Recommendations for complex lighting installations

Application note

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Linmore LED
ULTRALINK
WIRELESS CONTROLS SIMPLIFIED

www.linmoreled.com/ultralink

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1. Introduction

This document deals with the correct configuration of complex lighting installations. An installation is complex if it meets at least one of these criteria:

- There are issues with the lighting control functions.
- There are more than 200 devices.
- At least some devices are placed in a straight line.
- Distances between devices are longer than 60% of the radio range of the devices.
- Daylight harvesting scenario is used.
- A gateway is used with energy/occupancy monitoring, scheduling, or automated demand response.

The performance of a mesh network depends on the complexity of the project. For example, a network can work correctly with a very simple lighting profile (manual On/Off) even if there are more than 200 devices. But when more factors are involved, such a large network can have performance issues.

2. Large installations

2.1 Network traffic

In a lighting installation based on the Bluetooth mesh network, devices constantly send and receive mesh messages. Relays send these messages further into the network. The traffic depends on the number of devices and relays. Also, to increase the delivery rate (delivery of information between devices), messages are retransmitted, which further increases the traffic. And if the network is large, the traffic will also be large.

Relays multiply the number of messages sent from devices and then send the messages to the distant parts of the network. More messages sent and more relaying increases the reliability of the network. But it also increases the overall traffic and thus the interference, which in the end reduces the delivery rate. As a result, some lighting scenarios may not work as expected. Large traffic can also result in incorrect data collected by monitoring systems.

2.2 Using areas

To reduce the problem of network traffic, use areas. Areas divide installations into smaller parts, which reduces traffic and increases the performance of the network.

Traffic in one area is logically separated from traffic in another area. Thus, it is easier to handle mesh messages and their repetitions. When areas are used, the number of mesh messages sent by a device does not change, but the messages are confined to the area.

If you divide a large installation into areas, the delivery rate for all devices increases and thus the quality of the mesh network. Each area has a plan (floor plan or site plan) and zones, each with a separate profile. Devices from one area cannot control devices in other areas through zone linking. Zones can be linked only with zones in the same area. Linking the zones between different areas is not possible.

The figure on the left shows a large grid installation that has problems with the delivery of messages between devices. There is large network traffic and only one area. As a result, the red devices do not receive mesh messages. The figure on the right shows the same installation but divided into two areas. As a result, the delivery rate is much improved.

Large grid installation with one area	Large grid installation with two areas
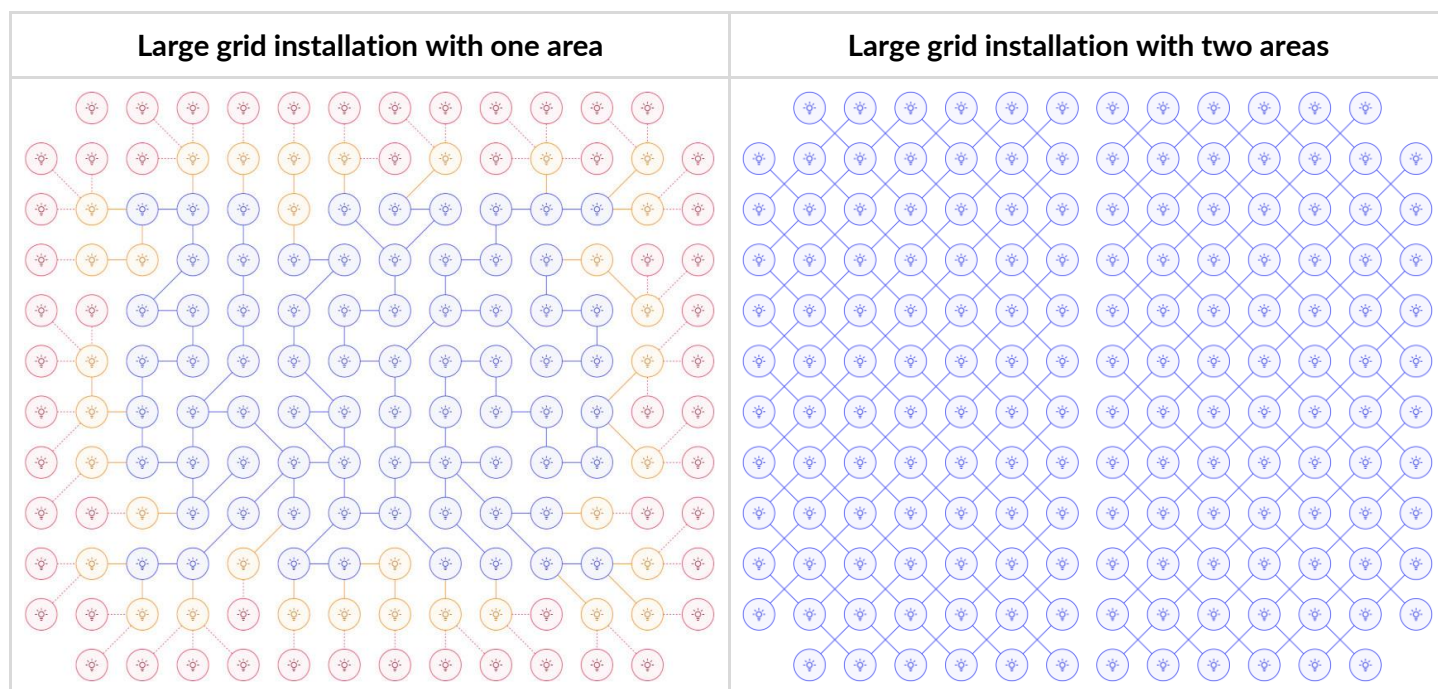
2.3 Setting up areas in new projects

