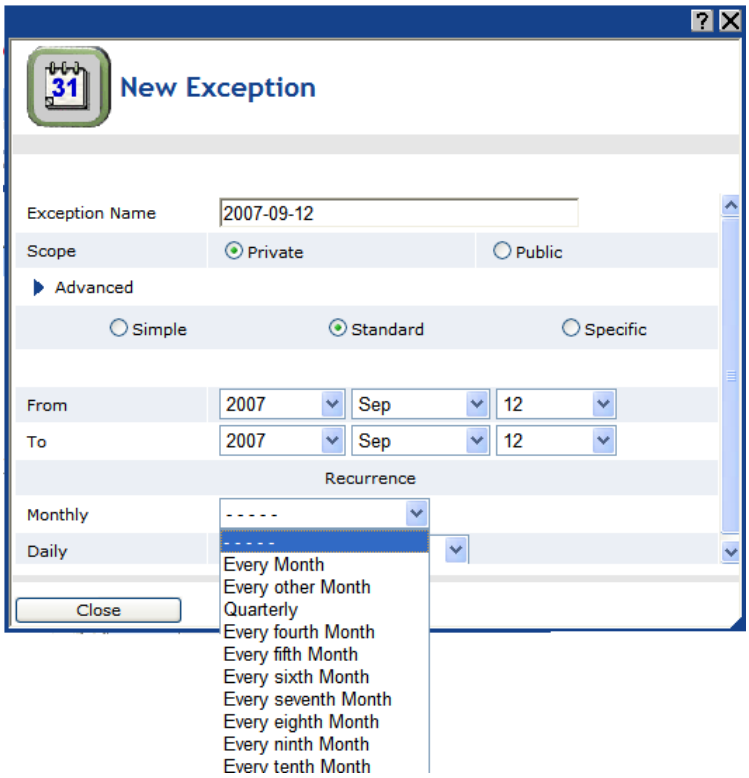


2. The **Scheduler: Exception Schedules** Web page opens.
3. Right-click the date that will be the start date for the exception schedule, point to **Add Exception**, and select **New Exception** from the shortcut menu.

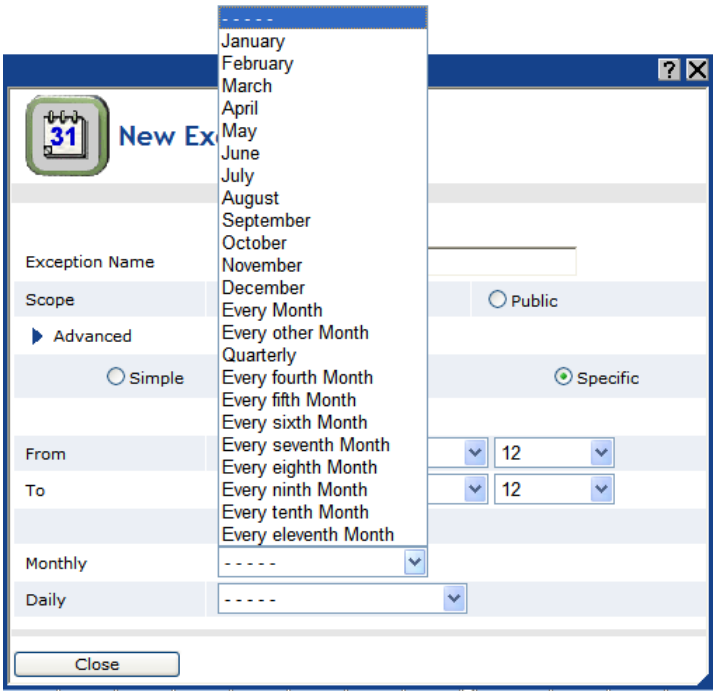
4. The **New Exception** dialog opens.



5. Enter a descriptive name for the exception. The default name is the selected start date in the following format: <*year*>-<*month*>-<*date*>.
6. Click the **Standard** or **Specific** radio buttons to expand the dialog to show the **Recurrence** property.
    - Clicking **Standard** lets you apply the exception to every month, every other month, every third month, and so on, up to every eleventh month. It also lets you apply the exception to specific days such as every Monday, every Tuesday, and so on; every weekday or every weekend day; and every other day, every third day, and so on, up to every sixth day.

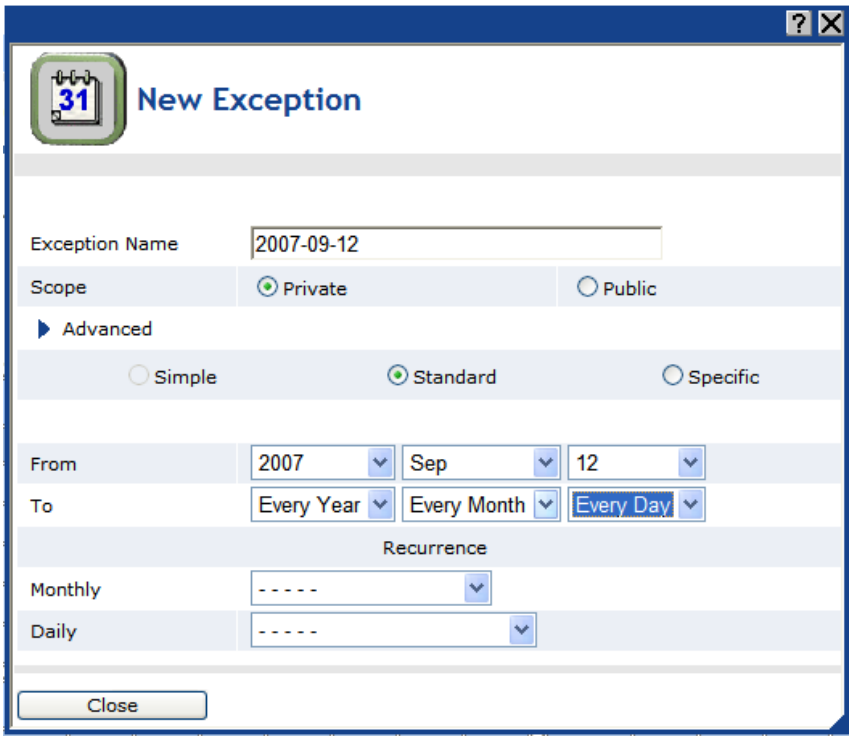


- Clicking **Specific** lets you apply the exception to specific months such as January, February, and so on, up to December, in addition to the monthly options offered by clicking **Standard**. It also lets you apply the exception to specific dates, such as the 1st to 30th day of the month; specific dates starting from the end of the month such as last day of the month, 2nd last day of the month, and so on, up to the 30th last day of the month; and specific recurring days such as every first, second, third, fourth, fifth, or last Sunday, Monday, and so on, up to Saturday. This is in addition to the daily options offered by clicking **Standard**.

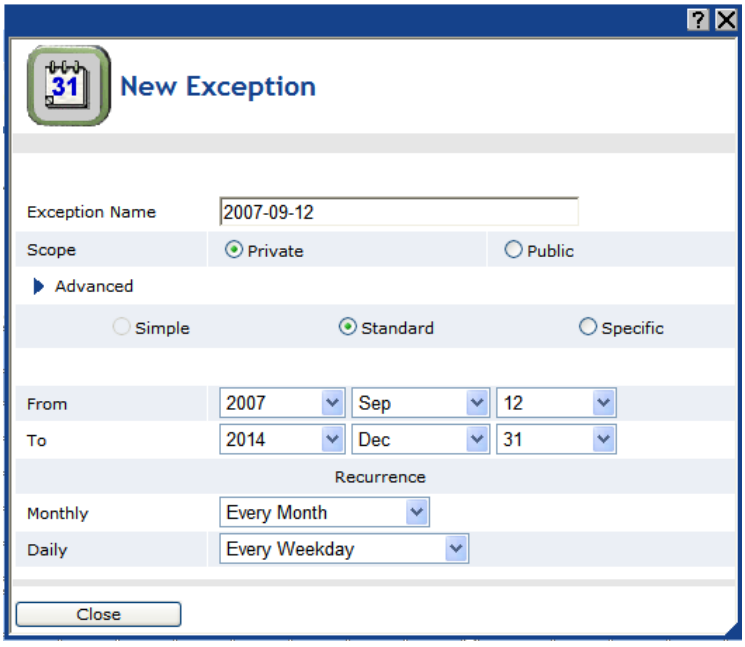


7. Specify the range of dates for which the exception schedule is used. Specify the start and end dates in the **From** and **To** properties, respectively.

   Tip: You can create an exception that occurs every day from the specified start time to the specified stop time instead of specifying actual start and end years, months, and dates. In the **To** and **From** properties, select **Every Year**, **Every Month**, or **Every Day** in the year, month, or day boxes based on when this recurring exception is to begin and end. This procedure is useful for creating complex recurring exceptions in which the recurring exception specified in this property is combined with the recursion defined in the **Recurrence** property. It is important to note, though, that it takes longer for the Event Calendar to calculate and display exceptions when complex recurring exceptions are used.



