LUTRON

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Revision C
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# Clear Connect System Type X Best Practices

Type X is an extension of the Clear Connect family of wireless protocols that enables more aesthetic options and flexible deployments. Type X operates in the 2.4 GHz frequency band and complements Lutron's ultra-reliable and ultra-responsive sub-GHz Clear Connect system Type A wireless solution. Highly optimized for advanced lighting control, Type X delivers on the control requirements for today's high performance applications such as full spectrum tunable lighting.

This document outlines the best practices for designing and implementing a system based on Type X.

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# Clear Connect System Type X Overview

## Devices and Subnets

A Type X system can consist of multiple subnets where each subnet comprises of one Type X Gateway device and up to 100 other wireless devices like lamps, downlights, etc. The Gateway device, referred to as the Clear Connect Type X-Gateway, can wirelessly communicate with the other devices in the subnet using the Type X protocol. The Gateway also requires a power over Ethernet (PoE) connection for power supply, inter-subnet communication, and Internet connectivity. Requirements and best practices related to the Gateway and device placement are discussed later in this document.

## Frequency Band of Operation

Type X is based on the IEEE 802.15.4 standard and operates in the 2.4 GHz frequency band. The standard allows for 16 channels between 2.40 GHz and 2.48 GHz, 15 of which are available for use in a Type X system. This narrowband communication system co-exists with other systems and devices in the 2.4 GHz band like Wi-Fi devices, Bluetooth devices, microwave ovens, etc. The spread of the available channels across the entire frequency band enables Type X to co-exist with other 2.4 GHz systems in the same space. Best practices for co-existence are discussed later in this document.

## Mesh Networking

Type X delivers secure and reliable communication while using a mesh network topology. In a mesh network, devices participating in the mesh repeat and route messages as needed.

Consider a message that is sent by a device meant for another device that is far away. Even if the destination device cannot hear the originating device directly, a mesh topology utilizes other devices in between the originator and the destination to repeat and route the message.

In Type X, the system intelligently decides which devices have the routing and repeating capabilities to best enable communication in the space. To co-exist with the potentially dynamic 2.4 GHz interference environment, a Type X system dynamically adjusts which devices participate in the mesh to improve the reliability of communication.

Type X devices are smart digital devices that require continuous power for optimal mesh performance. To ensure reliable communication, it is important to wire Type X devices, especially lamps, such that their power cannot be inadvertently or frequently interrupted. Installers must avoid using switches to provide power to Type X devices. This prevents inadvertent loss of power to devices that may be participating in the mesh network to repeat or route messages.

## Type X Best Practices

While the primary goal of devices in a space is to achieve and conform to the architectural requirements, certain device placement guidelines and recommendations lead to an optimal customer experience.

### Gateway Placement

The following specifications and best practices apply to the placement of the Gateway:

- Each Clear Connect Gateway-Type X can communicate with up to 100 other Type X devices.
- All assigned Type X devices must be within 75 ft (22.9 m) of the Gateway with at least two non-battery operated Type X devices placed within 25 ft (7.5 m) of the Gateway. As a result, a centralized placement of the Gateway in the subnet is ideal.
- In multiple subnet deployments, the installer should separate two subnets that share a channel by as much as possible to minimize cross talk.
- It is recommended that the Gateway and the Type X devices assigned to it are located on the same floor.
- Do not install the Clear Connect Gateway-Type X inside or adjacent to metal enclosures.

The illustration in Figure 1 demonstrates the placement of two Gateways on the main floor of a residence. The Gateways are in the office and pantry to ensure coverage throughout the main floor of the residence. The larger diameter circle around the Gateways represents the 75 ft (22.9 m) radius of the subnet. The smaller circle depicts the 25 ft (7.5 m) coverage radius of the Gateway itself and includes at least two Type X devices assigned to the Gateway. Each larger colored circle is colored differently to indicate that they should be assigned different Type X channels.

A similar placement concept would apply to commercial installations as well.

It is important to note that while the specification requires a minimum of two non-battery powered Type X devices within 25 ft (7.5 m) of the Gateway, the Gateway is the point of control for many of the system messages used by our customers. The availability of more than two neighboring devices provides additional possible routes for propagation of system messages and may improve system performance.

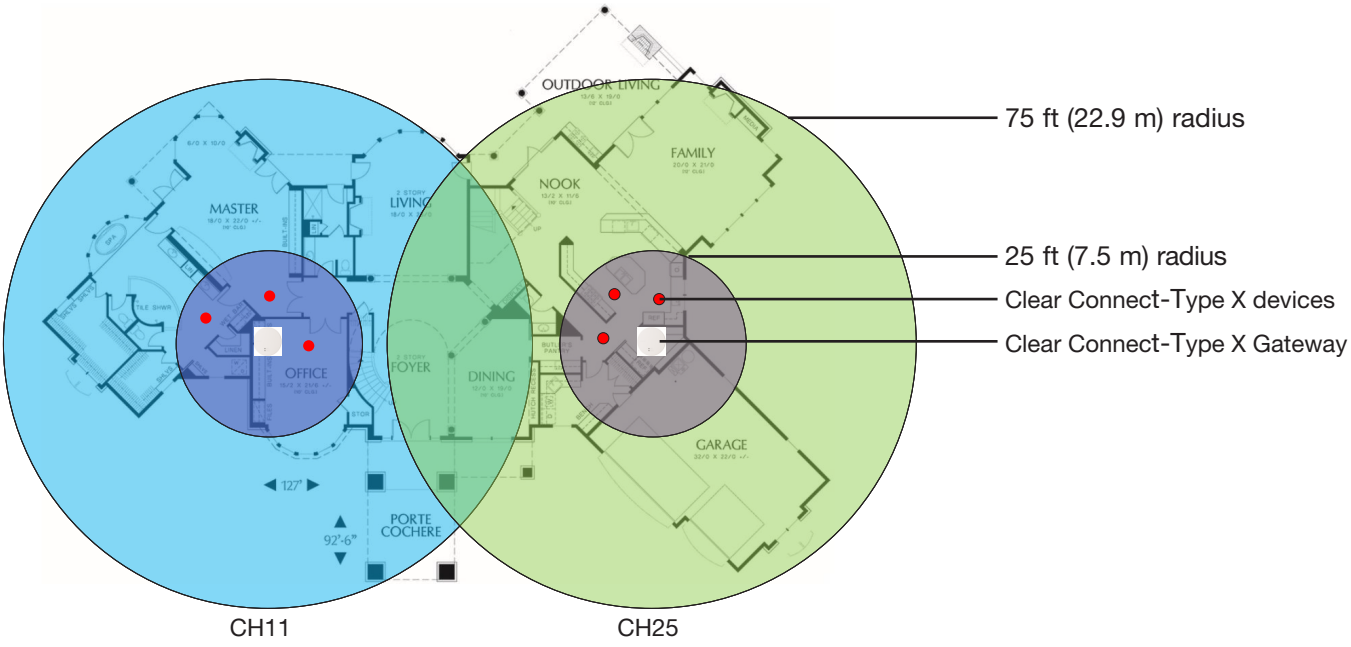


Figure 1 - Main Floor of Residence with two Gateways on the Floor

## Type X Best Practices (continued)

### Gateway Placement (continued)

Type X signals will suffer degradation as they pass through floors and other construction materials. The amount of signal degradation will depend on the construction material type, so, to ensure the highest customer experience, it is recommended that the Gateway and the Type X devices assigned to it are located on the same floor.