UltraLink web app
1. Create a project with some areas so that each area will have fewer than approximately 200 devices.

UltraLink mobile app
2. Add devices to different areas created in the web app. For example, if you have 300 devices on floor 1, add 150 devices to the area EAST 1. Then, add another 150 devices to the area WEST 1.

⛔ Do not add more than approximately 200 devices to one area.

2.4 Setting up areas in existing projects

Areas are available in all projects starting from the project version 201908. If you have a project with more than approx. 200 devices, continue as follows.

UltraLink web app
1. Make sure that the project version is 201908 or later. For information about how to update projects, see *UltraLink Activation and Commissioning user manual*.
2. Create some areas so that each area will have fewer than approximately 200 devices.
UltraLink mobile app
3. Remove devices from areas with more than approximately 200 devices.
4. Add devices to different areas created in the web app. For example, if you have 300 devices on floor 1, add 150 devices to the area EAST 1. Then, add another 150 devices to the area WEST 1.
⛔ Do not add more than approximately 200 devices to one area.

2.5 Replay protection list

Each message sent in the Bluetooth mesh network consists of a source and destination address and a sequence number. To be protected from replay attack, each device must remember the last seen sequence number for each source address of the sender. The list of that information is called a replay protection list (RPL).

Each Bluetooth mesh device (controller, sensor, mobile device) has its own RPL. A device with the UltraLink firmware has an RPL of the following size:

- 126 for firmware version 2.13 and earlier,
- 255 for firmware version 2.14–2.17,
- 350 for firmware version 2.18 and later.

The RPL size limits the number of devices a device can subscribe to, that is, the number of devices that control the device. This means that it limits the number of devices in the zone and the number of devices in the linked zones.

Example limits (where firmware version is 2.18 or later, approximately 10% of devices are relays, and there are two mobile devices):

- For one zone with no linking but with a daylight harvesting scenario – approx. **140 devices** where each device is a sensor-controller.
- For two similar zones linked together and with a daylight harvesting scenario – approx. **100 devices.**
- For one zone with a manual control – approx. 300 devices due to the RPL limit, but approx. **200 devices** due to the maximum number of devices in the area.

It is possible to calculate how many slots in the RPL of each mesh device are used. Knowing this number can prevent RPL attacks and blocking the RPL. If the RPL of a device is full, the device will not be able to receive any more mesh messages. The RPL of each device is persistent and periodically cleaned.