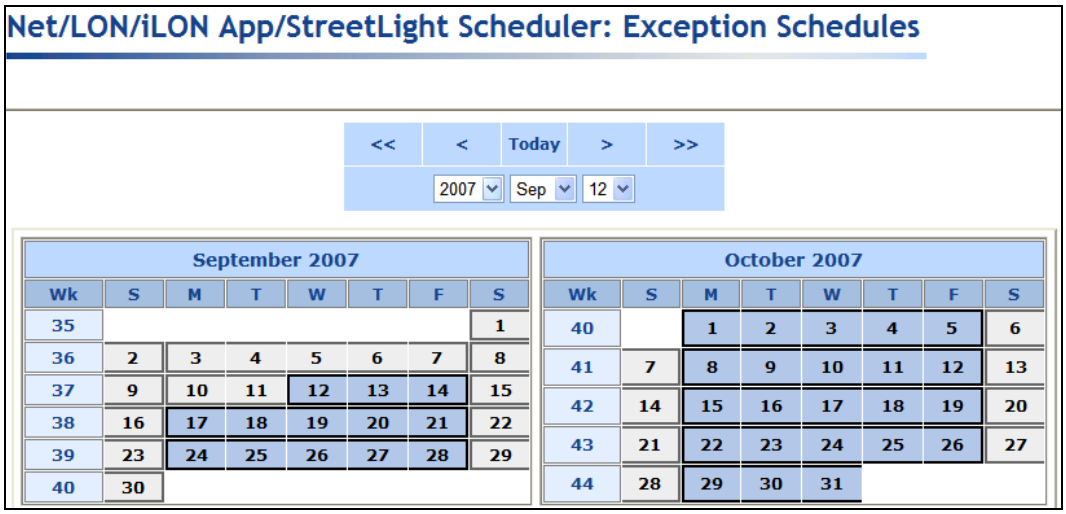
8. Under **Recurrence**, select the monthly and daily recursions from the **Monthly** and **Daily** lists. The default monthly recursion is every month. This means that if you do not specify a monthly recursion, the events occur every month within the specified range. The default daily recursion is every day. This means that if you do not specify a daily recursion, the events occur every day within the specified range.



9. Optionally, you can click **Convert to Group** at the top of the dialog to open the **New Exception Group** dialog. You can use this dialog to create a new exception group (a set of individual exceptions that share the same

schedule) that includes this exception and one or more other existing exceptions.

10. Click **OK** to add the exception and return to the **Scheduler: Exception Schedules** Web page (click **Cancel** to discard all changes and return to the **Scheduler: Exception Schedules** Web page). The range of dates on which the exception is to occur is highlighted light blue in the calendar and outlined with a color differentiating it from the other exceptions in the calendar.
11. Click **Submit**.

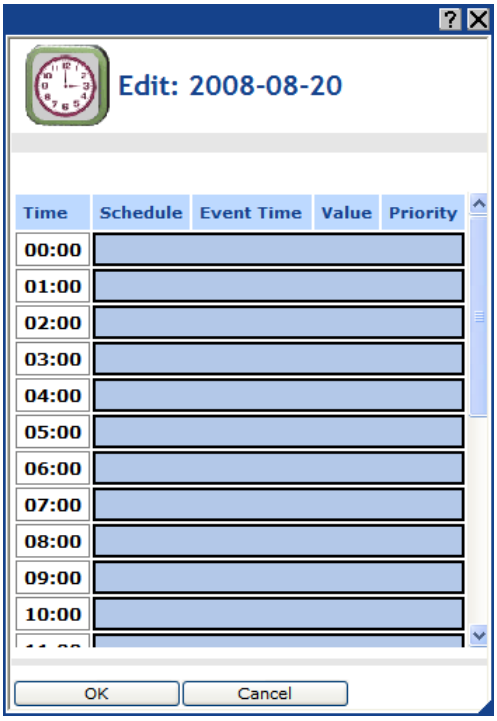


Creating Exception Events

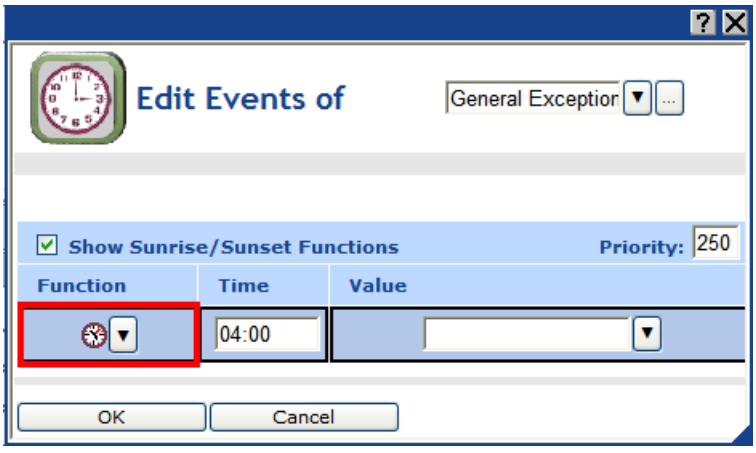
This section generally describes how to create events in an exception schedule. See *Demonstrating a Street Lighting Schedule* on page 105 for the specific events that you can create for scheduling a street lighting network.

To create events in an exception schedule, perform the following steps:

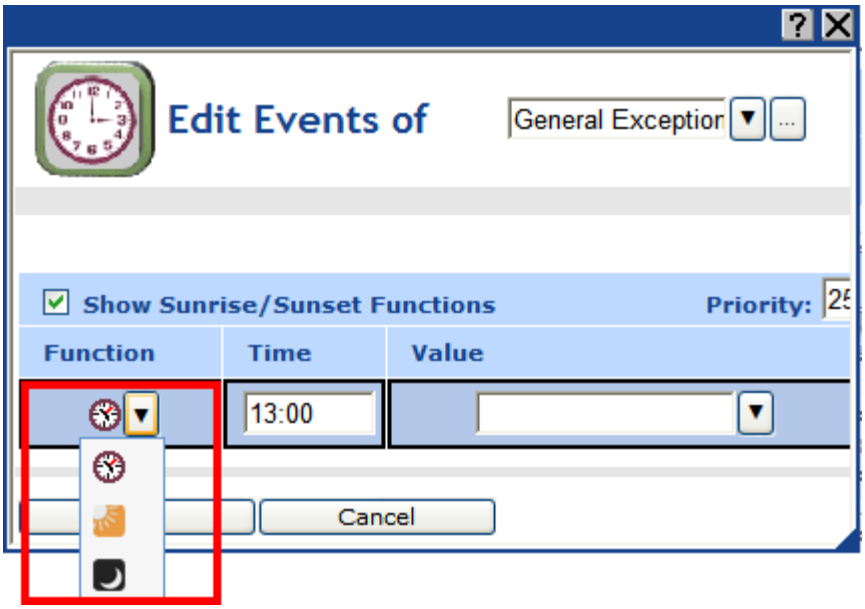
1. From the **Scheduler: Exception Schedules** Web page, click one of the light-blue-highlighted dates in the calendar to create the recurring exception schedule for the range of dates specified in the previous section. The **Edit: <***exception start date***>** dialog opens.



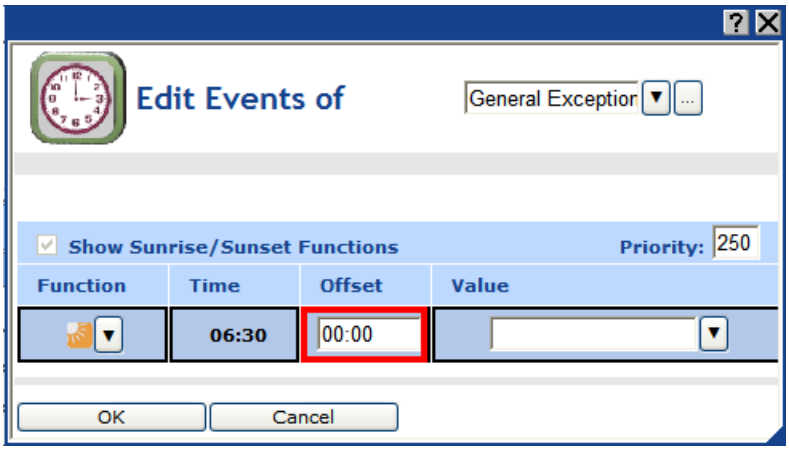
2. Click anywhere in the row under the **Schedule**, **Event Time**, **Value**, or **Priority** columns at the time the event is to occur. The **Edit Events of** dialog opens. Alternatively, you can right-click a time under the **Time** column or right-click the column to the right and select **Add Event** from the shortcut menu to open the **Edit Events of** dialog.
3. Select the **Show Sunrise/Sunset Functions** checkbox to create events based on sundown and sunrise times. A **Function** field appears in the dialog.



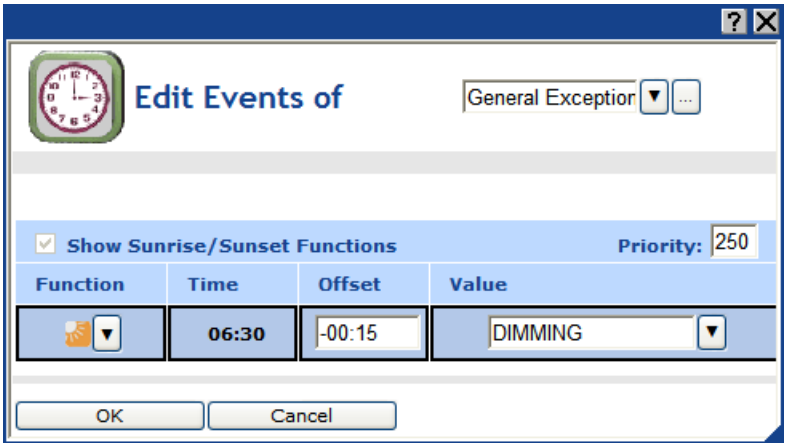
4. In the **Function** box, select the Sunrise ( ) or Sundown ( ) icon.