Since Type X signals propagate through floors, assigning channels to two subnets that overlap but are on different floors deserves attention to avoid interference. Ensuring that the two overlapping subnets are on different channels avoids inadvertent interference between them. Figure 2 shows the upper floor of the residence and the larger circles of different color depict that the two subnets on that floor are on different channels. Note that at this site, two subnets use the same channel (shown by the green circles in Figure 1 and Figure 2) but those subnets are on different floors, as far away as possible from each other. This site uses a three-channel re-use plan for the subnets which is discussed later in this document.

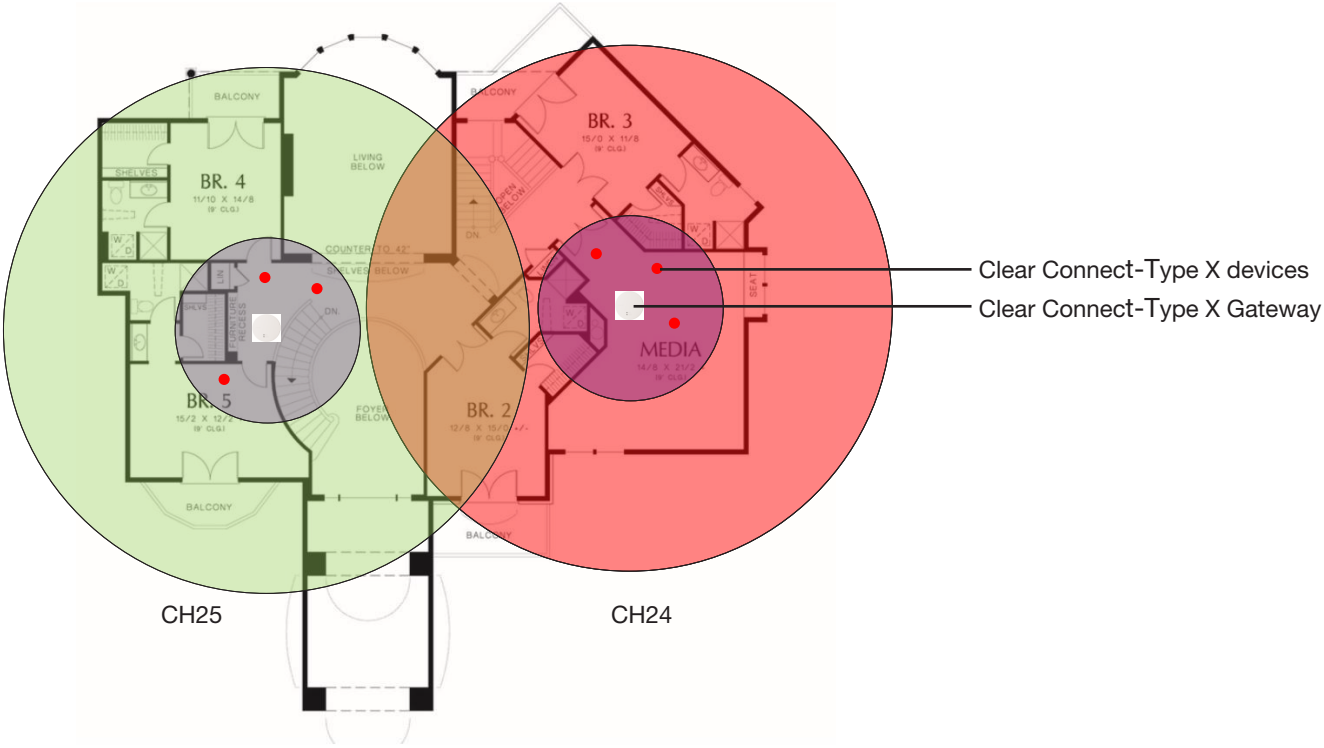


Figure 2 - Upper Floor of Residence with two Gateways on the Floor

## Type X Best Practices (continued)

### Device Placement

Following certain device-to-device layout guidelines enable the best use of the mesh capabilities of a Type X device.

- Each Type X device must have at least 2 other non-battery powered Type X devices within 25 ft (7.5 m).
- Within a subnet, groups or clusters of devices must not be separated by greater than 25 ft (7.5 m). See Figure 4 for more details.
- Type X loads are designed to work with most common fixture types, however, the performance of Type X devices can severely degrade if installed inside metal enclosures.

Figure 3 depicts a layout where each device (represented as a red dot) has at least two more Type X devices within its own 25 ft (7.5 m) RF coverage area (orange circle). This arrangement of devices enables the Type X system to dynamically select the most appropriate devices to be mesh routers to deliver an optimal customer experience.

Having multiple potential wireless paths to each node and requiring the subnet area to be within 75 ft (22.9 m) of the Gateway ensures high operational efficiency of the Type X mesh network.

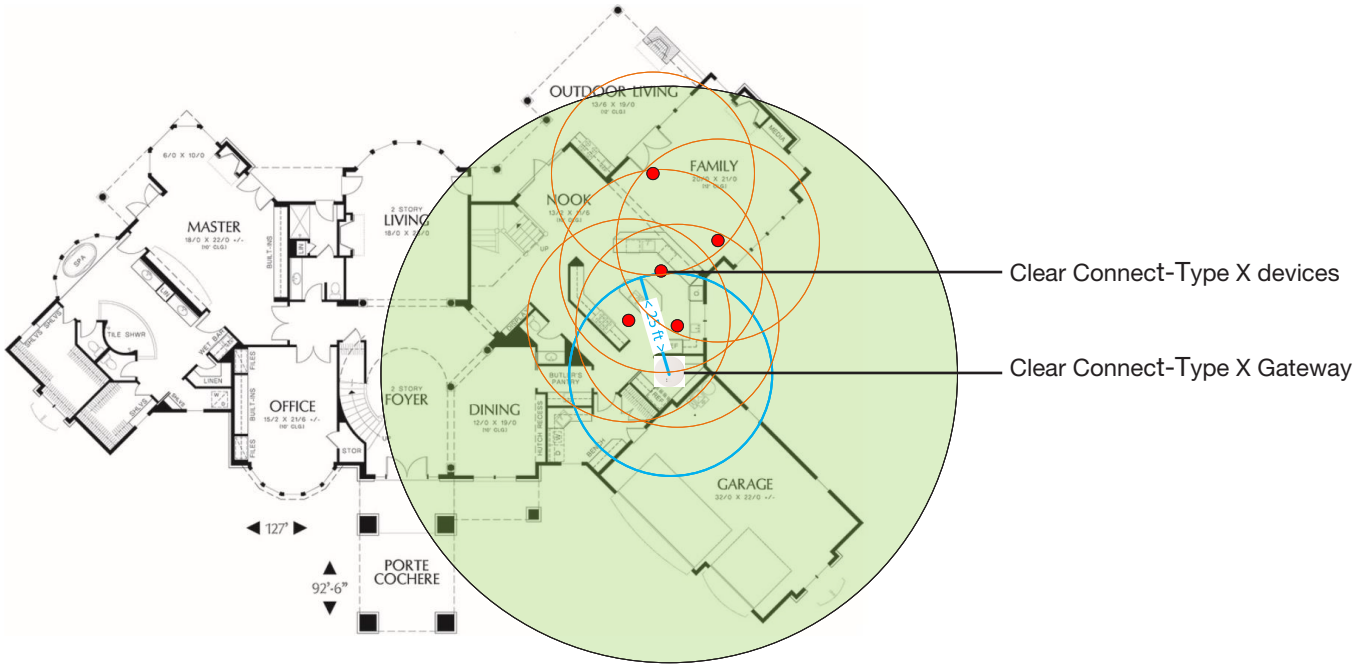


Figure 3 - Device Placement Multi-Room Example

## Type X Best Practices (continued)

### Device Placement (continued)

Figure 4 shows a project where you would like to deploy sixteen lamps in two conference rooms. You can see that the conference rooms are more than 25 ft (7.5 m) apart forming two separate groups of Type X devices that otherwise adhere to all other design rules (two devices within 25 ft (7.5 m) and all devices in a 75 ft (22.9 m) perimeter). However, these separated groups of Type X devices can cause a problem with the formation of a robust mesh. There are three ways this can be addressed, as described and illustrated below:

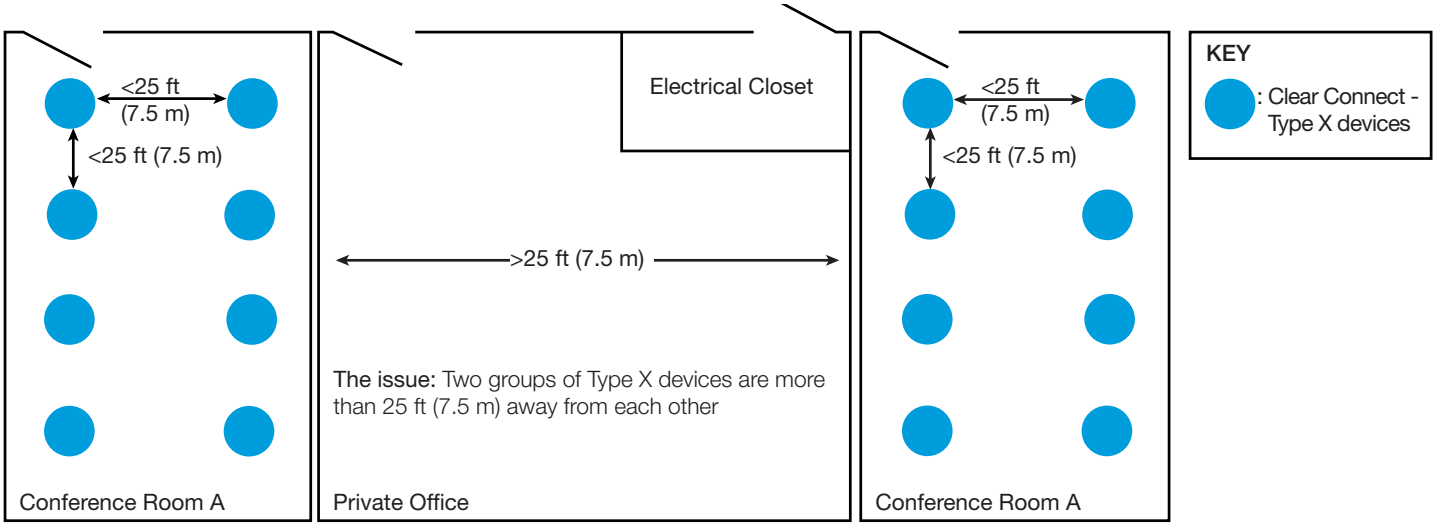


Figure 4 - Two groups of lamps separated by more than 25 ft (7.5 m).

1. **Solution 1 (refer to Figure 5)**: Add two Gateways and create two Type X subnets. One subnet per group of devices in each conference room.
2. **Solution 2 (refer to Figure 6):** Place a Gateway in between the two conference rooms such that it is within 25 ft (7.5 m) of at least two devices in each conference room.
3. **Solution 3 (refer to Figure 7):** Place the Gateway in one of the two conference rooms and place one or more additional Type X devices between the two conference rooms such that the additional device(s) is within 25 ft (7.5 m) of at least two other devices in each conference room.