2.6 Calculating the number of slots used in the RPL of a device

$$RPL = N_{MotionSensor} + N_{Switch} + N_{Luminaire} + N_{ALS} + N_{Relays} + 5 \cdot N_{Mobile}$$

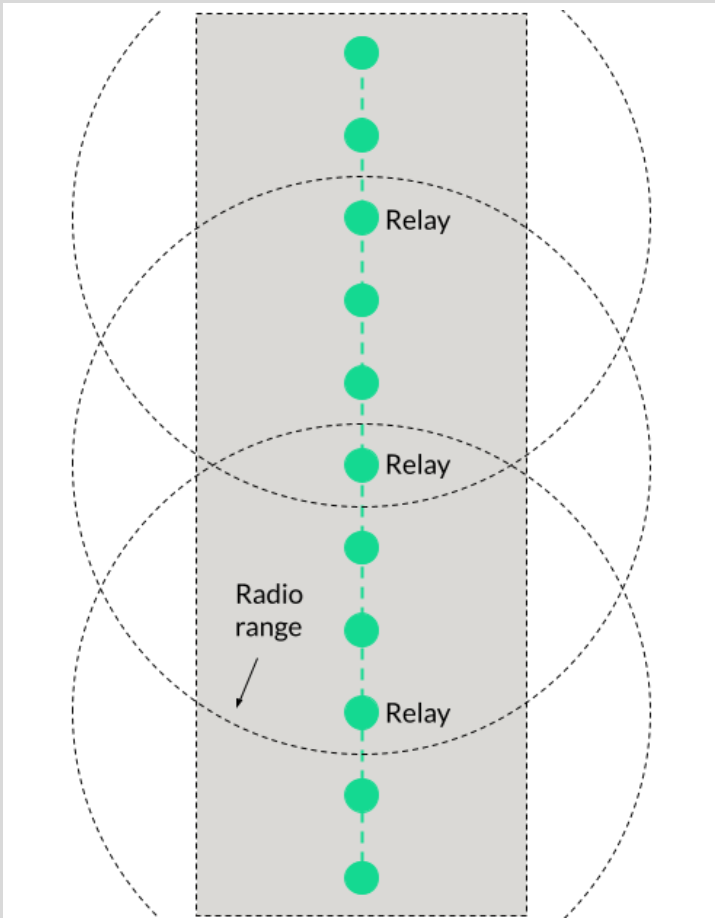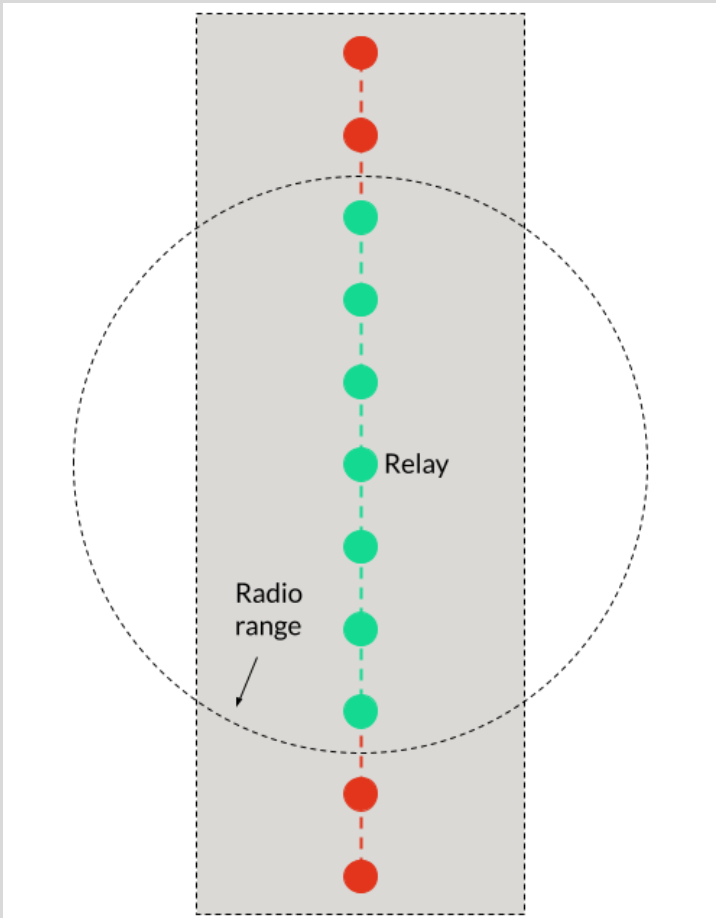|	
$N_{MotionSensor}$	Number of motion sensors that control the device from the same or a linked zone.
N_{Switch}	Number of switches that control the device from the same or a linked zone.
$N_{Luminaire}$	Number of luminaires in the zone if the zone uses daylight harvesting scenario.
N_{ALS}	Number of ambient light sensors (0 or 1) if the zone uses daylight harvesting scenario.
N_{Relays}	Number of relays in the direct radio range if the project version is 202101 or later and the firmware version is 2.20 or later.
N_{Mobile}	Number of mobile devices (up to 5) used to activate devices in the zone.