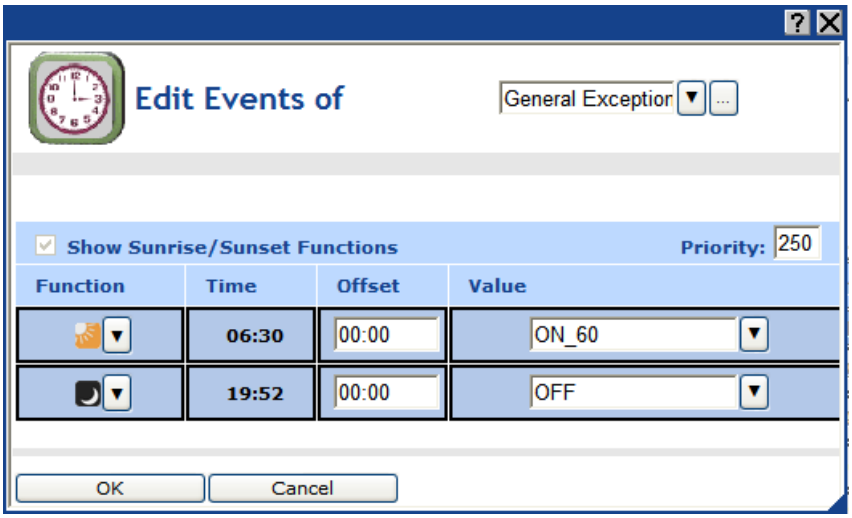
5. The calculated sunrise or sundown time appears in the **Time** box, which becomes read-only, and an **Offset** field is added to the dialog.



6. If the event is to occur sometime before or after sunrise or sundown, enter that period of time in the **Offset** box. To schedule an event to occur before sunrise or sundown, enter a negative value; to schedule an event to occur after these times, enter a positive value. For example, if you want an ON event to occur 30 minutes after sundown, enter **00:30**. If you want a DIMMING event to occur 15 minutes before sunrise, enter **-00:15**.

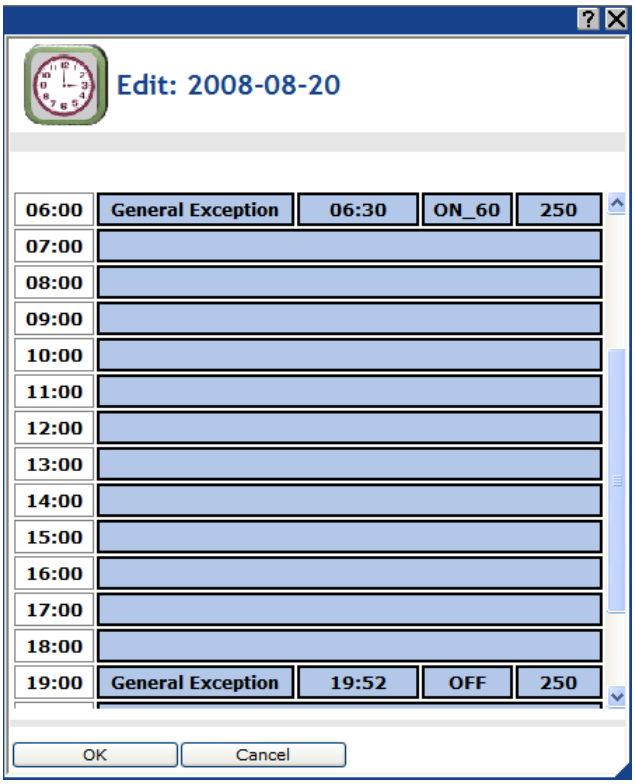


7. In the **Value** box, perform one of the following tasks:
   - Select the preset to be used to update the values of all the data points added to the Scheduler that have that preset defined for them. Alternatively, you can enter a new preset and then go back to the **Scheduler: Data Points** Web page and define the value (or values) for the preset.
   - Enter a valid value to be written to all the data points. To enter a value, all the data points added to the Scheduler must have the same network variable type (for example, **SNVT_switch**).
8. In the **Priority** box, enter a priority for the event between 0 to 255 (highest to lowest priority). This priority essentially locks out events with lower priorities so that they cannot update the data points written to by this event. After the Scheduler executes the event, the data points can only be updated by an event that has an equal or higher priority.
9. To create additional events in the exception, right-click anywhere in the **Time** or **Value** boxes, and select **Add** from the shortcut menu. A new row for the event is added to the dialog. Repeat steps 4–7 to specify the **Time** and **Value** of the new event in the exception. You can create up to one event per minute.



10. Click **OK** to save your events and return to the **Edit: <***exception date***>** dialog. Click **Cancel** to delete all changes and return to the **Edit: <***exception date***>** dialog.

11. The **Edit: <***exception date***>** dialog is updated to reflect the events that you added to the exception schedule. The events are highlighted light blue.



12. Click **OK** to save your changes to the **Edit: <***exception date***>** dialog and return to the **Scheduler: Exception Schedules** Web page. Click **Cancel** to delete all changes and return to the **Scheduler: Exception Schedules** Web page.

13. Click **Submit**.

Demonstrating a Street Lighting Schedule

This section demonstrates how you can control a street lighting network using a single Event Scheduler that includes one daily schedule and one exception schedule for weekdays, and one exception group that includes exception schedules for weekends and holidays. The following briefly describes how the street lighting network is controlled on weekdays and weekends/holidays.

- **Weekdays**. One daily schedule and one exception schedule are used to control the street lighting network on weekdays. The daily schedule turns on the lights at the start of the evening rush hour, dims them at the end of the evening rush hour, brightens them at the beginning of the morning rush hour, and dims them at the end of the morning rush hour. The exception schedule turns the lights off at sunrise and unlocks the lights at sundown, which enables the daily schedule to turn the lights on.

- **Weekends/Holidays**. One exception group (a group of exceptions that use the same schedule) is used to control the street lighting network on weekends and holidays. The exception schedule simply turns on the lights at sundown and turns them off at sundown.

Note: In this example, additional user-defined presets have been created for the **SNVT_switch** data point on the luminaire. These presets include ON_60 and ON_100, which set the **SNVT_switch** data point to 60.0 1 (60% brightness and on) and 100.0 1 (100% brightness and on), respectively. These presets are used in addition to the pre-defined OFF preset, which sets the **SNVT_switch** data point to 0.0 0 (0% brightness and off). See *Selecting Data Points* on page 88 for more information about creating presets for data points that have been added to the Event Scheduler.

Creating the Weekday Schedule

You can create a schedule that controls the street lighting network on weekdays using one daily schedule and one exception schedule. This schedule uses the default Daily Schedules and the following events, which occur Monday through Friday:

- An ON_100 event that turns on the lights to 100% at the start of the evening rush hour.
- An ON_60 event that dims the lights at the end of the evening rush hour.
- An ON_100 event that brightens the lights at the beginning of the morning rush hour.
- An ON_60 event that dims the lights at the end of the morning rush hour.

After you set up the daily schedule, you create a one-time exception that recurs every weekday. In the weekday exception schedule, you create the following single event:

- An OFF event starting at sunrise and ending at sundown that turns the lights off. After the OFF event ends at sundown, the daily schedule assumes control of the network and turns the lights on.

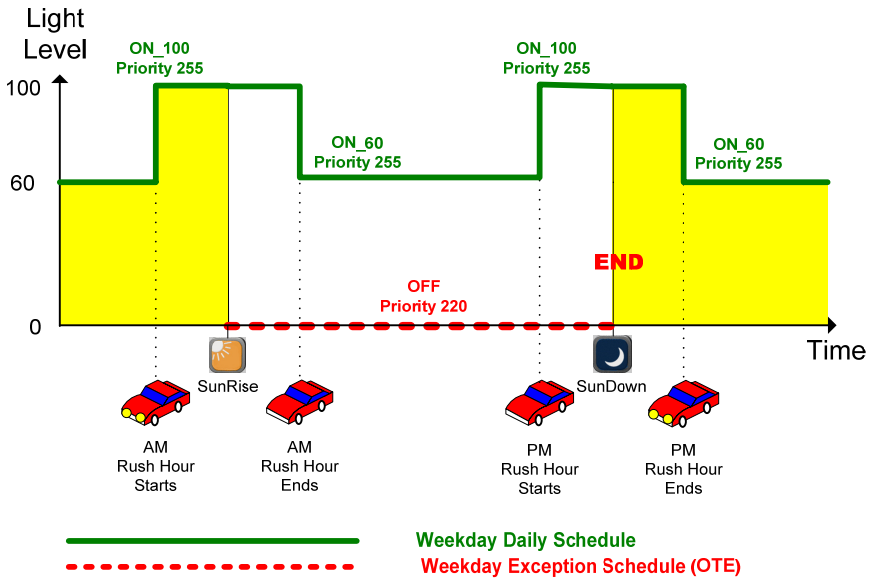


Figure 12. Weekday Schedule

Creating the Weekday Daily Schedule

The weekday daily schedule turns on the lights at the start of the evening rush hour, dims them at the end of the evening rush hour, brightens them at the beginning of the morning rush hour, and dims them at the end of the morning rush hour. To create the weekday daily schedule, perform the following steps:

1. In the **Scheduler: Configure** Web page, click the **Daily Schedules** icon. The **Scheduler: Daily Schedules** Web page opens.
2. Click a **Time** box that is under any of the columns for **Monday** through **Friday**. The **Edit** dialog opens.
3. Create each of the following events:
   - At the beginning of the morning rush hour (for example, 05:00), an ON_100 event with a priority of 255. This event fully illuminates the lights to 100% if sunrise has not yet occurred. If sunrise has occurred already, this event does not execute because the exception schedule has turned off the lights at sunrise using a higher priority event, which locks out this lower priority event.
   - At the end of the morning rush hour (for example, 09:00), an ON_60 event with a priority of 255. This event dims the lights to 60% if sunrise has not yet occurred. If sunrise has occurred already, this event does not execute because the exception schedule has turned off the lights at sunrise using a higher priority event, which locks out this lower priority event.
   - At the beginning of the evening rush hour (for example, 17:00), an ON_100 event. This event turns the lights on and fully illuminates them to 100% once sundown occurs, if the evening rush hour is ongoing.
     - If the start of the evening rush hour occurs before sundown, the ON_100 event is not executed until sundown, because the

ON_100 event in the weekday daily schedule has a lower priority (255) than that of the OFF event in the weekday exception schedule (220), which does not end until sundown. After the OFF event in the weekday exception schedule is executed at sundown, the ON_100 event is executed and the lights are turned on and fully illuminated to 100%.