## Type X Best Practices (continued)

### Device Placement (continued)

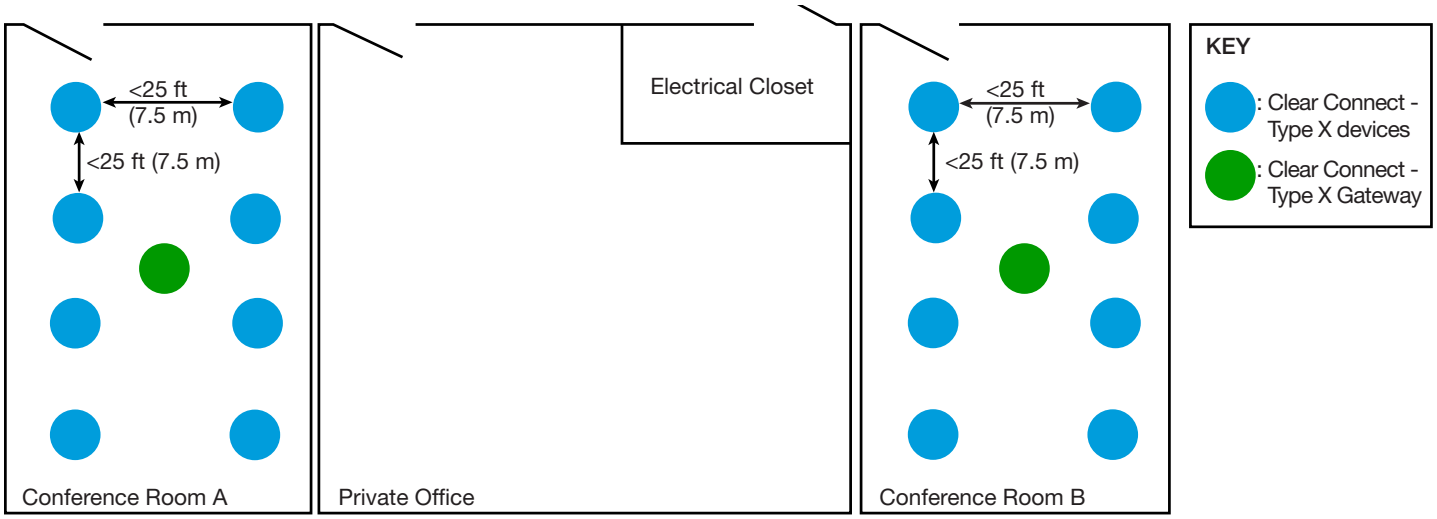


Figure 5 - Solution 1 *Where two Type X subnets are formed.*

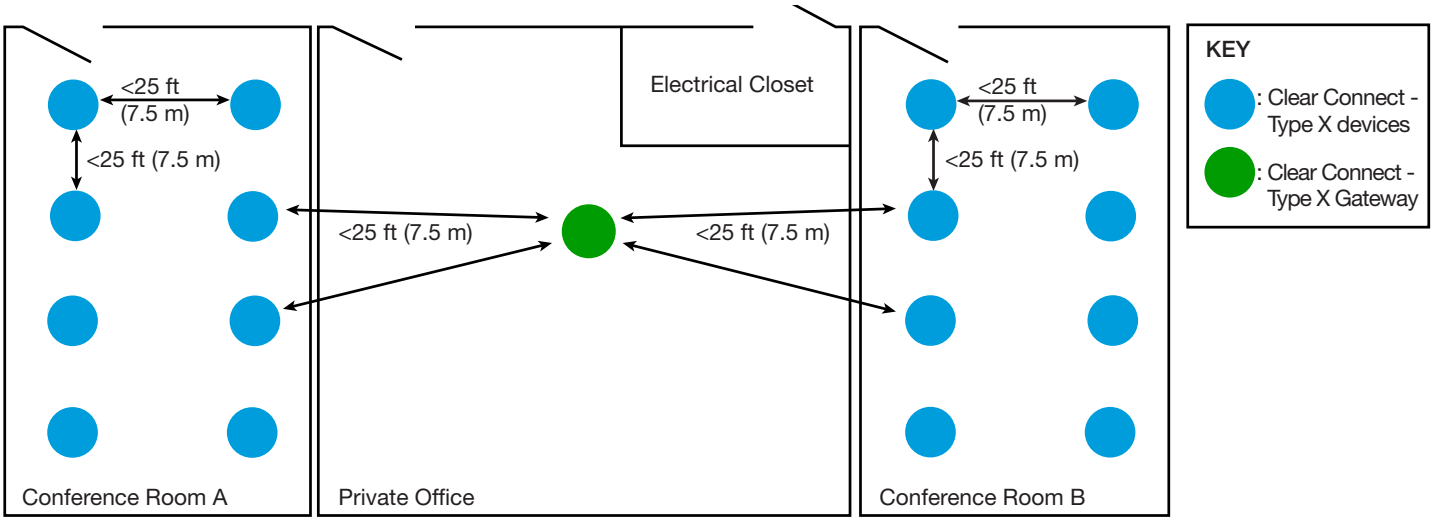


Figure 6 - Solution 2 *Where the Gateway is placed between the two groups of devices.*

## Type X Best Practices (continued)

### Device Placement (continued)

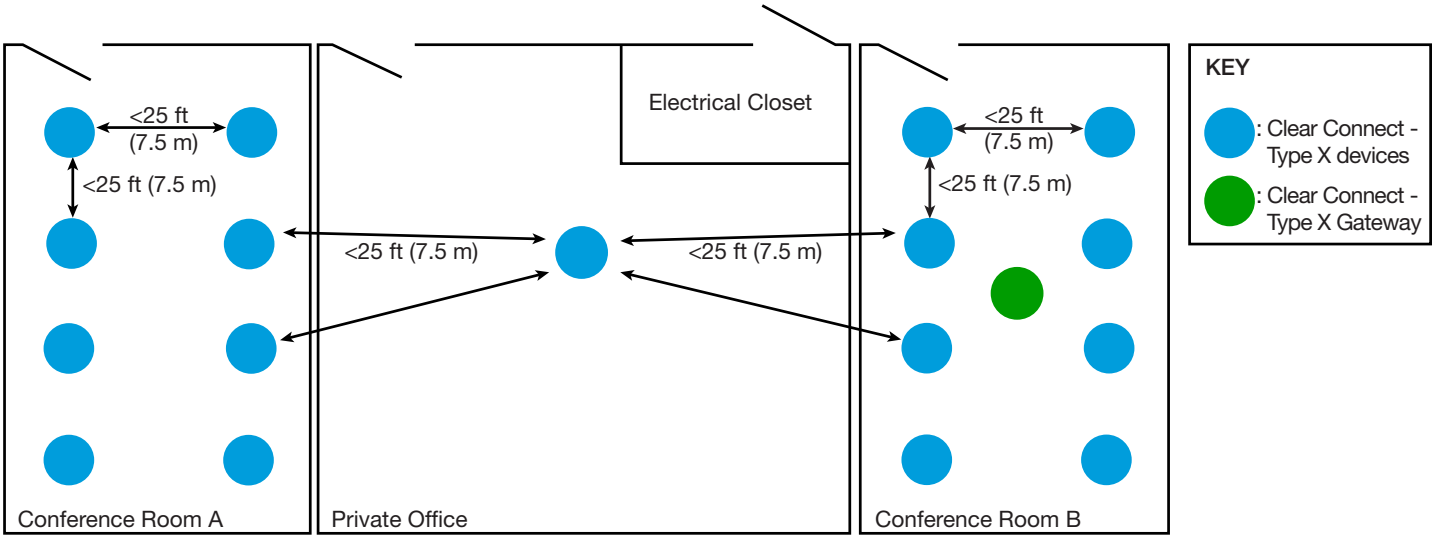


Figure 7 - Solution 3 *Where additional devices are placed between the two groups of devices.*

Solution 1 will provide the greatest reliability because it removes the need to connect the two groups. While Solution 2 and Solution 3 show connecting these groups with a single path/device, placement of additional devices to provide more paths will further increase reliability.

## Type X Best Practices (continued)

### Co-existing with Non-Type X Equipment and Systems

Placing Type X devices and gateways away from sources of substantial wireless interference in the 2.4 GHz frequency band ensures the highest performance levels of the Type X system. Type X devices operate using narrowband channels between 2.40 and 2.48 GHz, where interference sources such as those listed below may also be present.

With proper channel selection, Type X devices can avoid other 2.4 GHz equipment that use partial sections of the band.

Some other devices, like microwave ovens, generate broadband wireless noise across the entire 2.4 GHz band and placing them away from the Type X devices ensures optimal operation.

- For best performance, Lutron recommends moving Wi-Fi devices off of 2.4 GHz and into the 5 GHz band (802.11n or 802.11ac) to prevent potential overlap and interference with Type X devices.
- **Clear Connect Gateways-Type X:** Must be placed a minimum of 5 ft (1.5 m) away from the following types of devices that generate signals in the 2.4 GHz frequency band:
  - 2.4 GHz Wi-Fi wireless access points, routers and hotspots
  - 2.4 GHz Wi-Fi devices like thermostats or voice recognizing control devices
  - Microwave ovens
  - 2.4 GHz wireless video equipment and baby monitors
  - Lutron Vive Wireless Hubs (HJS-x)
- **Other Type X devices** (lamps, dimmers, control devices, etc.): Must be placed a minimum of 3 ft (1.0 m) away from the above listed interference sources in the 2.4 GHz band.
- **Radio Powr Savr occupancy/vacancy sensors** (models starting with LRFx): Must be mounted at least 4 ft (1.2 m) away from Clear Connect Gateways-Type X and 2 ft (0.6 m) away from other Type X devices such as lamps, fixtures and controls.

## Channel Selection

Type X is a narrowband communication system that operates on 1 of 15 allowed channels that span across the entire 2.4 GHz frequency band. When compared to the overall size of the 2.4 GHz band, the Type X system occupies a small bandwidth. This narrowband nature gives Type X a better chance of co-existing with other occupants in the band. It is, therefore, important to select the appropriate channel to minimize interference from other sources.

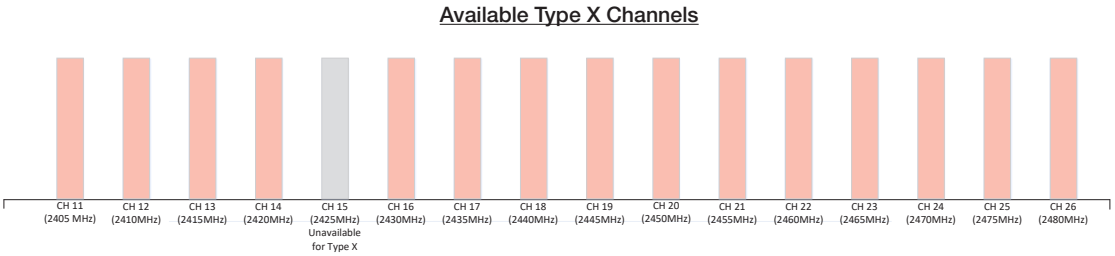


Figure 8 - Type X Channels

Not all interference sources pose an equal challenge to Type X communication. Some high-power, wideband interference sources like Wi-Fi are more challenging to co-exist with as compared to narrowband interference sources like Bluetooth. Fortunately, at most installations Wi-Fi is deployed on one of three standard channels – 1, 6 or 11. If the Wi-Fi deployment at a site follows the standard channel scheme of 1-6-11, a preferred set of Type X channels are known to have the best chance of working. However, it is important to note that not all Wi-Fi deployments follow the 1-6-11 scheme and such sites may require additional frequency band surveys to determine the best channels for Type X systems.

