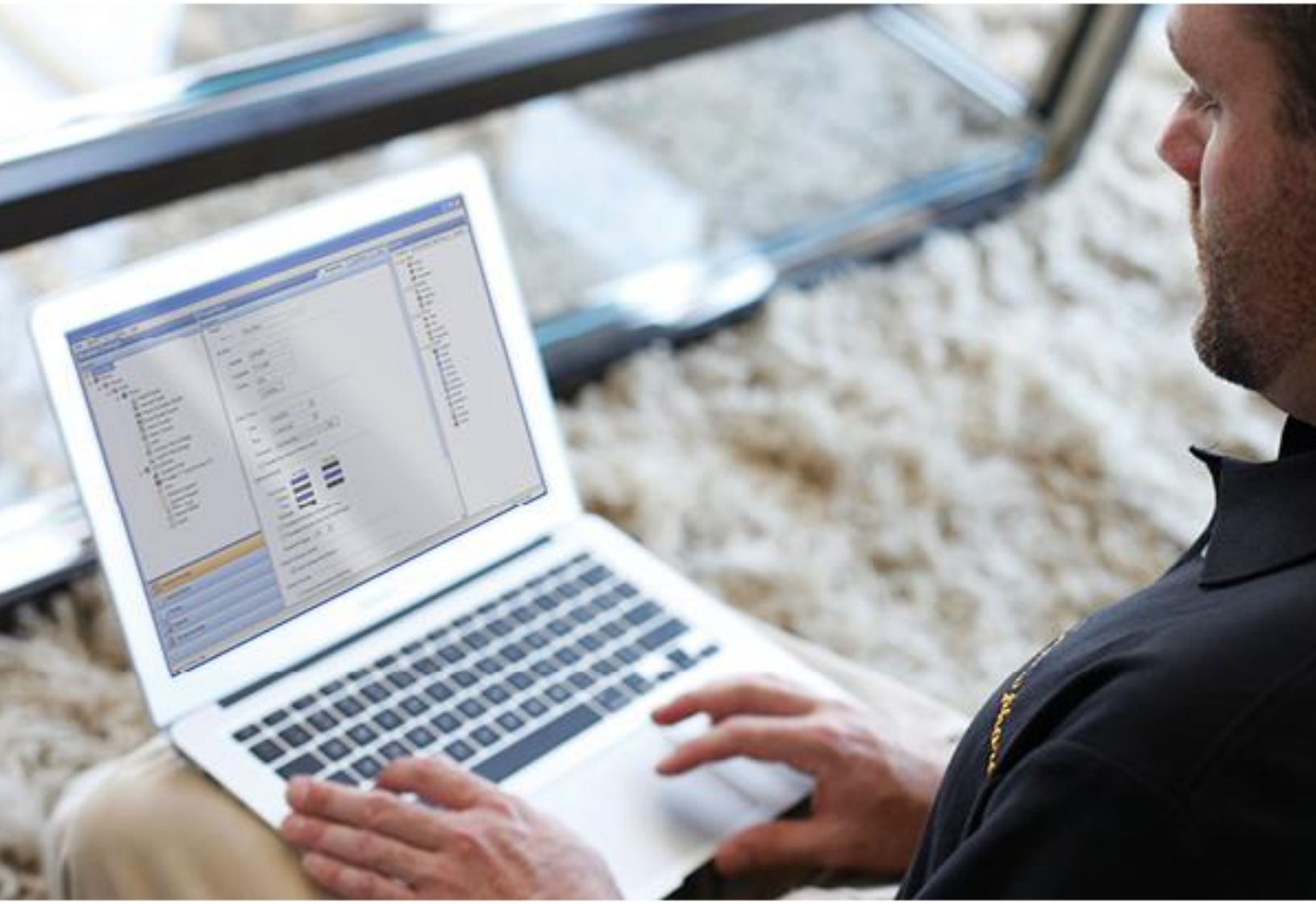
ZigBee Pro Best Practices



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Contact Information

Control4 Corporation
11734 S. Election Road
Salt Lake City, UT 84020 USA
http://www.control4.com

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ZigBee Pro Best Practices

Introduction

This document provides examples, guidelines, and best practices based on Control4® test results for creating an optimum communication mesh of Control4 system devices.

