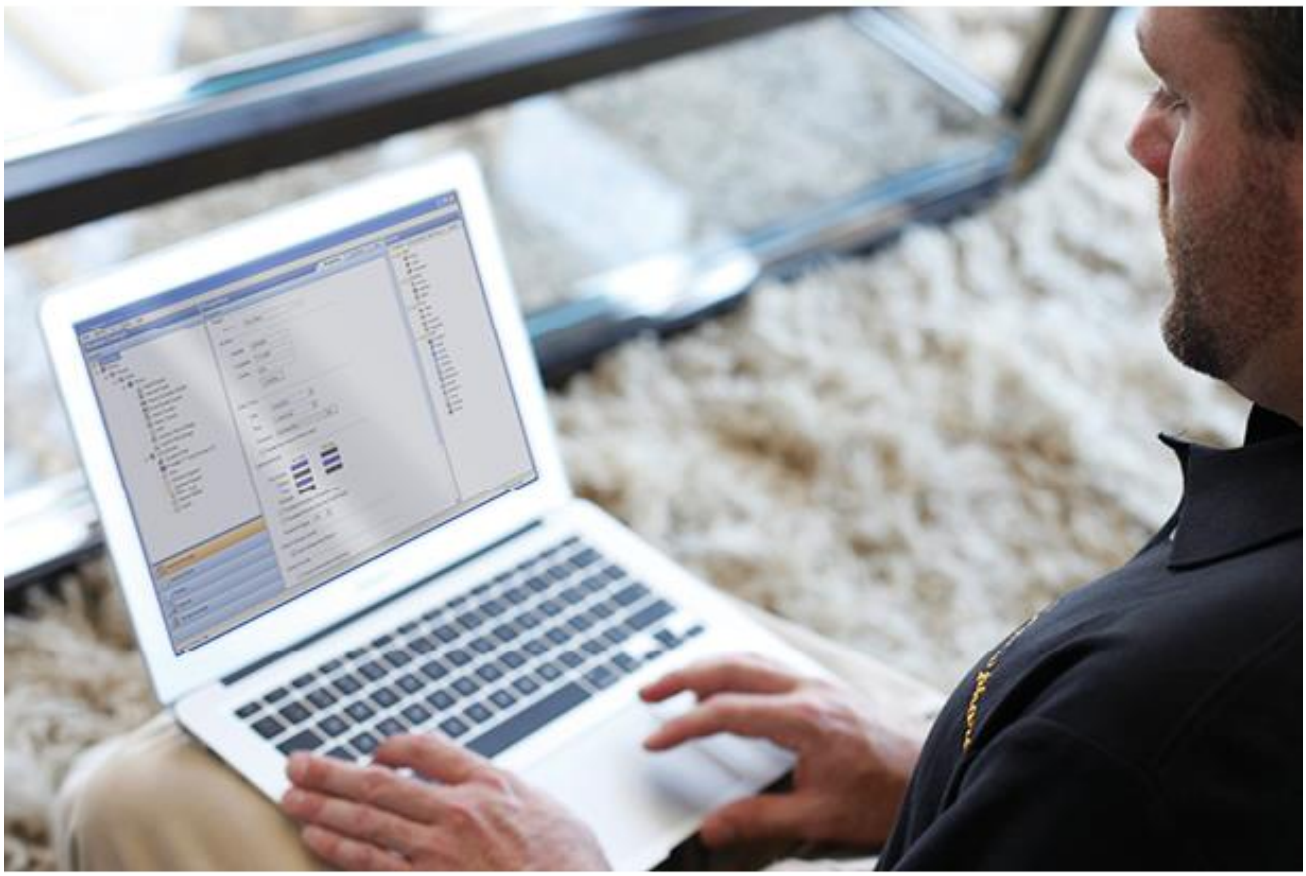
ZigBee Pro Best Practices



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ZigBee Pro Best Practices

Introduction

This document provides examples, guidelines, and best practices based on test results at Control4® about how you can create a mesh that will provide optimum communication among the devices in a Control4 system.

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

Please familiarize yourself with the terms below before you read this guide. See "ZigBee Pro in Composer Pro" for examples of how these terms are used in a Control4 system.