  - If the end of the evening rush hour occurs before sundown, the ON_100 event is never executed, because the weekday daily schedule executes an ON_60 event with a priority of 255 at the end of the evening rush hour. The ON_60 takes precedence because it is the most recent event between two events with the same priority.

- At the end of the evening rush hour (for example, 20:00), an ON_60 event. This event either dims the lights to 60% if sundown occurs during the evening rush hour, or it turns the lights on and sets them to 60% if sundown occurs after the end of the evening rush hour.

  For more information on creating events in the Daily Schedule, see ***Error! Reference source not found.*** on page **Error! Bookmark not defined.**.

4. Click **OK** to return to the **Scheduler: Daily Schedules**. The events that you created are listed under the columns for **Monday** through **Friday**.

Net/LON/iLON App/StreetLight Scheduler: Daily Schedules

Time	☐ Sunday	☑ Monday	☑ Tuesday	☑ Wednesday	☑ Thursday	☑ Friday	☐ Saturday
0:00							
1:00							
2:00							
3:00							
4:00							
5:00		05:00 ON_100	05:00 ON_100	05:00 ON_100	05:00 ON_100	05:00 ON_100	
6:00							
7:00							
8:00							
9:00		09:00 ON_60	09:00 ON_60	09:00 ON_60	09:00 ON_60	09:00 ON_60	
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00		17:00 ON_100	17:00 ON_100	17:00 ON_100	17:00 ON_100	17:00 ON_100	
18:00							
19:00							
20:00		20:00 ON_60	20:00 ON_60	20:00 ON_60	20:00 ON_60	20:00 ON_60	
21:00							
22:00							
23:00							

5. Click **Submit**.

6. Click **Back** to return to the **Scheduler: Configure** Web page.

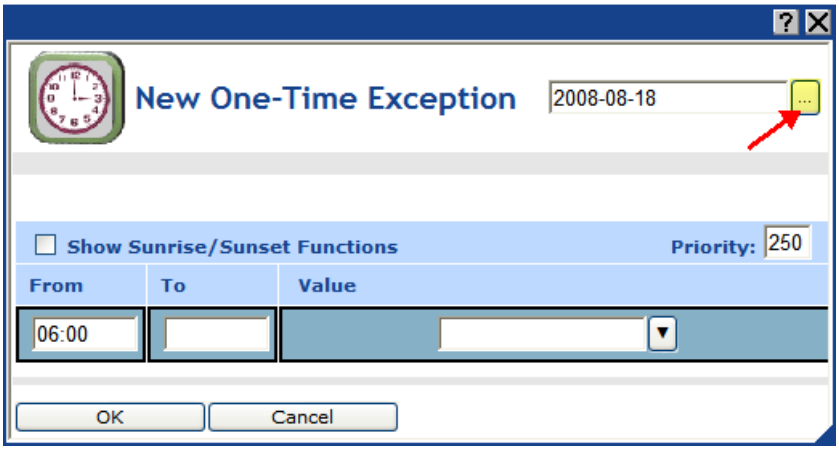
Creating the Weekday Exception Schedule

The weekday exception schedule turns on the lights at sundown and turns them off at sundown. To create the weekday exception schedule, you create a new one-time exception; change the name, range of dates, and recursions for the exception; and then create the sunrise and sundown events.

To create a new exception for the weekday schedule, perform the following steps:

1. In the **Scheduler: Configure** Web page, click the **Exception Schedules** icon. The **Scheduler: Exception Schedules** Web page opens.
2. Right-click the date that is to be the start date for the exception schedule, point to **Add Exception**, and select **New One-Time Exception** from the shortcut menu.

3. The **New One-Time Exception** dialog opens. Click the button to the right of the exception name in the upper right-hand corner of the dialog.



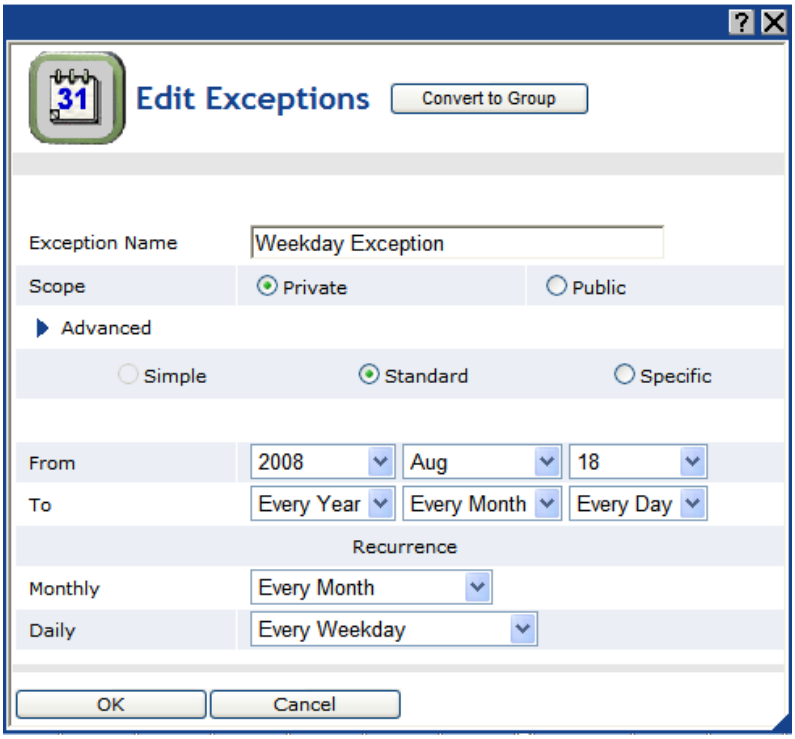
4. The **Edit Exceptions** dialog opens. Set the name, range of dates, and recursions for the exception:
    a. In the **Exception Name** property, enter a descriptive name for the exception such as "Weekday Exception". The default name is the

selected start date in the following format: <*year*>-<*month*>-<*date*>.

b. Click **Standard** to expand the dialog to show the **Recurrence** property. This option lets you apply the exception to every month and every weekday.

c. In the **From** and **To** properties, specify the start and end dates of the exception.

d. Under **Recurrence**, select **Every Month** from the **Monthly** list. This option means that the exception recurs every month in the specified range of dates. Select **Every Weekday** from the **Daily** list. Thus, the exception recurs every weekday of every month in the specified range of dates.



5. Click **OK** to return to the **New One-Time Exception** dialog.

6. Create the sunrise and sundown events for the exception:

   a. Select the **Show Sunrise/Sunset Functions** checkbox. A **Function** box appears to the right of the **Time** boxes under the **To** and **From** properties.

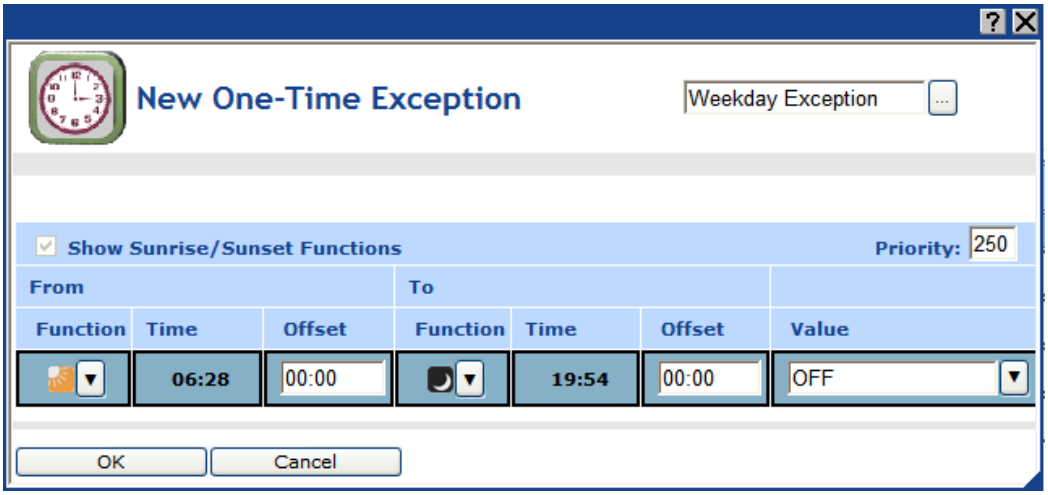
   b. In the **Function** box under the **To** property, select the Sunrise icon ( ). The calculated sunrise time appears in the **Time** box, which becomes read-only, and an **Offset** box is added to the right of the **Time** box. If the event is to occur sometime before or after sunrise, enter that period of time in the **Offset** box. For example, if you want a DIMMING event to occur 15 minutes before sunrise, enter **-00:15**

   c. In the **Function** box under the **From** property, select the Sundown icon ( ). The calculated sundown time appears in the **Time** box,

which becomes read-only, and an **Offset** box is added to the right of the **Time** box. If the event is to occur sometime before or after sundown, enter that period of time in the **Offset** box. For example, if you want an ON_100 event to occur 30 minutes after sundown, enter **00:30**.