2.7 Recommendations for large installations

- Divide projects into areas so that no area has more than approximately 200 devices.
  - Divide projects of 300 devices into two areas of 150 devices.
  - Divide projects of 400 devices into two areas of 200 devices.
  - Divide projects of 600 devices into three areas of 200 devices or into four areas of 150 devices.
- Divide areas into zones.
- Use devices with firmware version 2.18 or later.
- Take into account the factors that contribute to the RPL of a device.
- Do not use zone linking so that one zone is controlled manually from more than 28 zones. The more links a zone has, the fewer devices can be added to the linked zones. The devices in the linked zones also contribute to the RPL of a device.

3. Linear installations

If an installation is linear, devices communicate in one direction and in a straight line. In linear installations the distance between devices can be long, for example 30 meters. Such a distance requires some devices to be set up as relays manually.

Relays play a very important role in lighting installations. They send mesh messages further, which increases the range of messages. If relays are incorrectly placed and devices are not in range of at least one relay, the mesh network will be disjointed and will not work correctly. See the examples that follow.

Correct placement of relays	Incorrect placement of relays
The distance between devices is approximately 10 meters. Radio range is approximately 35 m.	
Relays are set up manually using the UltraLink mobile app so that each relay is in radio range with the next relay.	One relay was set up automatically. Some devices are not in the radio range of the relay.
Messages can be sent further into the network.	Some devices do not receive messages and are not part of the network.
Lighting control will work correctly.	Lighting control will not work correctly.

3.1 Setting a device to act as a relay

⚠️ When you add devices to a zone, approx. 10% of them are automatically set up as relays. In linear installations this will not work, especially if the distance between devices is long.
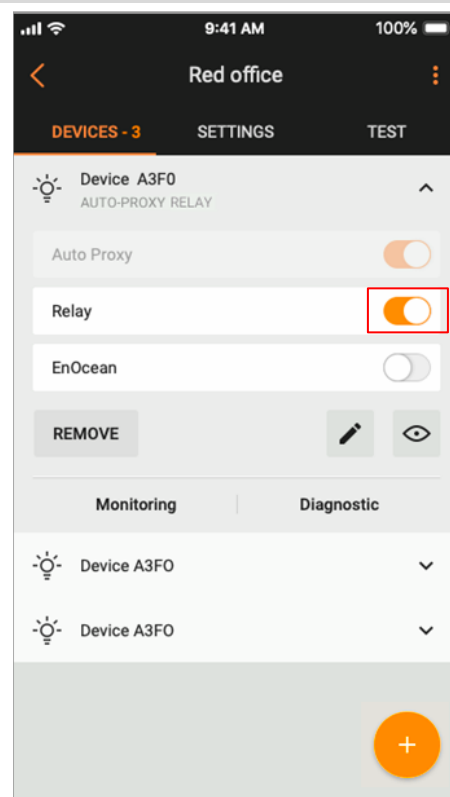

UltraLink mobile app

1. In the **UltraLink mobile app**, go to the project, area, and zone.
2. Tap the device you want to act as a relay (iOS/iPadOS), or tap ⋮ to open the context menu (Android).

   ℹ️ To find the particular device, tap 💡 next to a device name to make the device flash.