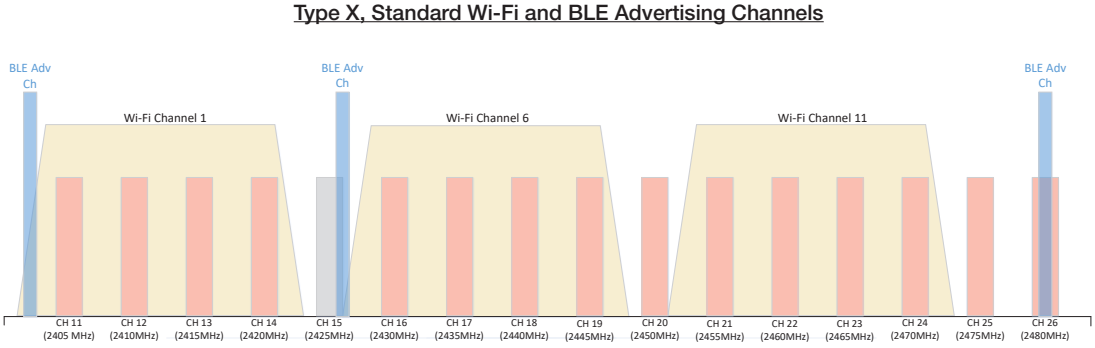


Figure 9 - All Type X Channels Shown with Standard Wi-Fi and Bluetooth Low Energy Advertising Channels (BLE)

It is important to note that the 2.4 GHz spectrum is dynamic and can change due to several factors – occupants of the space may change, Wi-Fi system gets updated, neighboring systems can interfere, etc. To ensure reliable communication, Type X has been designed to work in a reasonable interference environment.

# Channel Selection (continued)

## Co-Existence with Standard Wi-Fi Deployments

If a site uses 2.4 GHz Wi-Fi deployed on standard channels (1-6-11), five Type X channels are preferred for system deployment because they avoid or minimize interference from Wi-Fi.

The five preferred channels for Type X, in order of preference are as follows:

- Channel 25 (2475 MHz)
  - Is outside the highest Wi-Fi channel of operation.
  - Does not overlap with Bluetooth Low Energy (BLE) advertising channels.
- Channel 11 (2405 MHz) and Channel 24 (2470 MHz)
  - Both are at the edge of standard Wi-Fi channels with a reduced possibility of interference.
- Channel 20 (2450 MHz)
  - Quiet if standard Wi-Fi deployment scheme (1-6-11) is used.
  - Does not overlap with Bluetooth Low Energy (BLE) advertising channels.
  - Susceptible to some Wi-Fi access points operating on non-standard channels.
  - Susceptible to 40 MHz Wi-Fi channel deployments in 2.4 GHz band.
- Channel 26 (2480 MHz)
  - Avoids standard Wi-Fi channels (1-6-11).
  - Overlaps with Bluetooth Low Energy (BLE) advertising channel. Use only if the BLE device count (and traffic) is expected to be low.

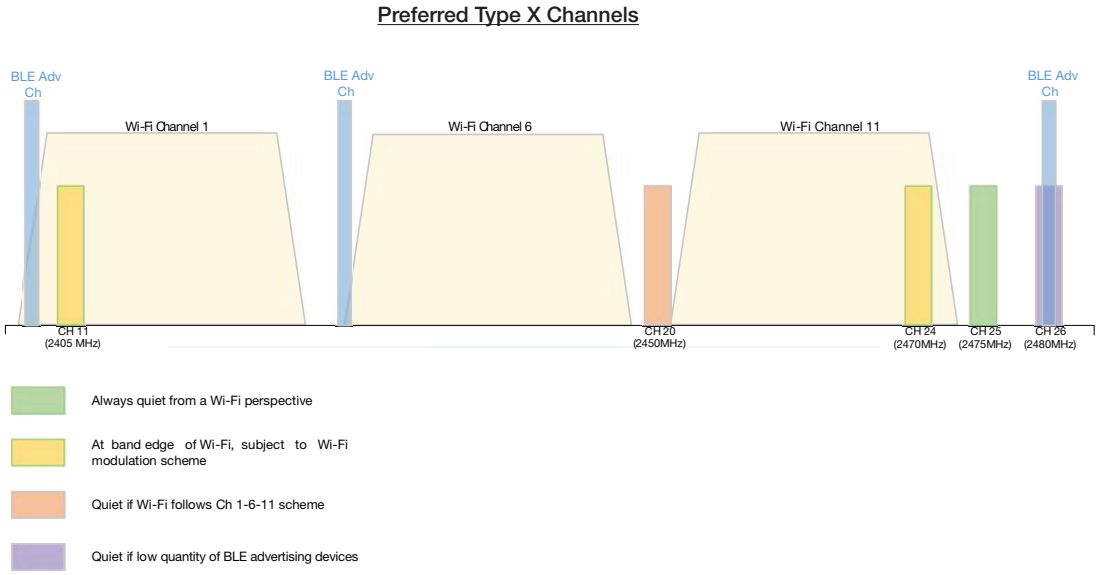


Figure 10 - Type X Preferred Channels Shown with Standard Wi-FI and Bluetooth Low Energy Advertising Channels

# Channel Selection (continued)

## Co-Existence with Non-Standard Wi-Fi Deployments

If non-standard Wi-Fi channels are used at a site, the Lutron recommended list of channels (25, 11, 24, 20 and 26) may not result in the best performance. For example, while channel 20 fits nicely in between the standard Wi-Fi channels of 6 and 11, using Wi-Fi channels 8 or 9 would subsequently cause overlap and potentially impact the performance of the Type X system.

For sites where the Wi-Fi deployment is on non-standard channels, it is recommended to conduct a site survey to determine the best Type X channel(s) to use.