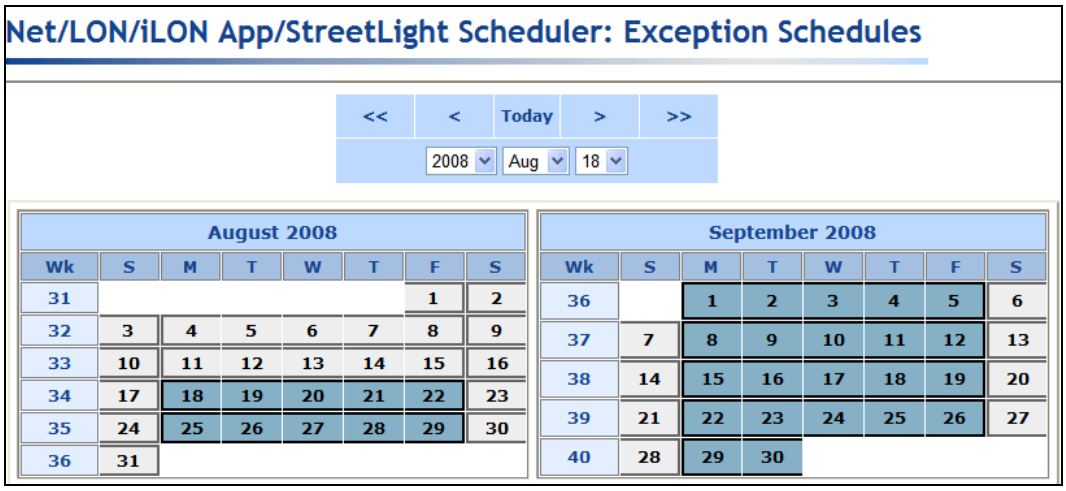
d. In the **Value** box, select **OFF**. If OFF does not appear as an option in the list, you can enter OFF and then create an OFF preset as described in *Selecting Data Points* on page 88.

e. In the **Priority** box, enter a priority that is lower than the 255 priority used for the weekday daily schedule (this example uses a priority of **220**). This priority essentially locks out the events in the weekday daily schedule, which have lower priorities (255).



7. Click **OK** to save your sunrise/sundown events and return to the **Scheduler: Exception Schedules** Web page.

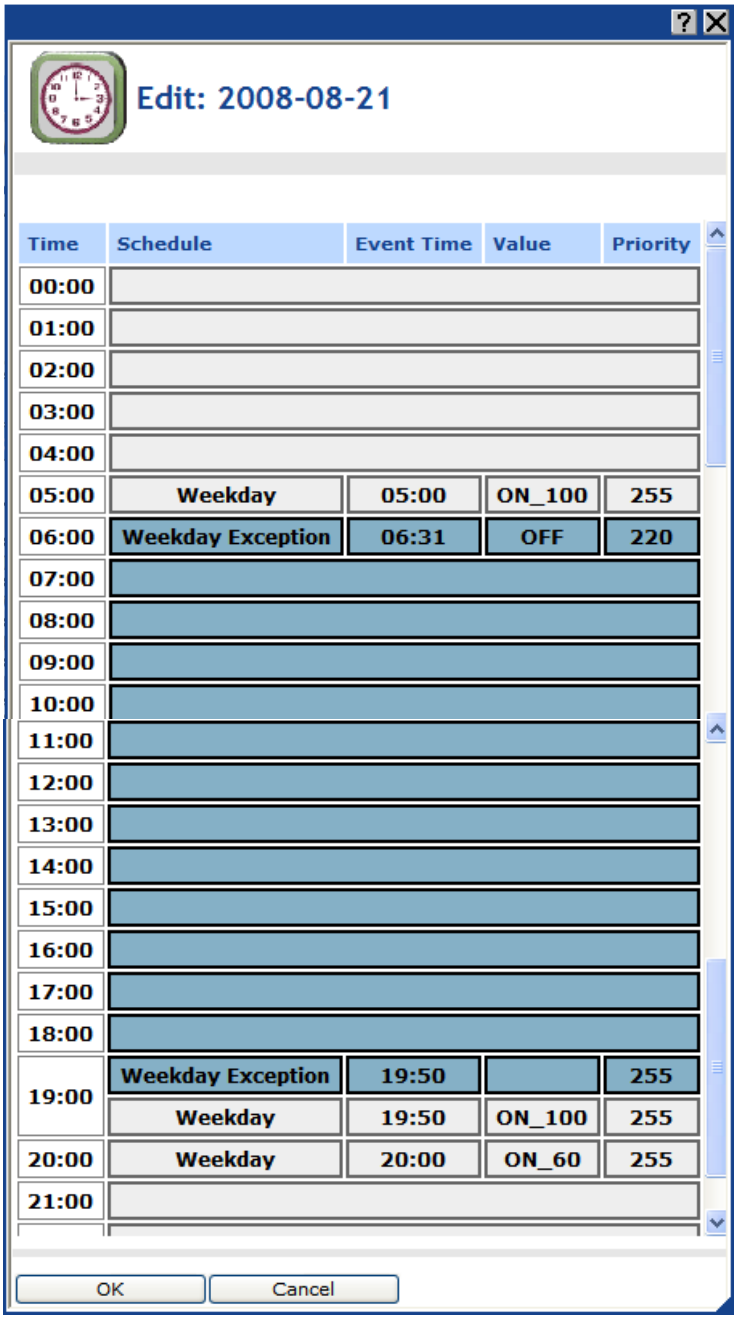
8. The range of dates on which the exception is to occur is highlighted teal (or dark blue) in the calendar on the **Scheduler: Exception Schedules** Web page.



9. Click **Submit**.

10. You can verify how the weekday exception schedule has been updated with the morning and evening weekday rush hour events in the daily schedule that are now scheduled before and after the OFF event:

    a. Click one of the teal-highlighted dates in the calendar. The **Edit: <***exception date***>** dialog opens.



Time	Schedule	Event Time	Value	Priority
00:00				
01:00				
02:00				
03:00				
04:00				
05:00	Weekday	05:00	ON_100	255
06:00	Weekday Exception	06:31	OFF	220
07:00				
08:00				
09:00				
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
16:00				
17:00				
18:00				
19:00	Weekday Exception	19:50		255
	Weekday	19:50	ON_100	255
20:00	Weekday	20:00	ON_60	255
21:00				

    b. The schedule for the selected weekday date shows the lower priority rush hour events (priority 255) that are scheduled before the OFF event at sunrise (priority 220), and it hides the lower priority rush hour events scheduled after the OFF event. The schedule also shows the lower priority rush hour events that are

scheduled to occur once the OFF event ends at sundown and resets the data point priority to 255.

Creating the Weekend and Holiday Exception Schedules

You can create a schedule that controls the street lighting network on weekends and holidays. This schedule creates an exception group that includes an exception that recurs every weekend and exceptions for each holiday that occurs on a weekday in which there is no rush hour. After you create the exception group and weekend and holiday exceptions, you create the following events in the weekend/holiday exception schedule:

- An OFF event at sunrise that turns the lights off.
- An ON_60 event at sundown that turns the lights on to 60%.

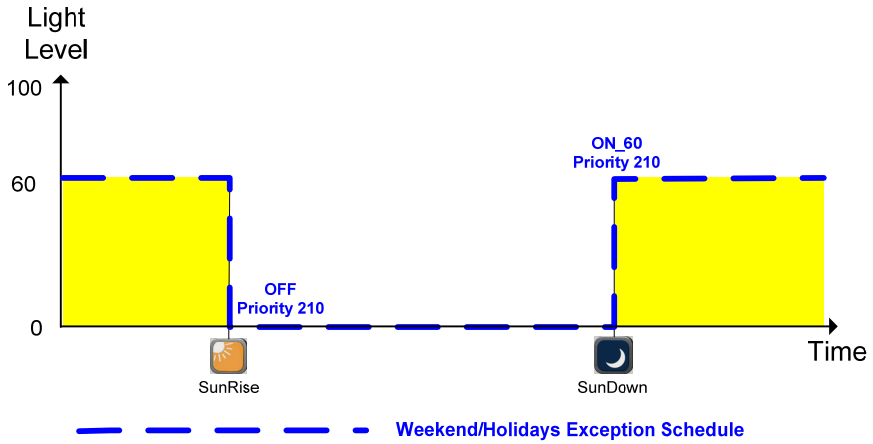
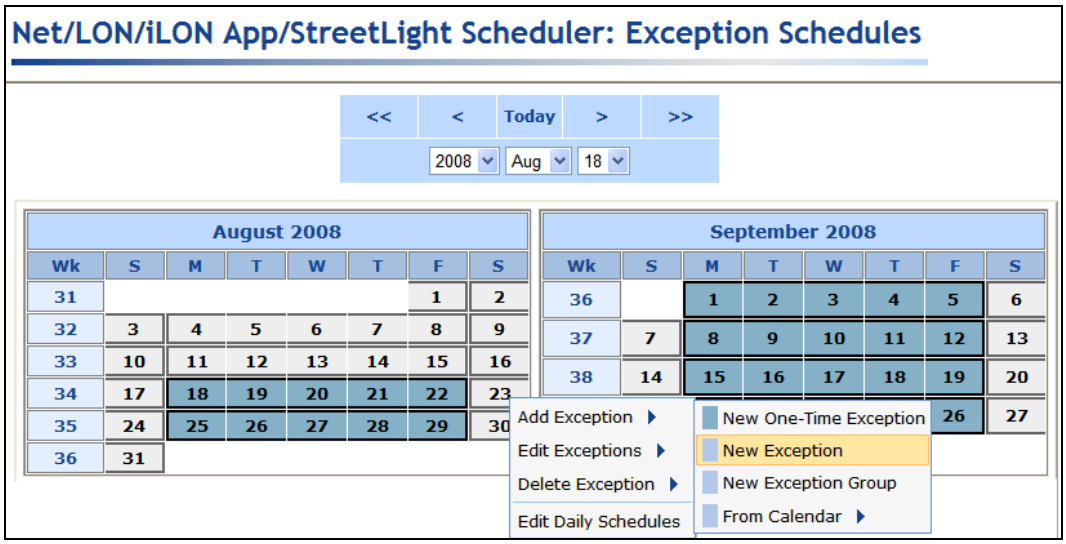


Figure 13. Weekend and Holiday Schedule

To create the weekend/holidays exception group, perform the following steps:

1. Right-click the date that is to be the start date for the weekend/holiday exception schedule, point to **Add Exception**, and select **New Exception** from the shortcut menu.