If you've already created a mesh successfully, you may not need to use this guide, but it could provide useful tips for future installations.

Terms and definitions

Familiarize yourself with these terms before you go any further in this guide. See *ZigBee Pro in Composer Pro* below for examples of how these terms are used in a system.

EmberNet—Supplier of ZigBee® semiconductors, software, and development tools (original Control4 ZigBee devices).

Refer to these articles on the Control4 Knowledgebase for information about EmberNet:

- KB Article *601*: How To Update EmberNet to ZigBee Pro (a Quick Guide)
- KB Article *128*: How To Update an EmberNet ZigBee device to ZigBee Pro (video)

- KB Article *393*: Updating guideline to ZigBee Pro

End node—A ZigBee device that can't route communication from other ZigBee nodes. It can only be a child node (devices that are powered by batteries, for example, remote, Card Access contact, door lock). See *Child node* below.

Hop—The transmission of data from one device to another device in a Control4 system.

Routing nodes—A ZigBee device that relays ZigBee communication from one or more ZigBee devices to another ZigBee device, making a path back to a ZAP (or it directly communicates to a ZAP). Routing nodes can be both a parent node and a child node. See *ZAP*.

- **Child node**—A ZigBee device that communicates through a parent node.
- **Parent node**—A ZigBee device that routes ZigBee communication from a child node to another ZigBee device or to a ZAP.

ZAP (ZigBee Access Point)—Handles commands to and from ZigBee devices to the ZServer. See *ZServer*.

ZAP Coordinator—Responsible for setting up the security parameters of the mesh. A ZServer must have a ZAP Coordinator. See *ZServer*.

ZigBee—A wireless network that uses bi-directional wireless mesh network technology to transfer messages from one device to another. A mesh network topology allows the devices to forward messages from one device to another, thereby extending the effective range of the network.

ZigBee mesh—A term for a ZigBee network. A ZigBee mesh is a complete ZigBee network (has both a ZServer and a ZAP Coordinator configured).

ZigBee Pro—The 1.1 version of ZigBee that provides improvements in standardization by allowing more interoperability with other Control4 devices, support for home automation profiles, and improves the scalability of multiple ZigBee access points.

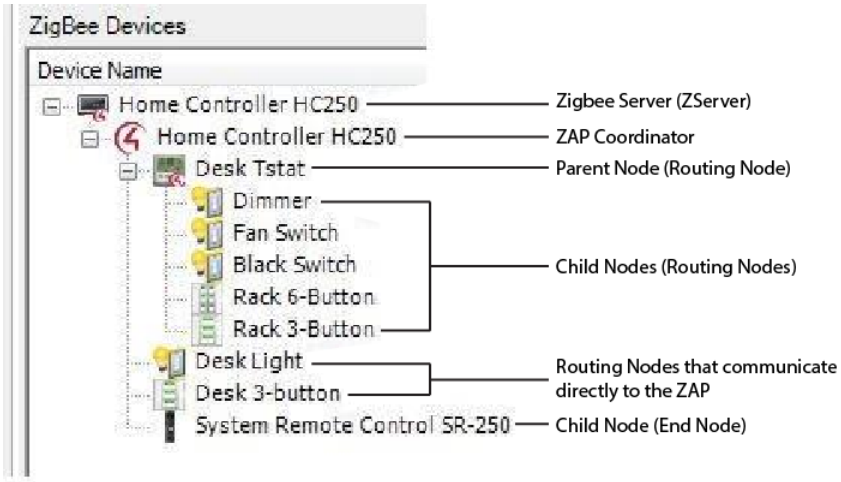
ZServer—A ZigBee server that handles the commands to and from the Director.

ZigBee Pro in Composer Pro

The following screens show examples of ZigBee devices in Composer Pro.