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

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 specification for a suite of high-level communication protocols used to create personal area networks built from small, low-power digital radios (source: *Wikipedia*).

ZigBee Pro - A standardization protocol made by the ZigBee Alliance.

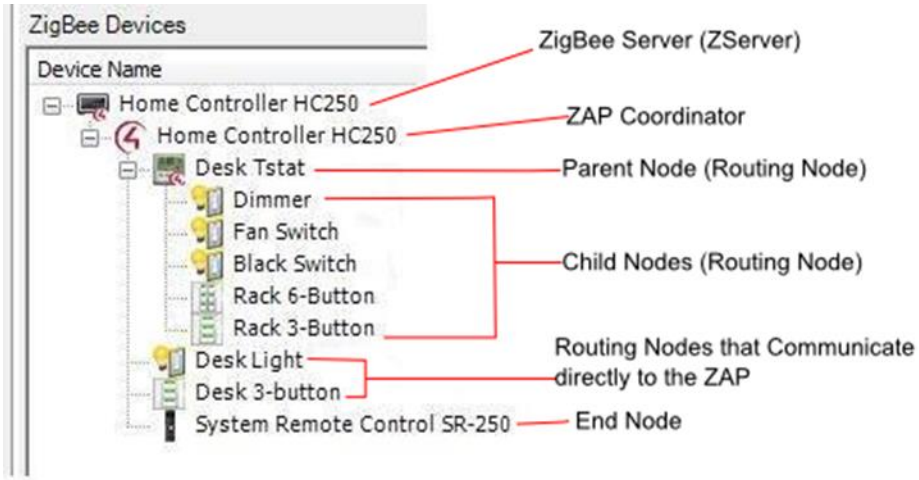
ZServer - A ZigBee Server that handles the commands to and from the Director.

ZigBee Pro in Composer Pro

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

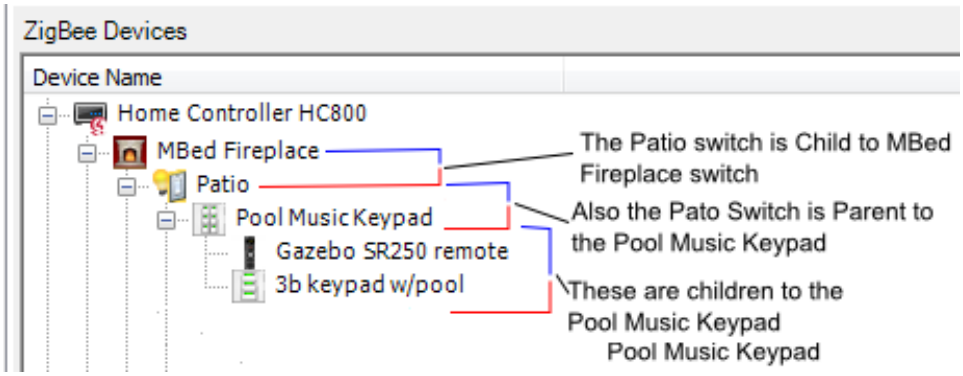
ZigBee Pro routing tree

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 best practices

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

There are four (4) main deployment scenarios for a Control4 ZigBee Pro mesh:

1. Single controller running ZServer and ZAP
2. Single ZServer and multiple ZAPs
3. Multiple ZServers with one ZAP associated with each ZServer
4. Multiple ZServers with multiple ZAPs associated with each ZServer

Deciding on which scenario to use depends on a number of factors: size of the home or office, materials of the walls, and so on.

Below are some factors to keep in mind as you design your ZigBee mesh.