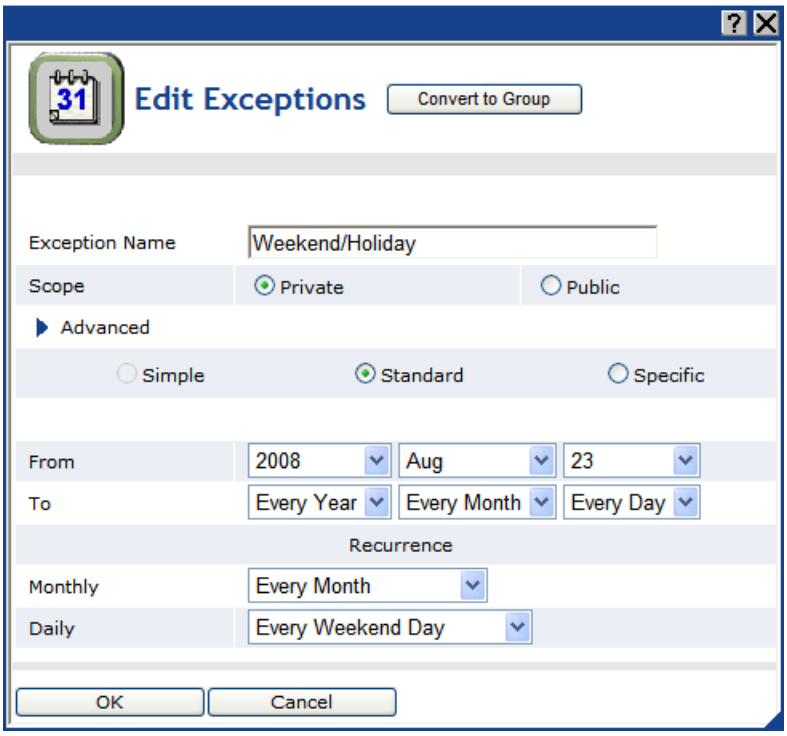
2. The **Edit Exceptions** dialog opens. Set the name, range of dates, and recursions for the exception following these steps:

    a. In the **Exception Name** property, enter a descriptive name for the exception such as "Weekend/Holiday". The default name is the selected start date in the following format: <year>-<month>-<date>.

    b. Click **Standard** to expand the dialog to show the **Recurrence** property. This option lets you apply the exception to every month and every weekend day.

    c. In the **From** and **To** properties, specify the start and end dates of the exception.

    d. In the **Monthly** list under **Recurrence**, select **Every Month**. This option means that the exception recurs every month in the specified range of dates. In the **Daily** list, select **Every Weekend Day**. Thus, the exception recurs every weekend day of every month within the specified range of dates.

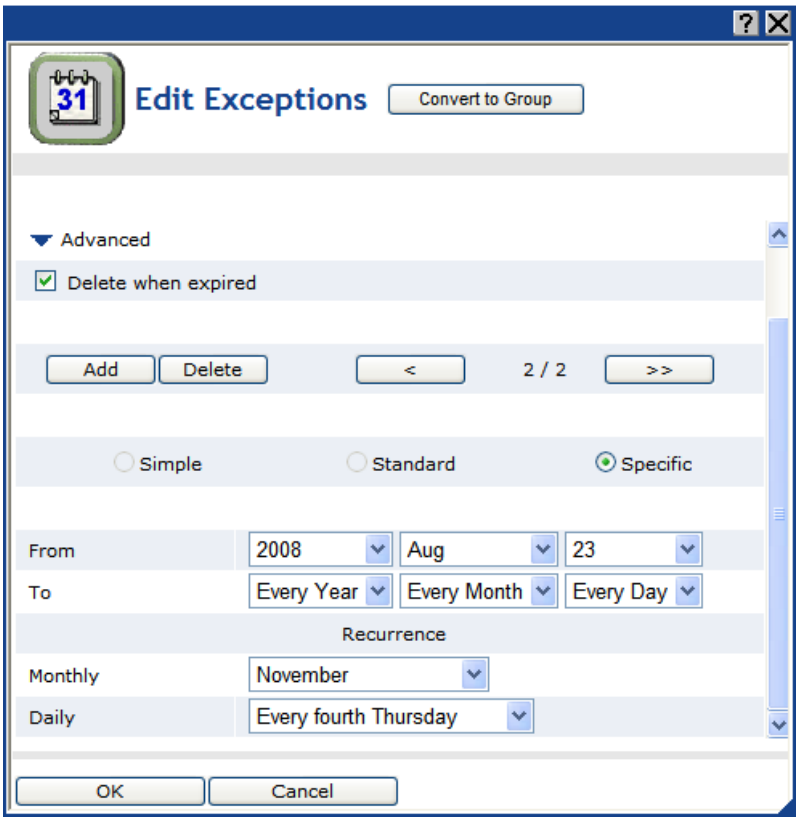


3. In the **Advanced** property located directly below the **Private** property, click the blue arrow ( ) to expand the dialog to show options for adding, deleting, and editing additional exceptions included under the current exception. Add a new exception by performing the following steps:

    a. Click **Add** to create an exception group and add new exceptions for weekday holidays to the group. All new exceptions that you add to the group use the same exception schedule, but you can specify a different range of dates and recursions for the new holiday exceptions. For example, you could create a new exception for Thanksgiving that uses the same range of dates as the weekend exception, but uses a different set of recursions. All the changes that you make to the schedule of one exception are globally applied to the schedules of all the exceptions within the group. For example, if you create an ON event in the schedule for the Thanksgiving exception, that ON event is automatically added to the schedule of the weekend exceptions.

    b. To create the exception for Thanksgiving (as an example), click **Specific**.

    c. In the **Monthly** list under **Recurrence**, select **Every November**. This option means that the exception recurs every November in the specified range of dates. In the **Daily** list, select **Every Fourth Thursday**. Thus, the exception recurs every fourth Thursday of every November (that is, every Thanksgiving) in the specified range of dates.

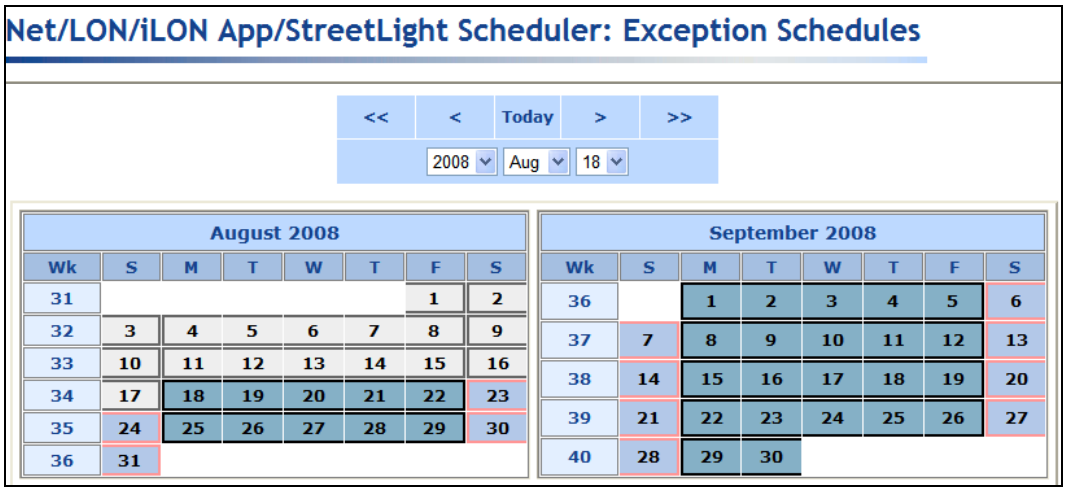


d. Repeat steps a–c for additional weekday holiday exceptions to be added to the exception group.

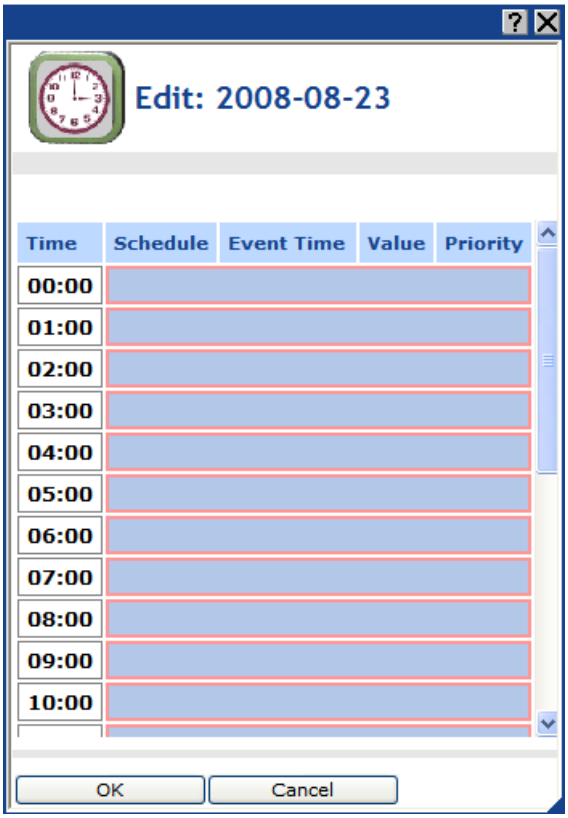
Notes:

- You can click the arrows to scroll through the various exception instances. You can edit the scope (private or public), dates, and recursions for the selected instance.
- You can click **Delete** to remove the selected exception instance from the Event Scheduler.