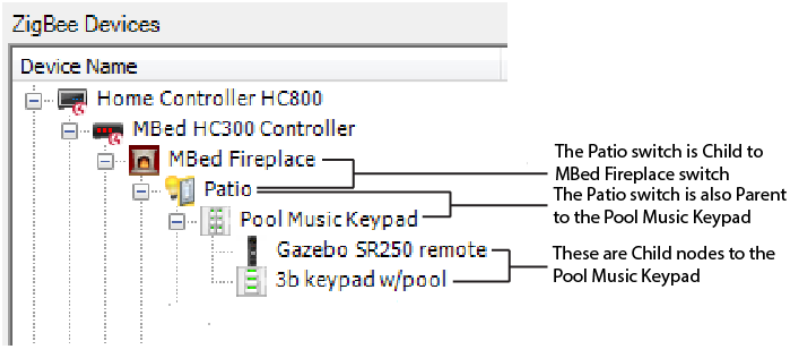
ZigBee Pro routing tree

This screen shows the ZigBee devices in a Composer Pro project (**Network Tools** > **ZigBee Network** > **Routing Tree**).



ZigBee Pro parent and child node relationships

This screen shows the relationships between parent nodes and child nodes in a Composer Pro project.



ZigBee Pro recommended configurations

This *Best Practices* document is based on currently shipping Control 4 controllers, the HC-250 and HC-800 running Control4 OS 2.6.0. This document is subject to change in the future with the release of new hardware and software from Control4.

There are four main deployment scenarios for a Control4 ZigBee Pro mesh:

- Single controller running ZServer and ZAP
- Single ZServer and multiple ZAPs
- Multiple ZServers with one ZAP associated with each ZServer
- Multiple ZServers with multiple ZAPs associated with each ZServer

NOTE: A single ZServer with a single ZAP or multiple ZAPs can reliably handle only 125 ZigBee devices or nodes.

NOTE: You should use no more than three ZAPs with a single ZServer. ZAPs do not load balance, so adding more ZAPs will not always allow you to add more ZigBee devices.

Control4 successfully tested the following configurations for scalability:

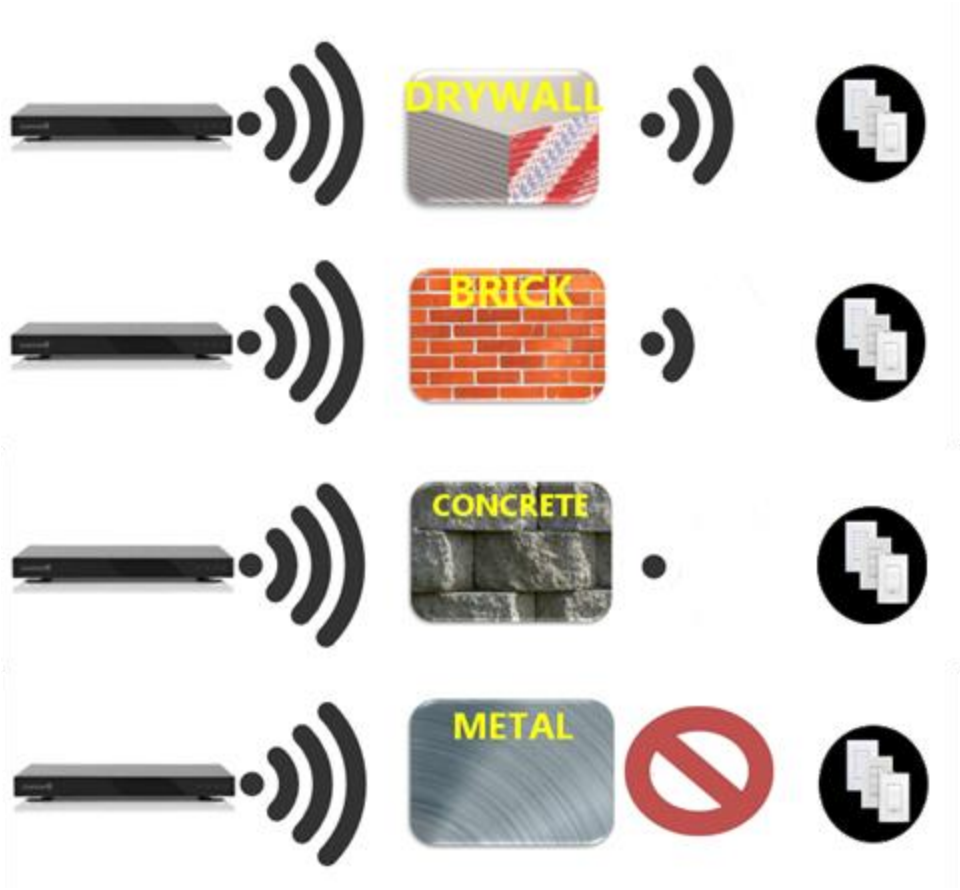
- Eight ZServers with one ZAP per ZServer with 125 ZigBee devices/nodes per ZAP
- Sixteen ZServers with one ZAP per ZServer with 50 ZigBee devices/nodes per ZAP
- Twenty ZServers with one ZAP per ZServer with 25 ZigBee devices/nodes per ZAP