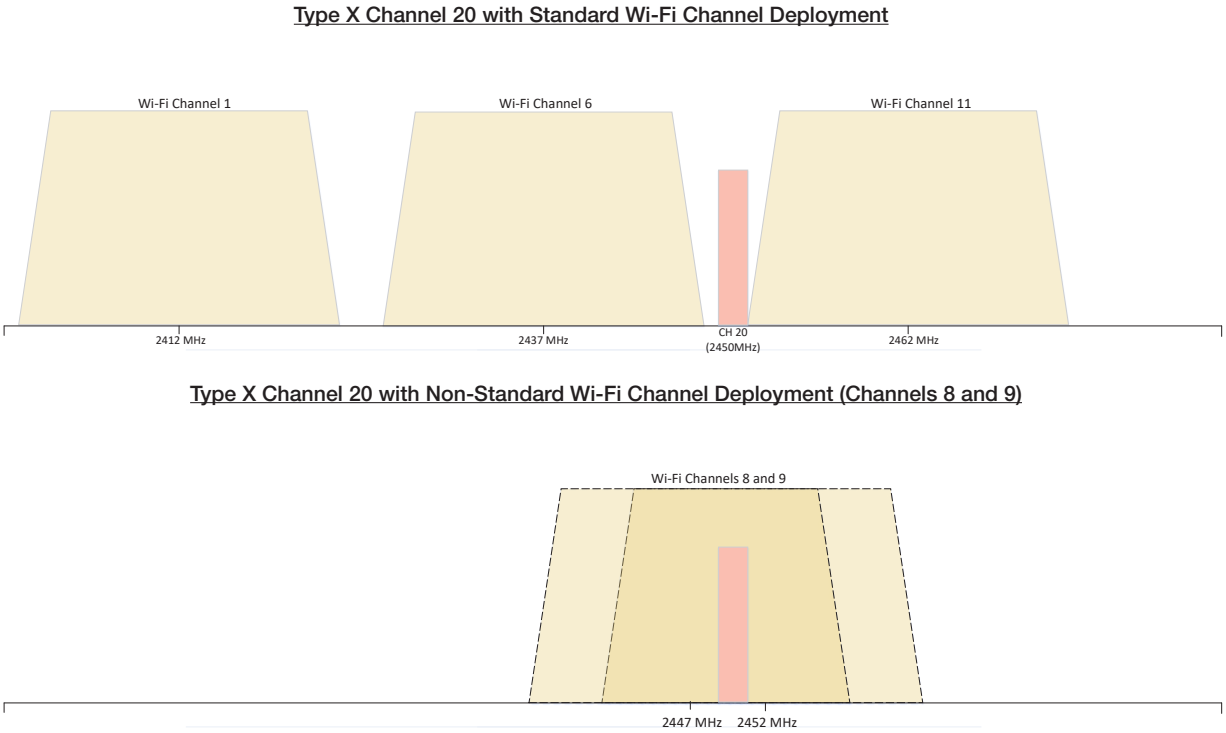


Figure 11 - Example of Non-Standard Wi-Fi Deployments Causing Potential Interference with Type X Channel 20

## Site Survey Recommendations

A site survey may be required if the installation is experiencing interference issues or if the installer wants to identify the best channels for Type X deployment.

Lutron recommends using the Wi-Spy and Chanalyzer tool from MetaGeek LLC to perform site surveys. Please reach out to your Lutron representative for assistance with site surveys.

While ideally a few interference-free channels are available for use, in case no interference-free channels are available, some possibilities to consider are:

1. Choose the Type X channels with the least magnitude of interference.
2. Choose the Type X channels that are on the fringes of the Wi-Fi channels.

## Channel Selection (continued)

### Installations with Multiple Type X Subnets

Large installations will require the use of multiple Type X subnets. To ensure best performance when deploying multiple subnets, the following recommendations should be followed:

- Separate two subnets that share the same channel by as much distance as possible.
- Lutron recommends a three-channel reuse plan throughout the space as shown in Figure 12. The Gateway and Lutron Designer PC and Programming Tool cycle through the 3 default channels as additional Gateways get added to the job site. It is up to the installer to ensure that the location and coverage of the Gateways adheres to the recommendations. If need be, the installer can choose a different set of channels through the Lutron Designer PC and Programming Tool based on results from site surveys or inputs from site owners.
- If nearby subnets must use the same channel, minimize overlap between those subnets. This should be especially considered for installations with multiple floors. Two overlapping subnets separated by a floor should use different channels as shown in Figure 13.
- If a space is configured to be a single lighting zone, i.e., all devices in that space are controlled together, it is best to not divide that space across two different subnets to maximize performance.

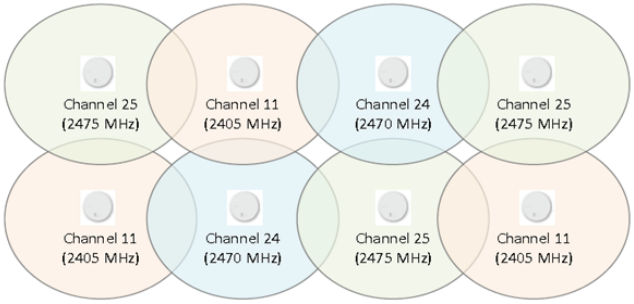


Figure 12 - Three Channel Reuse Plan for Single Floor with Multiple Subnets

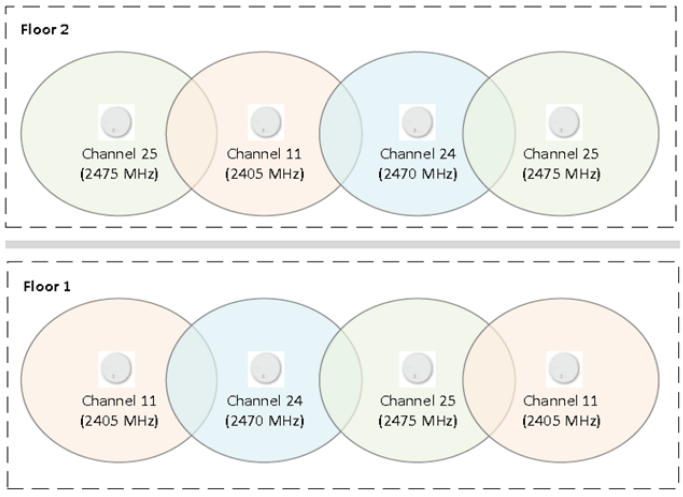


Figure 13 - Three Channel Reuse Plan for Multiple Floors with Multiple Subnets

These strategies are some of many that can be leveraged to enhance system performance. The Type X channels used, and the quantity of channels used will depend on the deployment of other 2.4 GHz devices in the space as well as the dimensional layout and quantity of Type X devices per floor. Site managers or installers should make sure that the recommended default channel by the Lutron Designer software still meets the requirements.

## Channel Selection (continued)

### Example Installations

The following examples leverage the rules and recommendations outlined in this document to highlight best practices associated with Type X use and deployment.

**Residential Apartment:**

Consider a residential apartment with the following details:

- The apartment is on a single floor
- The installation has 100 or less Type X devices