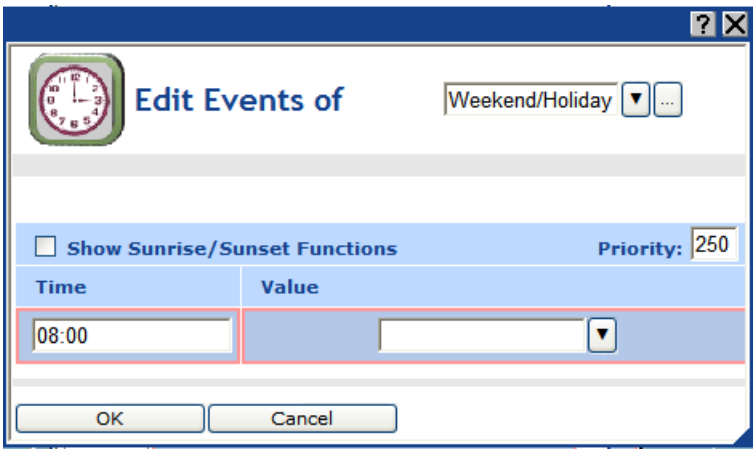
4. Click **OK** to save exception and return to the **Scheduler: Exception Schedules** Web page.
5. The range of dates on which the exception is to occur is highlighted light blue and outlined with a color differentiating it from the other exceptions in the calendar on the **Scheduler: Exception Schedules** Web page.



6. Click **Submit**.
7. Create the sunrise and sundown events for the weekend/holiday exception following these steps:
    a. Click one of the light blue-highlighted dates in the calendar. The **Edit: <***exception date***>** dialog opens.



    b. Click anywhere in the row under the **Schedule**, **Event Time**, **Value**, or **Priority** columns at the time that the event is to occur. The **Edit Events Of** dialog opens. Alternatively, you can right-click a time under the **Time** column or right-click the column to the right and select **Add Event** from the shortcut menu to open the **Edit Events Of** dialog.

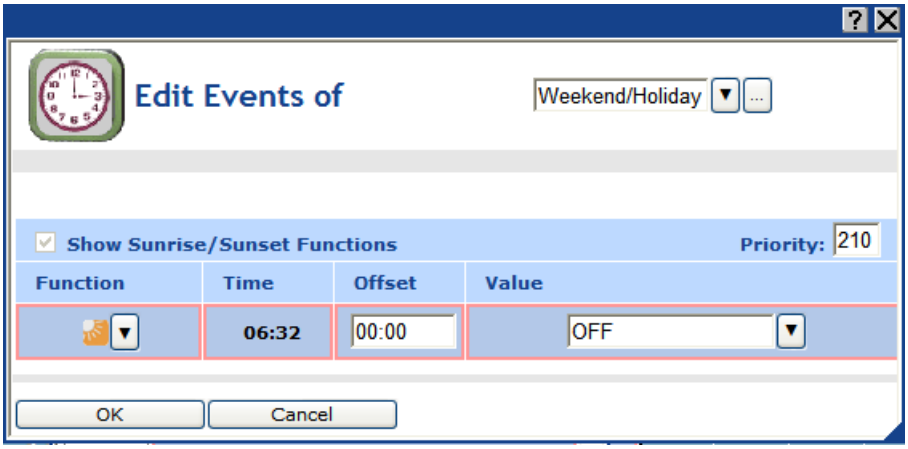


c. Select the **Show Sunrise/Sunset Functions** check box. A **Function** box appears to the right of the **Time** box.

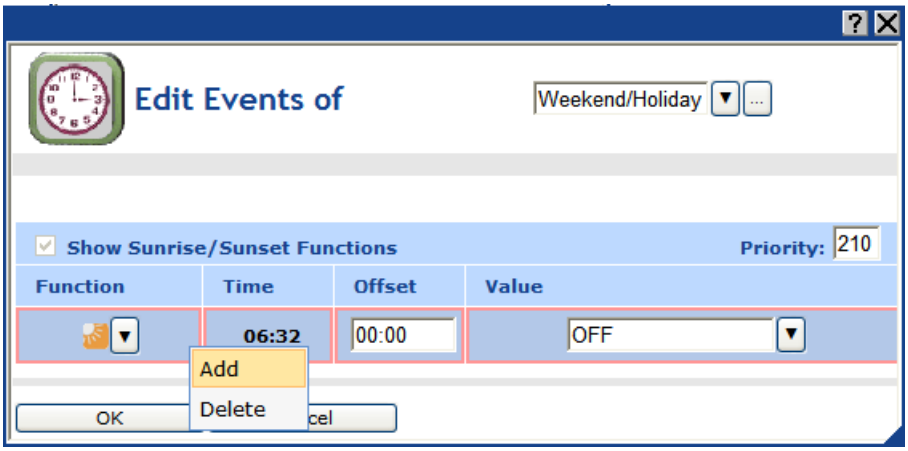
d. In the **Function** box, select the Sunrise icon ( ). The calculated sunrise time appears in the **Time** box, which becomes read-only, and an **Offset** box is added to the right of the **Time** box. If the event is to occur sometime before or after sunrise, enter that period of time in the **Offset** box. For example, if you want a DIMMING event to occur 15 minutes before sunrise, enter **-00:15**

e. In the **Value** box, select **OFF**. If OFF does not appear as an option in the list, you can enter OFF and then create an OFF preset as described in *Selecting Data Points* on page 88.

f. In the **Priority** box, enter a priority that is lower than the 255 priority used for the weekend daily schedule (this example uses a priority of **210**). This priority essentially locks out the events in the weekday daily schedule, which have lower priorities (255).

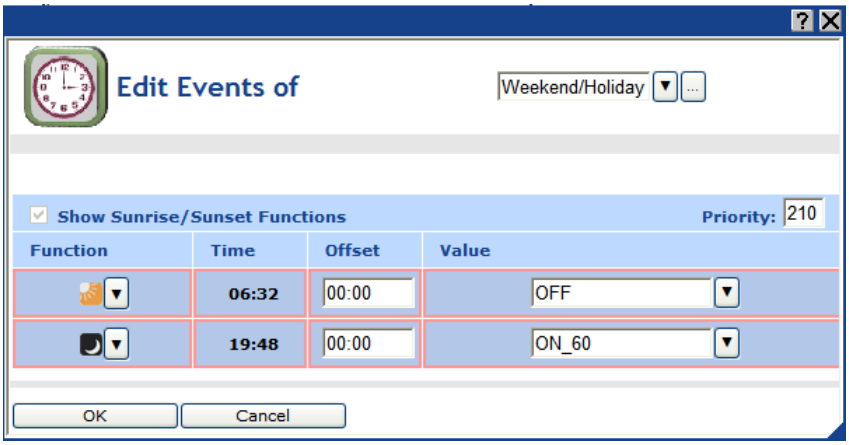


g. Create a new event: Right-click anywhere in the row of the current event and click **Add** on the shortcut menu. A new row is added to the dialog.



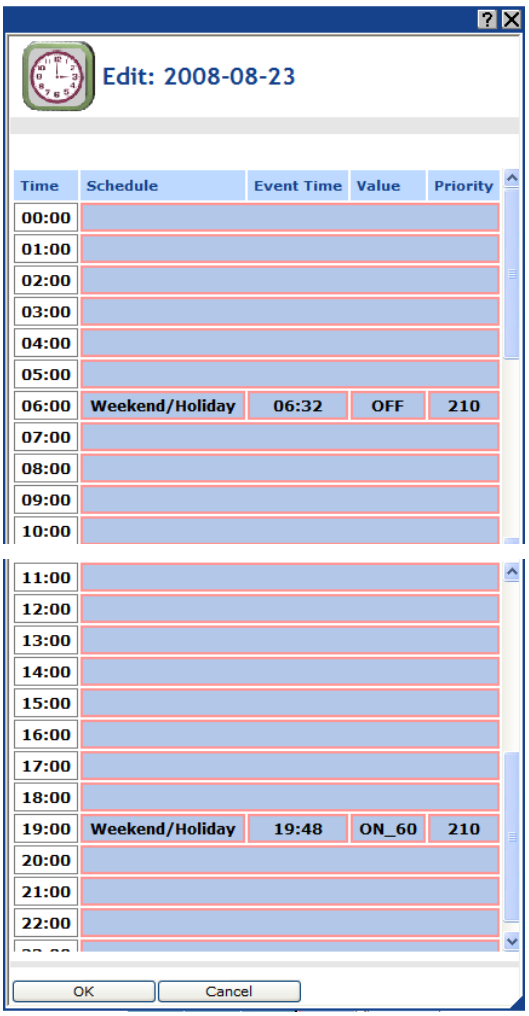
h. In the **Function** box, select the Sundown icon ( ). The calculated sundown time appears in the **Time** box, which becomes read-only, and an **Offset** box is added to the right of the **Time** box. If the event is to occur sometime before or after sundown, enter that period of time in the **Offset** box. For example, if you want an ON_60 event to occur 30 minutes after sundown, enter **00:30**.

i. In the **Value** box, select **ON_60**. If ON_60 does not appear as an option in the list, you can enter ON_60 and then create an ON_60 preset as described in *Selecting Data Points* on page 88.



j. Click **OK** to save your events and return to the **Edit: <***exception date***>** dialog.

8. The **Edit: <***exception date***>** dialog is updated to reflect the events that you created. Observe that the schedule for the selected weekend day shows the OFF that is scheduled at sunrise, and the ON_60 event that is scheduled at sundown.



9. Click **OK** to save your changes to the **Edit: <***exception date***>** dialog and return to the **Scheduler: Exception Schedules** Web page.
10. Click **Submit**.