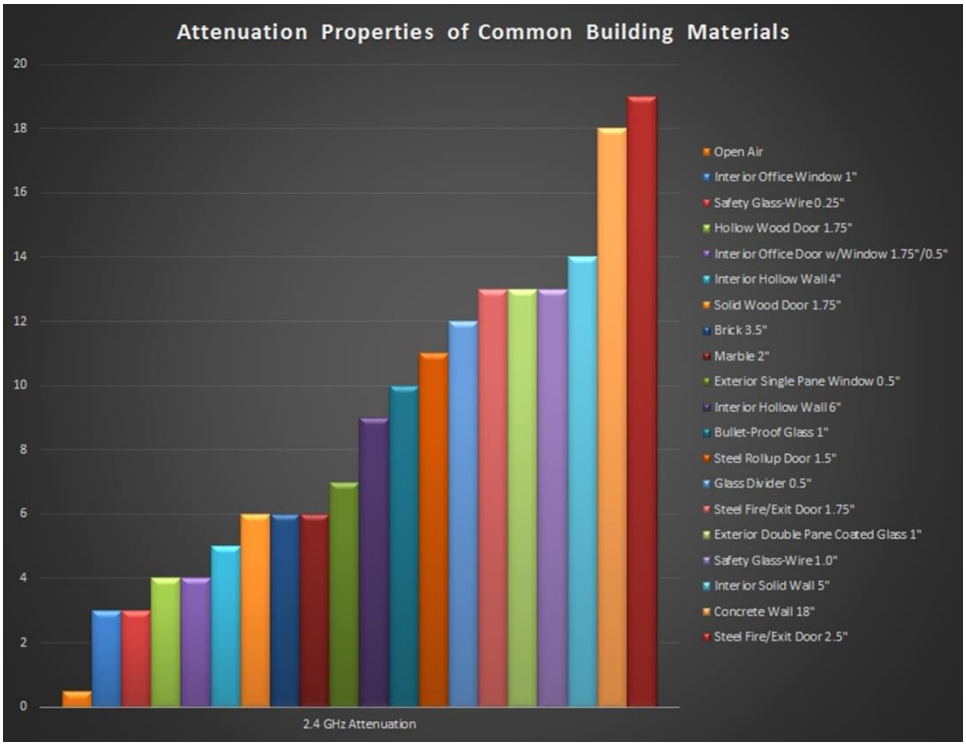
- A single ZServer with a single ZAP or multiple ZAPs can reliably handle only 130 ZigBee devices/nodes.
- You should use no more than three (3) ZAPs with a single ZServer. ZAPs do not load balance, so adding more ZAPs will not always allow you to add more ZigBee devices.
- The maximum number of ZServers tested at Control4 is 32.

Factors impacting ZigBee performance

Information about creating multiple ZServers is in KB Article *610*.

- 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, cinderblock, chicken wire, reinforced materials, such as Venetian plaster, and stucco, and so on. All of these materials and others will deteriorate the ability for ZigBee devices to communicate. Additional controllers and multiple meshes should be designed into projects where these materials or situations exist.
- An example of how the material can affect 2.4 GHz is shown below (source: PDF from The City of Cumberland, Maryland which can be found *here*).

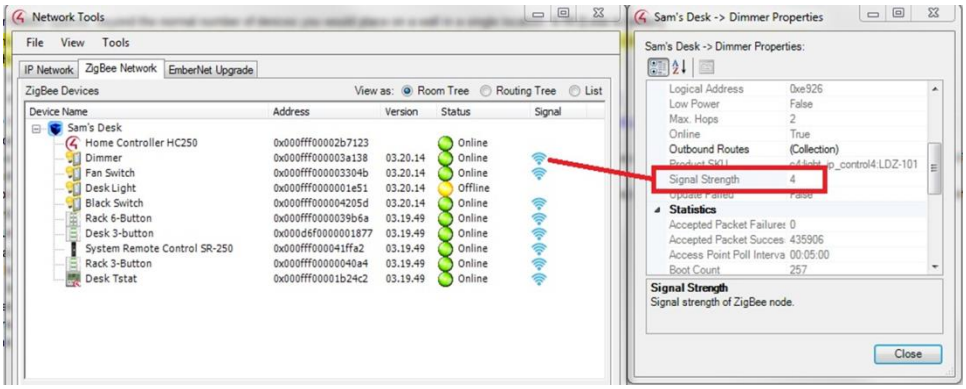


- Make the installation of your lighting devices distributed as much as possible:
  - Install Panelized Lighting if you can.
- Check for third-party devices that are broadcasting on the same channel or all channels causing interference:
  - Devices like 2.4 GHz cordless phones, wireless speakers, and baby monitors can cause interference. An example of this can be found in KB Article *633*.
  - 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 Internet at *http://www.metageek.net/products/wi-spy/*. Don't forget to use your promotion code (control4) for a 15% discount.
  - When setting up a ZigBee mesh, Auto Channel is the default setting. This will have the ZigBee antenna 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.