3. Tap the **Relay** toggle switch to move it to the right (iOS/iPadOS) or tap **Enable Relay** (Android).

   > Enable Relay
   >
   > Enable EnOcean
   >
   > Remove

4. Repeat steps 2–3 for the rest of devices that must act as a relay.

3.2 Recommendations for linear installations

✔	Set up relays manually in the UltraLink mobile app.
✔	Place relays so that each device is in range of at least one relay.
✔	Take into account the distance between devices. Long distance requires more relays to be set up in the zone.
✘	Do not rely on automatically set up relays.
✘	Do not set up a device to act as a relay and as a static proxy at a time. If you combine these functions, the performance of the device will decrease.
✘	Do not position relays close to each other.

4. Installations with a gateway

> ⚠️ A gateway is required only in installations that use the following services: energy monitoring, occupancy monitoring, scheduling, or automated demand response.

A gateway is a device that allows you to schedule events and collect data from Bluetooth mesh lighting networks. The collected data is then sent to the UltraLink Cloud, from where it can be viewed and analyzed. One gateway can schedule events in multiple areas and monitor energy/occupancy in a mesh network of up to approx. 200 devices.

> ℹ️ Because gateway performance is limited, one gateway can monitor energy or occupancy of up to approx. 200 devices in all areas. If the gateway monitors more than 200 devices, the reporting may not be correct.

> ℹ️ More than 200 devices can be scheduled, but each area must not have more than approx. 200 devices.

The number of gateways used in an installation depend on:
- Number of mesh devices in the areas.
- Building construction and arrangement of zones in the building.
- Services used (monitoring, scheduling, or automated demand response).

Consider the arrangement of areas in the project. If there is more than one area, the gateway must have a direct connection to at least one device in each controlled area. If there is a poor or no connection between the gateway and a controlled area, the gateway may not work in this area but it may work in another.
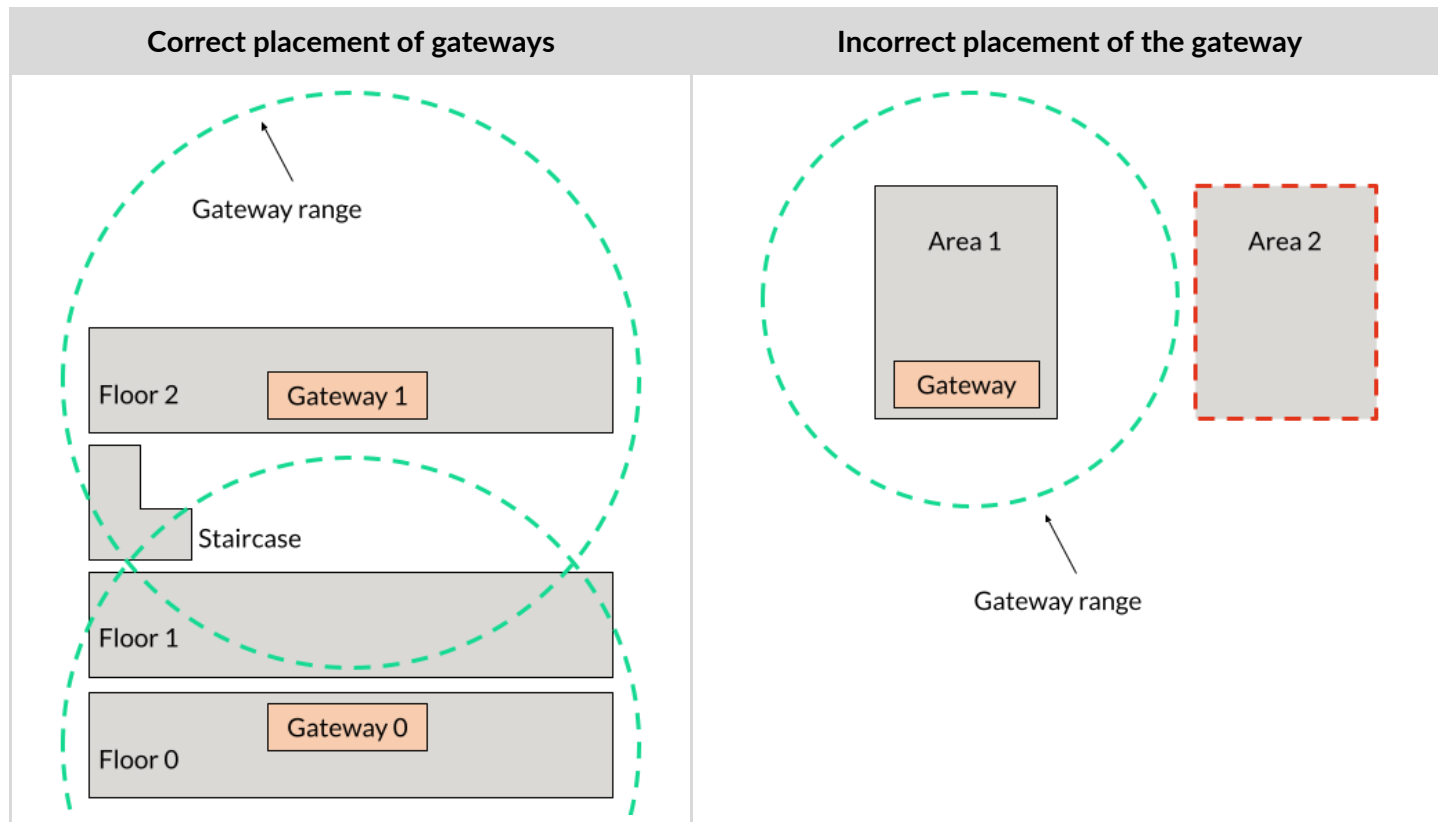
5. Frequently asked questions