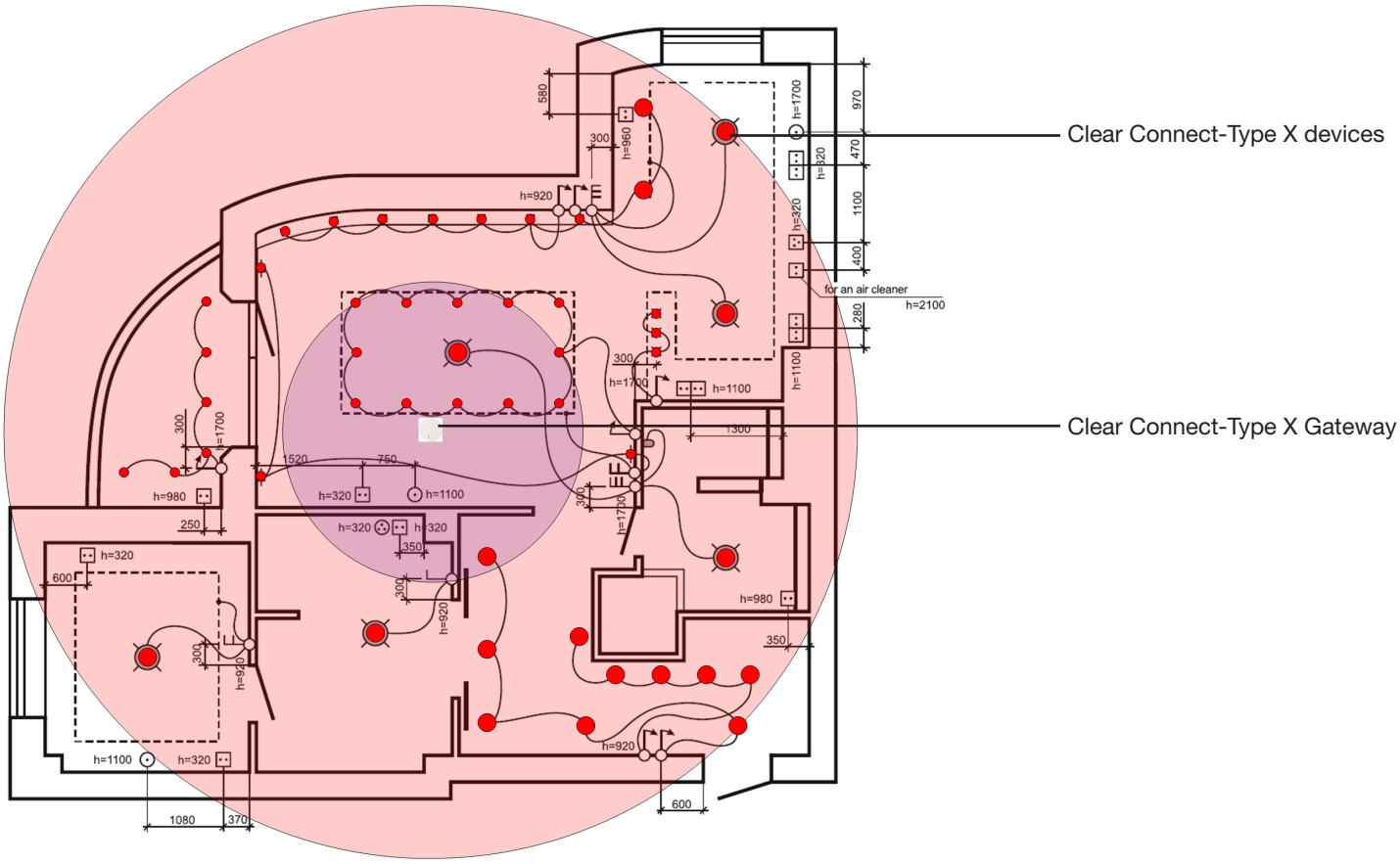


Figure 14 - Floor Plan of an Apartment

As shown in Figure 14, the installation adheres to the recommendations of this document as follows:

1. The Gateway is centrally located so all devices (like lamps and fixtures) are within 75 ft (22.9 m) of the Gateway.
2. The Gateway is configured to work on Type X Channel 25 because it is the highest in the preferred list of channels.
3. The Clear Connect Gateway-Type X and devices have at least two other non-battery powered devices within a 25 ft (7.5 m) radius.
4. The devices are not grouped or clustered such that one group of devices is separated from another group by more than 25 ft (7.5 m).
5. The installer informed the occupants that:
   a. Type X devices should maintain appropriate distances from other 2.4 GHz sources of interference.
   b. It is best to deploy all Wi-Fi on the site at 5 GHz only.
6. None of the Type X devices are fully enclosed in metal.

## Channel Selection (continued)

### Example Installations (continued)

**Single Family Home:**

Consider a Single-Family home with the following details:

- The home has two floors.
- The installation has between 150 and 200 devices.