Copying Event Schedulers to Other SmartServers

After you create Event Schedulers with the appropriate exceptions, you can copy the Event Schedulers to other SmartServers: Back up the SmartServer App device's XML configuration on the source SmartServer, copy the backup to one or more target SmartServers that have been reset to their factory default settings, and then reboot the target SmartServers. The Event Schedulers on the target SmartServers will include the current configurations of the Event Schedulers on the source SmartServer, including their events, data points, and presets. This saves you the effort of having to manually re-create the same exception schedules on the Event Schedulers of other SmartServers.

To copy the configured Event Schedulers to other SmartServers, perform the following steps:

1. Copy the root/config/network/<*Network*>/<*Channel*>/<*i.LON SmartServer App Device*> folder on the source SmartServer flash disk to

the local drive of your computer, a USB drive, another removable media, or a shared network drive with read/write permissions.

2. Restore the target SmartServer to its factory default settings with the **Setup – Cleanup** Web page or the console application:

   - To restore your SmartServer to its factory default settings using the SmartServer Web pages, right-click the local SmartServer, point to **Setup**, and select **Clean Up** from the shortcut menu. The **Setup – Cleanup** dialog opens. Click **Cleanup** to reset the SmartServer.
   - To restore your SmartServer to its factory default settings using the console application, enter the **factorydefaults** command, or enter the **factorydefaults keepipaddrs** command to reset the SmartServer but keep its basic IPv4 and IPv6 IP addresses. For more information about using the SmartServer console application, see Appendix B of the *i.LON SmartServer User's Guide*.

3. Copy the config/network/<*Network*>/<*Channel*>/< *i.LON SmartServer App Device*> folder to the root/config/network/<*Network*>/<*Channel*> folder on the flash disk of the target SmartServer.

4. Reboot the target SmartServer using the SmartServer Web pages or the SmartServer console application:

   - To reboot your SmartServer using the SmartServer Web pages, right-click the local SmartServer, point to **Setup**, and select **Reboot** from the shortcut menu. The **Setup – Reboot** dialog opens. Click **Reboot** to start the reboot.
   - To reboot your SmartServer using the SmartServer console application, enter the **reboot** command. For more information about using the SmartServer console application, see Appendix B of the *i.LON SmartServer User's Guide*.

5. You can open the Web interface of the target SmartServer and expand the SmartServer's App device in the navigation pane on the left side. Observe that the functional blocks and data points in the SmartServer App device match those of the source. You can click of the Scheduler functional blocks under the SmartServer App device and observe that it has the same configuration as the source.

6. Repeat steps 2–5 to copy the SmartServer App device configuration to additional target SmartServers.

A

Interoperable Interface for the Street Light Bridge

This appendix describes the data points (input network variables and configuration network variables and output network variables) that define the Street Light Bridge's interoperable interface.

Interface

You can use the Segment Controller to view the interoperable interface for a Street Light Bridge module from the module's Properties Web page.

The interface includes output data points (network variables) that contain status information for the Street Light Bridge module. The interface also includes input data points (network variables and configuration network variables) that define the operational characteristics of the Street Light Bridge module.

In general, you should not need to modify any of the data points, and there are a number of them that you should not modify unless directed to do so by Echelon Support. You might need to read and report data from these data points when troubleshooting a problem with assistance from Echelon Support.

Output Variables

Table 2 lists the output data points that are defined for the Street Light Bridge's interoperable interface.

Table 2. Output Data Points

Variable	Description
nvoSlbStatus	Provides internal status and statistics information.
nvoProtocol	Indicates the current RF Tunneling Protocol (RTP) version. Zero indicates the initial version.
nvoVersion	Provides the version numbers for both the bootrom and the application.
nvoSlbError	Reports the most recent internal error area and code. This value does not persist across device reset. A value of 0 indicates no error. However, not all non-zero codes represent errors.
nvoSlbInfo	Provides the model number for the mainboard, the revision number for the RF board, and the device RF address.

Input Variables

Table 3 on page 125 lists the input data points that are defined for the Street Light Bridge's interoperable interface. You should not modify data points that have "No" in the table's *Modifiable* column unless you are directed to do so by Echelon Support. Modifying these data points can degrade a Street Light Bridge module's performance or interrupt communications.

Table 3. Input Data Points

Variable	Description	Modifiable?
nviL5Timeout	Defines a timeout for updating the system firmware. Such updates should only be performed with guidance from Echelon Support.	**No** Changing this value can prevent communications with the device.
nciLtRate	Define characteristics for the algorithms that control channel and signal quality.	**No** Changing these values can prevent successful communications.
nciHbRate		
nciUpDwell		
nciDownDwell		
nciRcvStable		
nciCqaLimit		
nciSlotCount		
nciSlotWidth		
nciTransmitHb		
nciSqiThreshold		
nciSqiMin		
nciSqiWeight		
nciIdle		
nciSqiCycles		
nciSqiRestart		
nciRevival		
nciPriChs	Defines channels for RF data transmission on the primary (normal) LonTalk (ISO/IEC 14908-1) path. Valid values are 11 to 26. Values outside this range are ignored.	Yes See *Defining the Networking Channels* on page 36 for information about defining channels. Use 0 (zero) to indicate an unused channel.

Variable	Description	Modifiable?
nciPriRpt	Defines the repeat count for the primary path.	Yes See *Defining the Networking Channels* on page 36 for information about defining channels.
nciSecChs	Defines channels for RF data transmission on the secondary (alternate) LonTalk (ISO/IEC 14908-1) path. Valid values are 11 to 26. Values outside this range are ignored.	Yes See *Defining the Networking Channels* on page 36 for information about defining channels. Use 0 (zero) to indicate an unused channel.
nciSecRpt	Contains the repeat count used for the secondary path.	Yes See *Defining the Networking Channels* on page 36 for information about defining channels.
nciRepeatMode	Defines the Street Light Bridge repeating type: 0 – normal repeating operation (PL and RF) 1 – PL-PL repeating (no RF transmission) 2 – RF-RF repeating (no PL transmission)	Yes See *Defining Repeating* on page 40 for information about setting the repeat mode.
nciMediaAccess	Defines the power line media access protocol: 0 – Default (media access protocol is enabled during manufacturing, based on the module model type) 1 – Normal (overrides firmware setting and defines a PL-20N channel) 2 – CENELEC (overrides firmware setting and defines a PL-20C channel)	Yes See *Defining the Media Access Protocol* on page 37 for information about setting the media access protocol. Changes to this value take effect only after a device resets.

Variable	Description	Modifiable?
nciLedTimeout	Defines the timeout for the LEDs on the Street Light Bridge module. The timeout starts at each reset or power up of the device.	Yes Default value is 60 minutes. Set to 0 (zero) to leave LEDs on indefinitely, for example during installation debugging. See *Verifying Successful Installation* on page 22 for more information about the device LEDs.
nviErrMode	Controls error simulation mode.	Yes See *Simulating Communications Errors* on page 44 for information about error simulation.
nviErrRate	Defines the error rate for error simulation mode.	Yes
nciErrTimeout	Defines the error timeout for error simulation mode.	Yes

B

Cryptography License

This appendix provides the redistribution license for the cryptographic implementation used by the Street Light Bridge firmware.

License

For authentication, the Street Light Bridge firmware uses a cryptographic hash function, the Secure Hash Algorithm (SHA), described by the National Institute of Standards and Technology (NIST) Federal Information Processing Standards Publication 180-2 (FIPS PUB 180-2). The Echelon implementation is based on an open-source implementation that requires the following license terms to be published as a condition of its use:

```
/*
 * FIPS 180-2 SHA-224/256/384/512 implementation
 * Last update: 02/02/2007
 * Issue date:  04/30/2005
 *
 * Copyright (C) 2005, 2007 Olivier Gay <olivier.gay@a3.epfl.ch>
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 *
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 * modification, are permitted provided that the following conditions
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 * 2. Redistributions in binary form must reproduce the above copyright
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 * 3. Neither the name of the project nor the names of its contributors
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 *
 * THIS SOFTWARE IS PROVIDED BY THE PROJECT AND CONTRIBUTORS ``AS IS'' AND
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 * ARE DISCLAIMED.  IN NO EVENT SHALL THE PROJECT OR CONTRIBUTORS BE LIABLE
 * FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL
 * DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS
 * OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION)
 * HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT
 * LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY
 * OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF
 * SUCH DAMAGE.
 */
```

C

Glossary

This appendix lists terms used in this manual and in the Street Light Bridge interface.

A

Alternate path

The path specified by LTEP when the “alternate path” bit is set.

C

Channel

An RF or PLC frequency.

CQA

Channel Quality Assessment – algorithm that maintains statistics for all RF channels to support FAA.

D

Downstream [RF] channel

The channel which a device normal listens to on RF waiting for a downstream message.

Downstream message

A message (for example, request) going from the SmartServer to a target device.

F

FAA

Frequency Agility Algorithm – algorithm that chooses the best RF receive channel to ensure good RF communications.

L

LTEP – LonTalk Enhanced Proxy

The repeating scheme used by the SmartServer over PLC.

N

Normal path

The path specified by LTEP when the “alternate path” bit is not set.

P

Path

A means for getting from point A to point B which could include a specific carrier frequency, specific modulation scheme or whatever. This name is historical and not very accurate (since path would more typically be a route as opposed to mode of conveyance).

Primary channels

A set of channels used to transmit on when the normal path is specified by LTEP.

Primary receive channel

The channel a device listens to when awaiting an upstream message (for example, response) on the normal path.

S

Secondary channels

A set of channels used to transmit on when the alternate path is specified by LTEP.

Secondary receive channel

The channel a device listens to when awaiting an upstream message (for example, response) on the alternate path.

SLB

Street Light Bridge module.

SQI

Signal Quality Indicator – an abstract unit to indicate the (RF) signal quality. SQI is obtained by watching "normal" RF packets, and by executing a dedicated SQI measurement algorithm.

U

Upstream [RF] channel

The channel which a device listens to when waiting for an upstream message.

Upstream message

A message (for example, response) going from a target device back to the SmartServer.