Find more information about creating multiple ZServers in KB Article *610*.

Factors impacting ZigBee performance

Deciding on which scenario to use depends on a number of factors: size of the home or office, materials of the walls, etc. Consider the material the house is made of:

- Any amount of attenuation can impact the ZigBee wireless range, so you'll need to plan for alternate methods to get the ZigBee signal around the material.
- Be conscious of concrete floors, steel-reinforced floors, ceilings, walls, elevator shafts, masonry, rock, radiant floors, cinder block, chicken wire-reinforced materials such as Venetian plaster, stucco, and so on. All of these materials and others will degrade the ability for ZigBee devices to communicate. Additional controllers and multiple meshes should be designed into projects where these materials or situations exist.



- Another example of how different building materials can affect 2.4 GHz signals can be found here (information on 2.4 GHz signal attenuation caused by common building materials from the City of Cumberland, MD website).

Third-party devices that are broadcasting on the same channel or all channels can cause electromagnetic (radio frequency) interference and impact ZigBee performance.

- Devices like 2.4 GHz cordless phones, WiFi networks, wireless speakers, and baby monitors can cause interference. An example of this can be found in KB Article 633.
- A wireless router or WAP placed on top of a controller running the ZAP can block all wireless communication from that controller even if the channels are far apart. To resolve this, move the wireless router or WAP away from the ZAP.

Most environments allow only a 15- to 30-foot (five to nine meter) range for optimal signal strength. This can be as little as five to ten feet, given the construction materials or interference between your devices, and it can be 50 feet in open air. Know your environment well and plan ahead.

- Be aware that ZigBee devices implement a robust message delivery retry mechanism. While messages may successfully reach destinations at much longer ranges than those described above, messages may be retried a number of times to do so. To achieve optimal performance within the ZigBee network, attempt to maintain optimal signal strength using the range recommendations above.
- Make sure each ZigBee device is not outside the range of another ZigBee device.

Designing for ZigBee performance

The placement of controllers running ZAP and ZigBee devices is important to ensure good ZigBee performance.

- Make the installation of your ZigBee devices distributed as much as possible.
- Find a spot that is the most central to the house or general area for the ZAP Coordinator.
- All ZAPs, including the ZAP Coordinator, should be placed near the center of the group of nodes you want to control.
- The main system rack (head-end) is generally the *worst* possible location for a ZAP and should be avoided. The main system rack location is generally in a remote area of the home, typically surrounded by concrete walls, metal ducting, hundreds of copper wire runs, metal pipes, and dozens of electronic devices producing electromagnetic and radio frequency noise.
- If the house has multiple levels, consider creating a ZigBee mesh for each level to reduce lost or slow communication.

Choosing a good channel for the ZigBee mesh

When setting up a ZigBee mesh, *Auto Channel* is the default setting. This will have the ZAP Coordinator pick a channel at random and check how much interference there is on that channel.

- If it is clear, it will select that channel for the ZigBee mesh.
- If it finds any interference, it will go to the next channel until it finds a clear channel.
- This channel check only happens once when you initially set up the mesh.
- The controller does not continually check for a better channel.

There is a chance that third-party devices will have intermittent communication on the channel ZigBee is on. If the channel was selected during intermittent down time, ZigBee performance can suffer. Use Wi-Spy to scan for a long period of time to see this interference.

- Every Control4 Dealer should have a wireless scanning device to check the levels of each channel. A good device to use is Wi-Spy, which can be purchased on the Dealer Portal at dealer.control4.com/dealer/products/117_metageek.
- If Wi-Spy is not available, try channel 25, which is out of WiFi range.
    - Learn more about the ZigBee-WiFi channel relationship in KB Article 449.