Can relays from one area route mesh traffic for another area?

No. Relays in one area will only route traffic from devices in that area. In the following case, we recommend that you add the isolated device to the blue area.
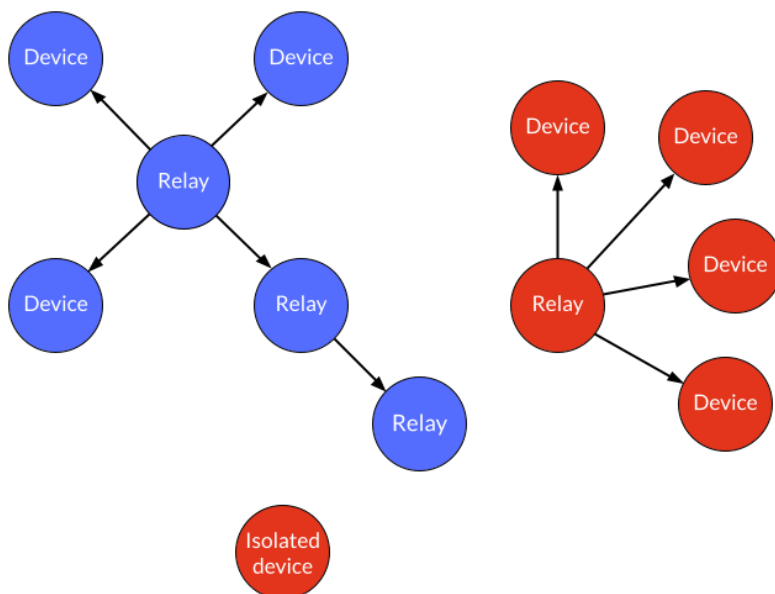
Do I always have to create separate areas in my project?

No. If you have an installation with fewer than approximately 200 devices, you can have all of them in one area.

Does zone linking work with zones in different areas?

No. Zone linking works only between zones in the same area.

I have a network with 700 devices. Can I divide it into two areas of 350 devices each?

No. We do not recommend this. For an area where each device is a sensor-controller, 350 devices is too many. In this case we recommend that you use at least four areas with no more than approximately 200 devices in each area. Make sure that all devices in each area are in the Bluetooth mesh range.

Do I need a gateway for areas to work?

No. A gateway is required only when you use energy/occupancy monitoring, scheduling, or automated demand response in that area.

Is the maximum number of devices in an area 200?

No. 200 devices is an estimate. In some cases a network of more than 200 devices will work correctly without dividing it into smaller areas. But the correct function of a network depends on such factors as: types of sensors used, publishing frequency of sensor data, arrangement of devices, and environmental conditions (wall thickness, ceiling thickness, and construction material).

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