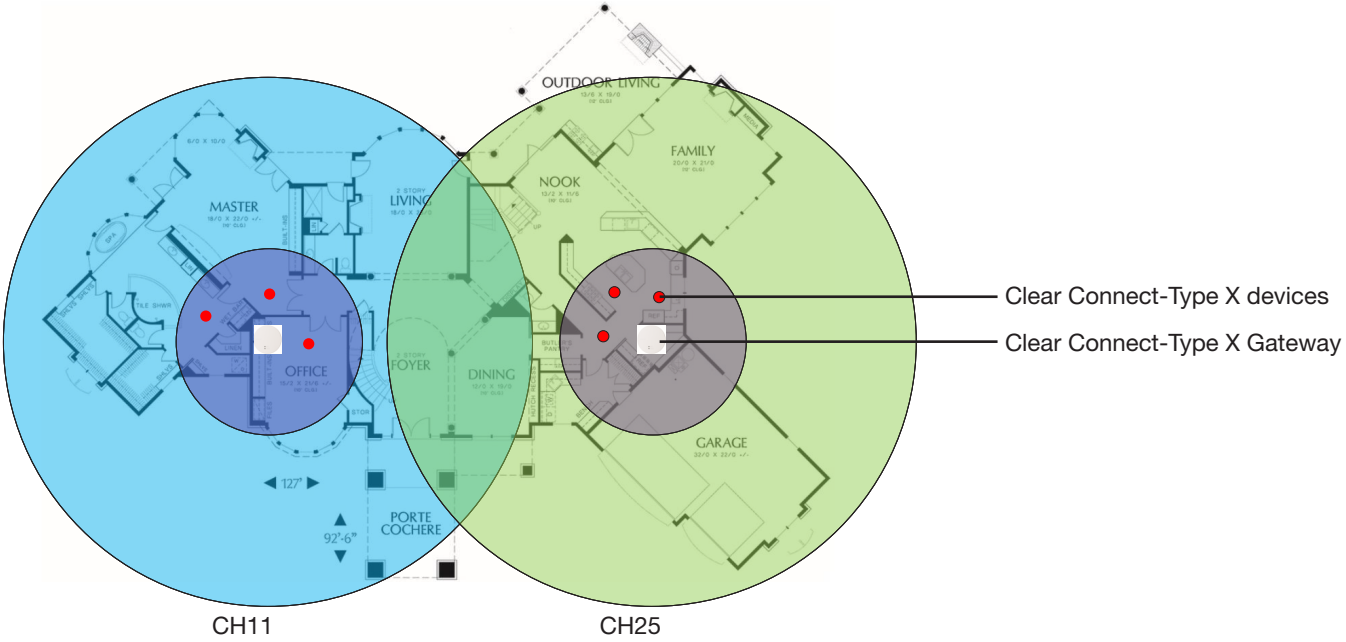


Figure 15 - Main Floor of Single-Family Home

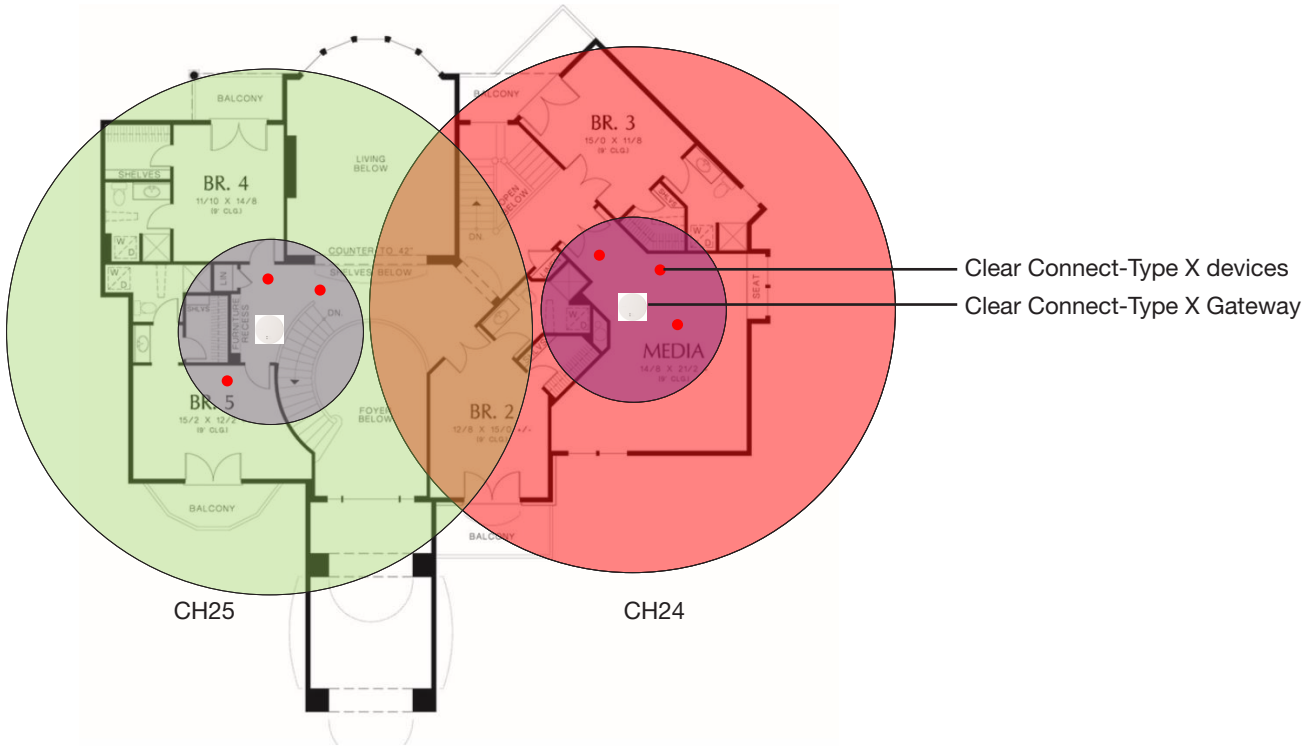


Figure 16 - Upper Floor of Single-Family Home

## Channel Selection (continued)

### Example Installations (continued)

**Single Family Home (continued):**

As shown in Figure 15 and Figure 16, the installation adheres to the recommendations of this document as follows:

1. Given the device count, four Gateways are used at this site with each Gateway having 100 devices or less.
2. The Gateways are centrally located in the subnets.
3. The default three-channel reuse plan is followed. Two subnets are on channel 25 and one subnet is on each of channels 11 and 24.
4. To maximize the distance between the two subnets on the same channel, they are located on different floors and at opposite ends of the home.
5. The two overlapping subnets that are on different floors are also on different channels.
6. All devices associated to a Gateway are on the same floor as that Gateway.
7. All Clear Connect Gateway-Type X and devices have at least two other non-battery powered devices (belonging to the same subnet) within a 25 ft (7.5 m) radius.
8. Within a subnet, the devices are not grouped or clustered such that one group of devices is separated from another group by more than 25 ft (7.5 m).
9. The installer informed the occupants that:
   a. Type X devices should maintain appropriate distances from other 2.4 GHz sources of interference.
   b. It is best to deploy all Wi-Fi on the site at 5 GHz only.
10. None of the Type X devices are fully enclosed in metal.

## Channel Selection (continued)

### Example Installations (continued)

**Commercial or Residential Building with Multiple Floors and Multiple Units Per Floor:**

Consider a building of Multiple Dwelling Units with the following details:

- The site has multiple floors
- Each floor has 6 units
- Each unit has 100 devices or less

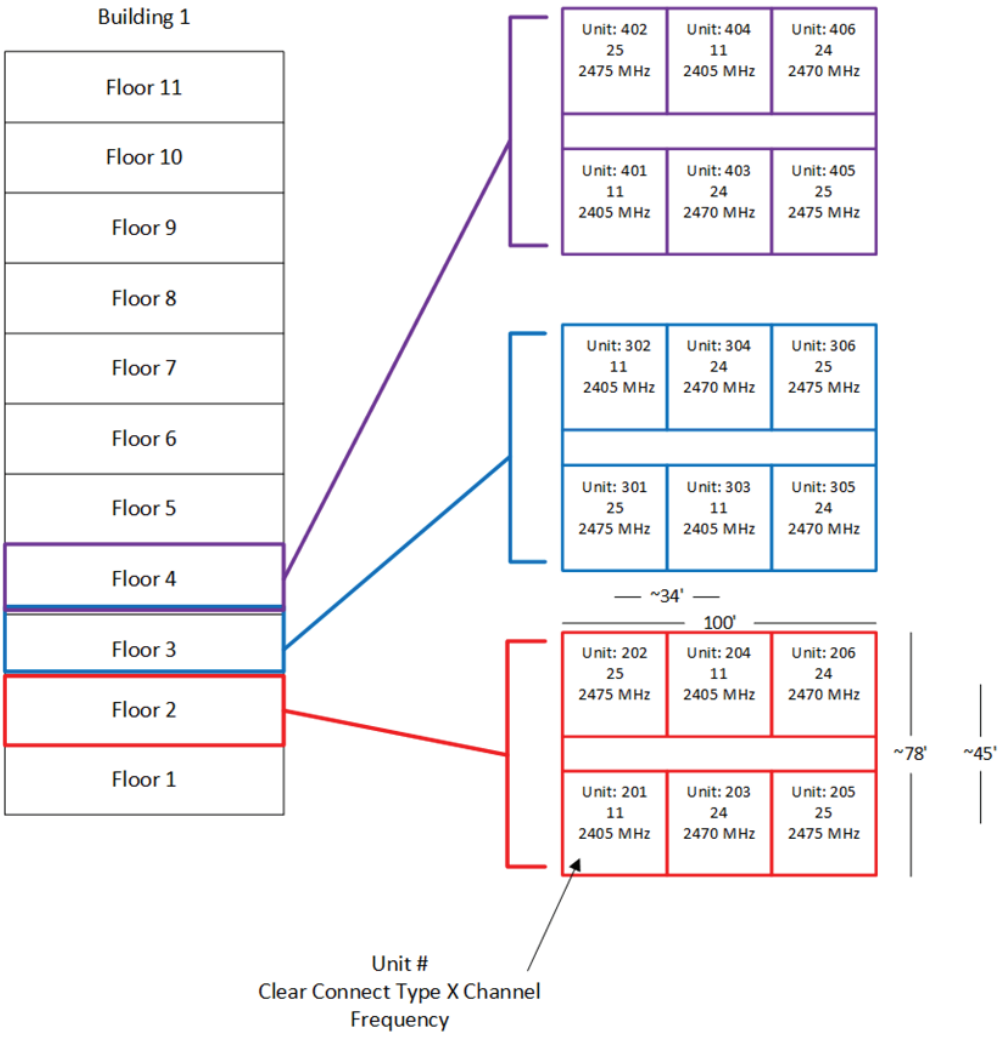


Figure 17 - Multiple Dwelling Unit with Multiple Floors and Multiple Units per Floor

## Channel Selection (continued)

### Example Installations (continued)

**Commercial or Residential Building with Multiple Floors and Multiple Units Per Floor (continued):**

As shown in Figure 17, the installation adheres to the recommendations of this document as follows:

1. Given the building layout and device count per unit, each unit is a separate Type X subnet. As a result, each floor has six subnets.
2. For best performance, a subnet does not span across multiple units or floors.
3. The Gateways are centrally located in the subnets.
4. Assuming the site IT infrastructure managers agree, the default three-channel reuse plan is adhered to for the entire site.
5. For any given floor, subnet channels are allocated to maximize the distance between subnets that use the same channel.
6. Overlapping subnets separated by a single floor are always on different channels.
7. All Clear Connect Gateway-Type X and devices have at least two other non-battery powered devices (belonging to the same subnet) within a 25 ft (7.5 m) radius.
8. Within a subnet, the devices are not grouped or clustered such that one group of devices is separated from another group by more than 25 ft (7.5 m).
9. The installer informed the occupants that:
   a. Type X devices should maintain appropriate distances from other 2.4 GHz sources of interference.
   b. It is best to deploy all Wi-Fi on the site at 5 GHz only.
10. None of the Type X devices are fully enclosed in metal.

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