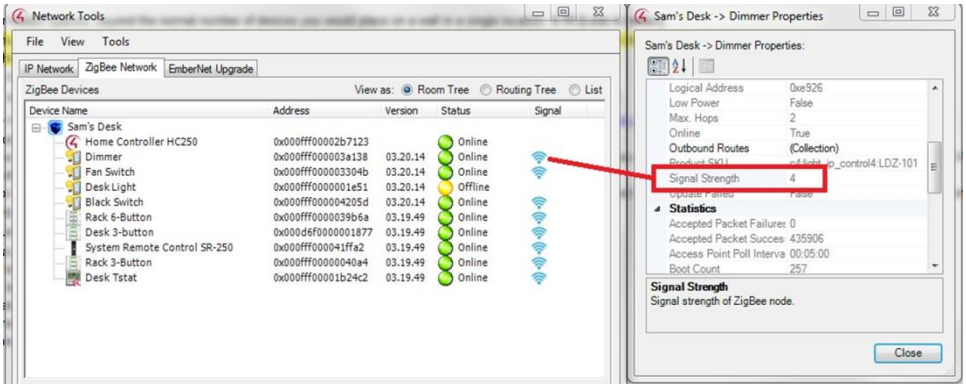
If you are using multiple ZServers, it is not necessary to separate the channels by two or more, as previously suggested. You can separate the channels by only one channel without issues. We recommend that you use Wi-Spy or some other wireless scanning device to make sure the channels you plan on using are clear.

It is not necessary to change channels manually on ZigBee Pro devices. During the identification process, the ZigBee device channel scans for an available ZAP.

The ZigBee Pro mesh is a secure network. It will pass a network key to the device and allow the ZigBee device to communicate on the network only when the ZigBee mesh is told to allow devices to join. This ensures the device is communicating to the correct mesh, and that unauthorized devices cannot communicate with the ZigBee mesh. This can be accomplished through the *Identify* window in Composer Pro > **Connections** > **Network** tab > **Identify** or the *Join Using* selection in **Tools** > **Network Tools** > **ZigBee Network** > [select ZServer].

Viewing ZigBee device signal strength

The signal strength indicators are located in Composer > Network Tools > ZigBee Network > Show Properties > Signal Strength.

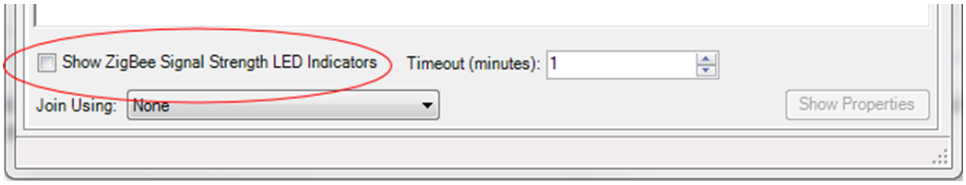


Be aware that the signal strength is only the strength the ZigBee device has to its *first* routing node. For this reason, it is important to use the *Routing Tree* to look for ZigBee devices with weak signals that other ZigBee devices may route through back to the ZAP.

- Some devices have better range. Newer-generation dimmers and switches have better range than Outlet Switches or Outlet Dimmers.

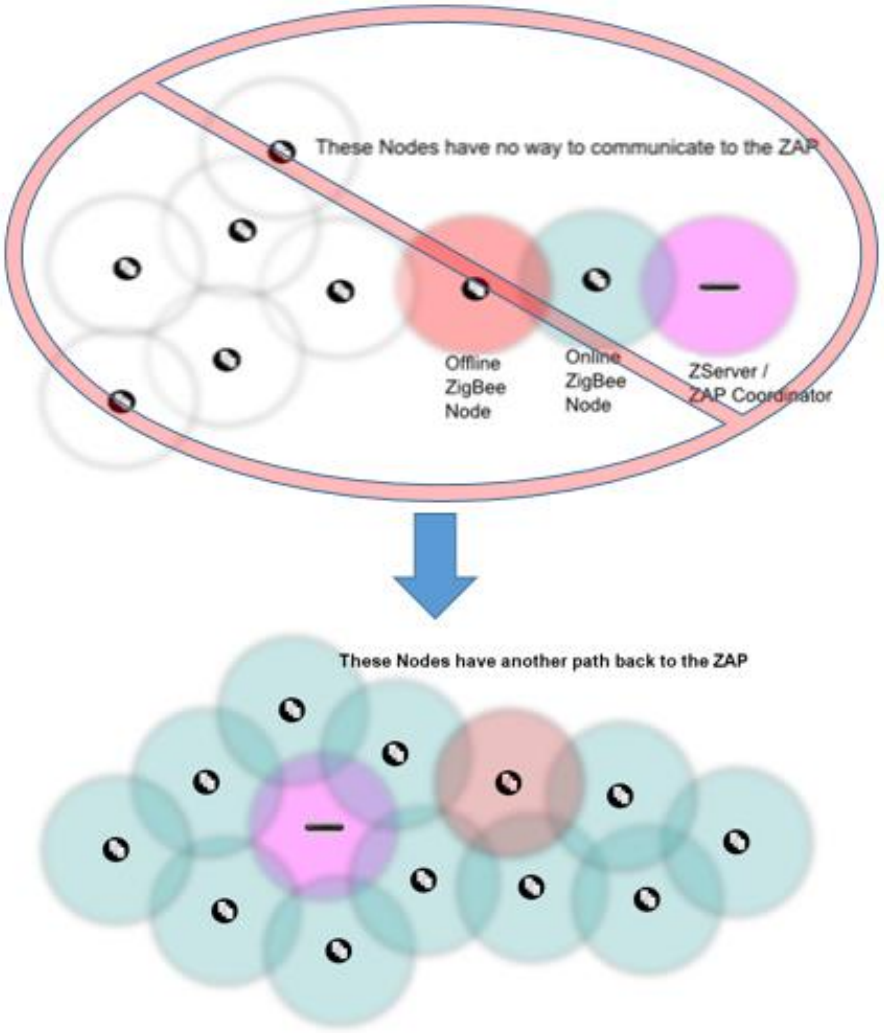
The *Signal* icon will change depending on the *Signal Strength* value. Not all devices support reporting signal strength, in which case none will be shown.

On the same page, you can also enable an LED blink that will make the LEDs on most ZigBee devices blink a color that indicates the signal strength (Green = good, Yellow = fair, Red = poor).



ZigBee device routing examples

It's best for ZigBee devices to have multiple paths to a ZAP. A group of devices all communicating to one parent node creates a communication bottleneck. Also, if that node stops working, then all of the nodes parented to that node will fall offline.



Locating your ZAP in a central location will give greater routing flexibility in the event that a ZigBee device falls offline.

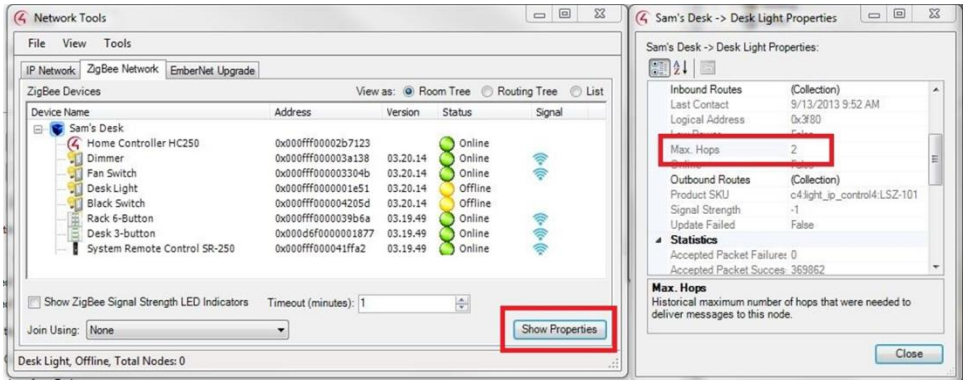
Each parent node device can only have a limited number of end node devices as child nodes.

- Maximum of six child end node devices in legacy ZigBee Pro devices.
- Newer-generation devices (for example, Adaptive Phase Dimmer or Configurable Keypad) support up to 64 child end node devices for each parent.
- The same applies to newer-generation controllers (HC-800, HC-250) as a ZAP: up to 64 child end node devices can route to a ZAP. Legacy controllers (HC-200, HC-300, HC-500) support six child end node devices for each parent.

Adding too many end node devices to a network to reach this limit can introduce communications problems as child nodes attempt to negotiate a best parent.

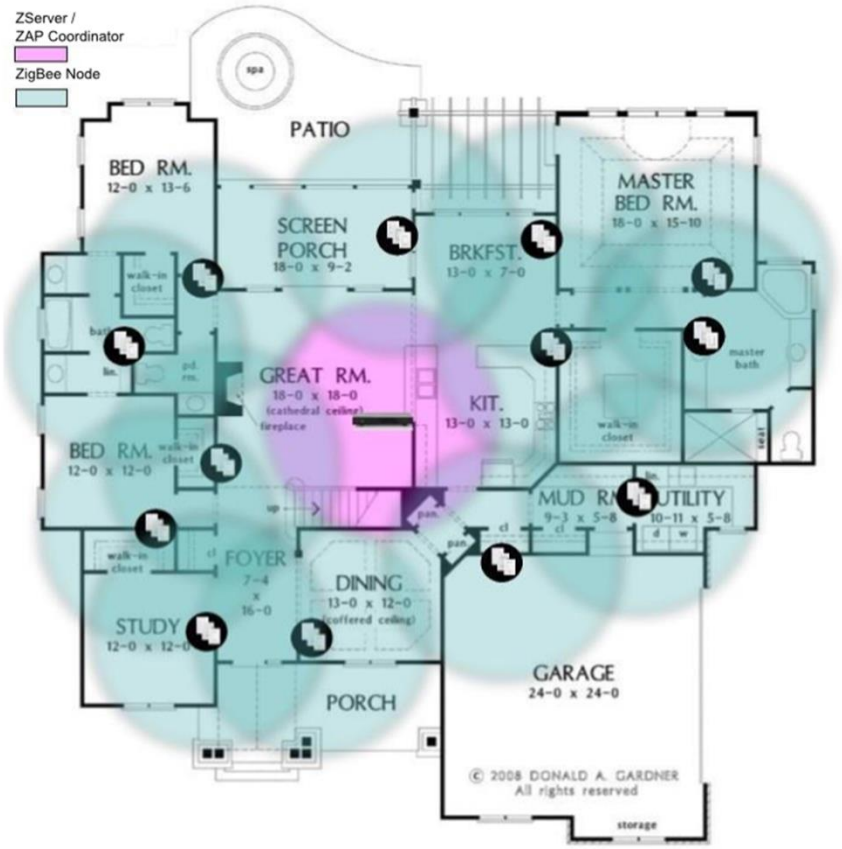
For best results, each ZigBee device should have no more than five hops to a ZAP. Hops of one to three are optimal and will yield improved performance, particularly with List Navigator and other ZigBee bandwidth-intense communications.

The max hops are located in Composer Pro > **Tools** > **Network Tools** > **ZigBee Network** > **Show Properties** > *Max Hops*.

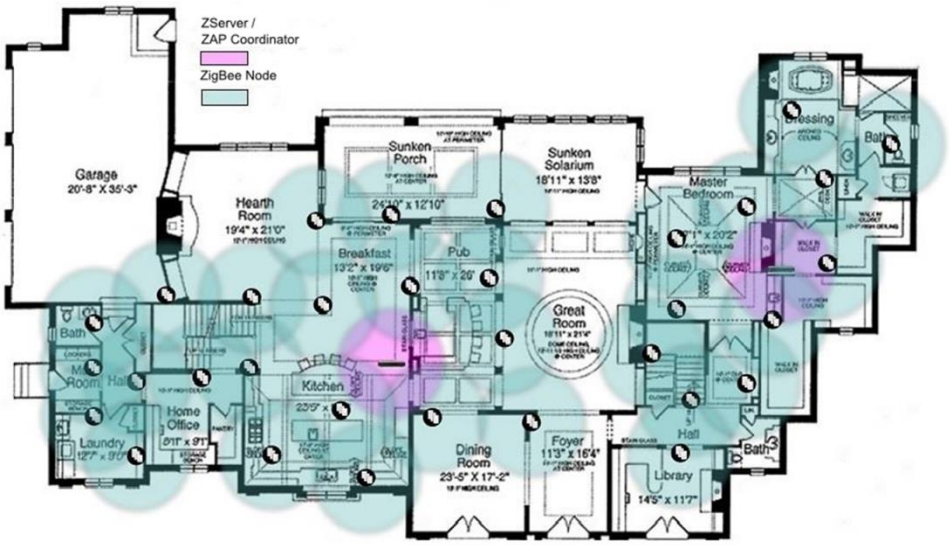


ZServer/ZAP Coordinator examples

This is an example of a single ZServer/ZAP system with a few devices. Notice that the ZServer/ZAP Coordinator is in the middle of the house, as opposed to the utility room.

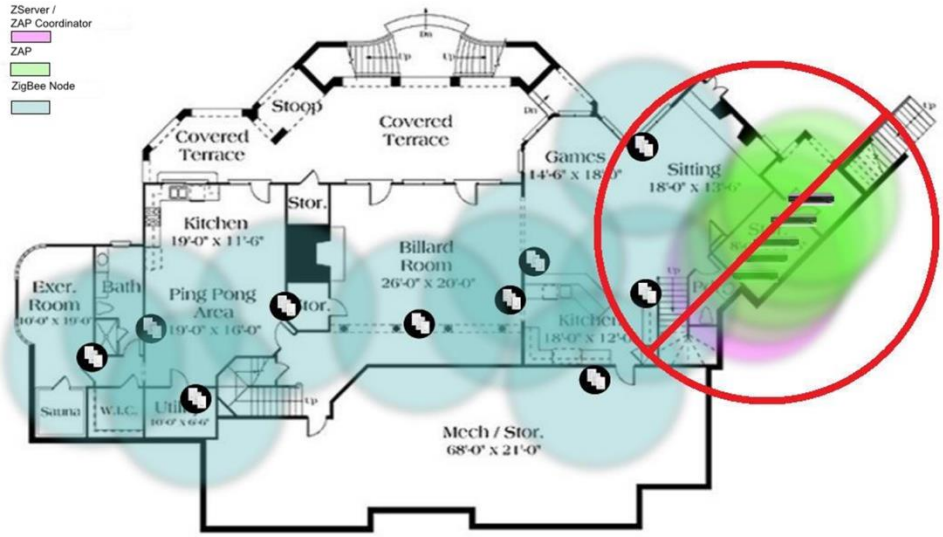


Following is an example of a multiple ZServer/ZAP (multiple ZigBee mesh) system.



The illustration below is an example of what **not** to do. This is a basement with all controllers in a rack, and they all have ZAPs enabled.

This creates a lot of confusion for the ZigBee nodes regarding which ZAP they need to talk to, causing delayed or lost commands.



Additional information

Additional ZigBee Pro training can be found at the Control4 University, Tech II, Module 1. You can also enter the keyword 'ZigBee' in the *Search Courses* section for additional courses.

Control4 courses

201 - OS 1.8.2 and ZigBee Pro Software

203 - Migrating the ZigBee Mesh between Controllers

ZigBee Knowledgebase articles

457 - ZigBee Pro - Button Press Magic Sequences - ZigBee Resets - ZigBee Device Factory Reset - Leave Mesh

489 - ZigBee Pro: Joining, Leaving. Status of ZigBee Pro and MiniApp Devices.

4 - Control4 Device Factory Reset, ZigBee Reset Tap Sequences, Screen Calibration, Remove from Mesh, Magic Button Press Cheat Sheet.

474 - Replacing Zap Coordinator With New Controller

233 - When Migrating to a new Controller do I have to Recommission my Mesh? (ZigBee Pro)

601 - How To Update EmberNet To ZigBee Pro (A Quick Guide)

772 - How To Reboot A ZigBee Dimmer/Switch Through Putty

358 - ZigBee Pro - Updating an Existing System or When Installing a New System That Will Include EmberNet Devices

485 - Card Access Products That can be ZigBee Pro Routing Nodes

359 - ZigBee Pro: How to Remove - Leave and Join Card Access Devices to the Mesh Network

470 - Philosophy behind Allow Join (ZigBee Pro)

948 - How to reconfigure the ZigBee mesh and change the ZAP Coordinator