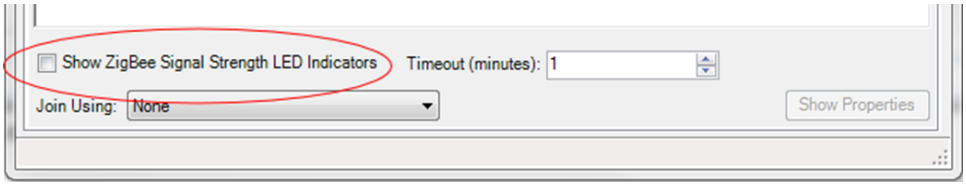
    - There is a chance that a third-party device or devices will have intermittent communication on the channel ZigBee is on, and if it selected that channel during intermittent down time, ZigBee performance can suffer. Use Wi-Spy to scan for a long period of time to see this interference.
    - If Wi-Spy is not available, try channel 25 which is out of WiFi range.
    - The ZigBee-WiFi channel relationship can be found in KB Article *449*.
    - A wireless router or wireless access point (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.
    - If you are using multiple ZServers, it is not necessary to separate the channels by two or more apart as previously suggested for ZAPs associated with those ZServers. 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.
    - In ZigBee Pro, it is not necessary to change channels; they are secure meshes and have network keys to ensure they are communicating to the correct mesh.
- Make sure the ZAPs are not located in a poor signal location:
    - Find a spot that is the most central to the house or general area.
    - 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 your 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 often dozens of electronic devices producing electrical and radio-frequency noise. This is typically the last location you want the ZAP to be placed.
    - If the house has multiple levels, consider creating a ZServer for each level to reduce lost or slow communication.
- Make sure each ZigBee device is not outside the range of another ZigBee device:
    - Most environments allow only a 15 to 30-foot (five (5) to nine (9) meters) range for optimal signal strength. This can be as little as five (5) to 10 feet given the construction materials between your devices, and 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.
    - The signal strength can be viewed in Composer Pro (see the screen below).
    - Be aware that the signal strength is only the strength it 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 be using to route back to the mesh and onto the ZAP.

The signal strengths are located in Composer Pro > Network Tools > ZigBee Network > Show Properties > Signal Strength.

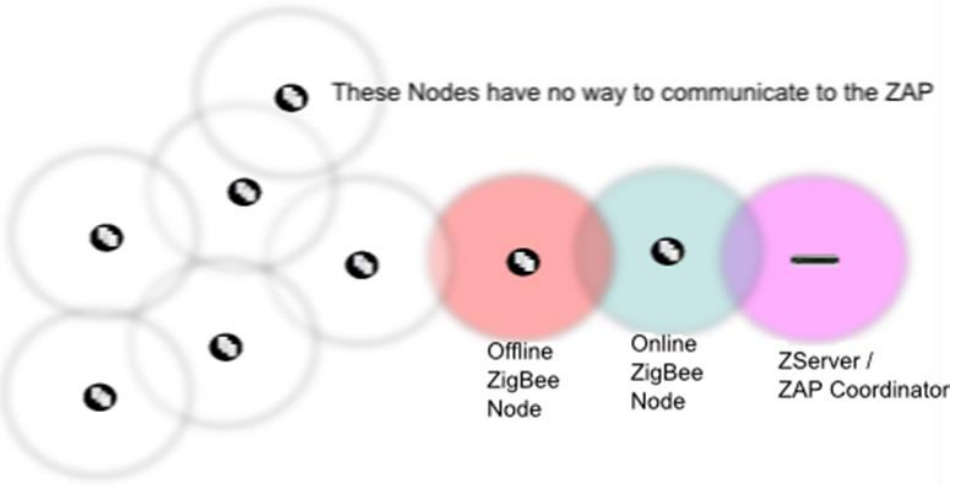
NOTE: The signal icon will change, depending on the signal strength value. Not all devices support reporting signal strength, in which case, none will be shown.

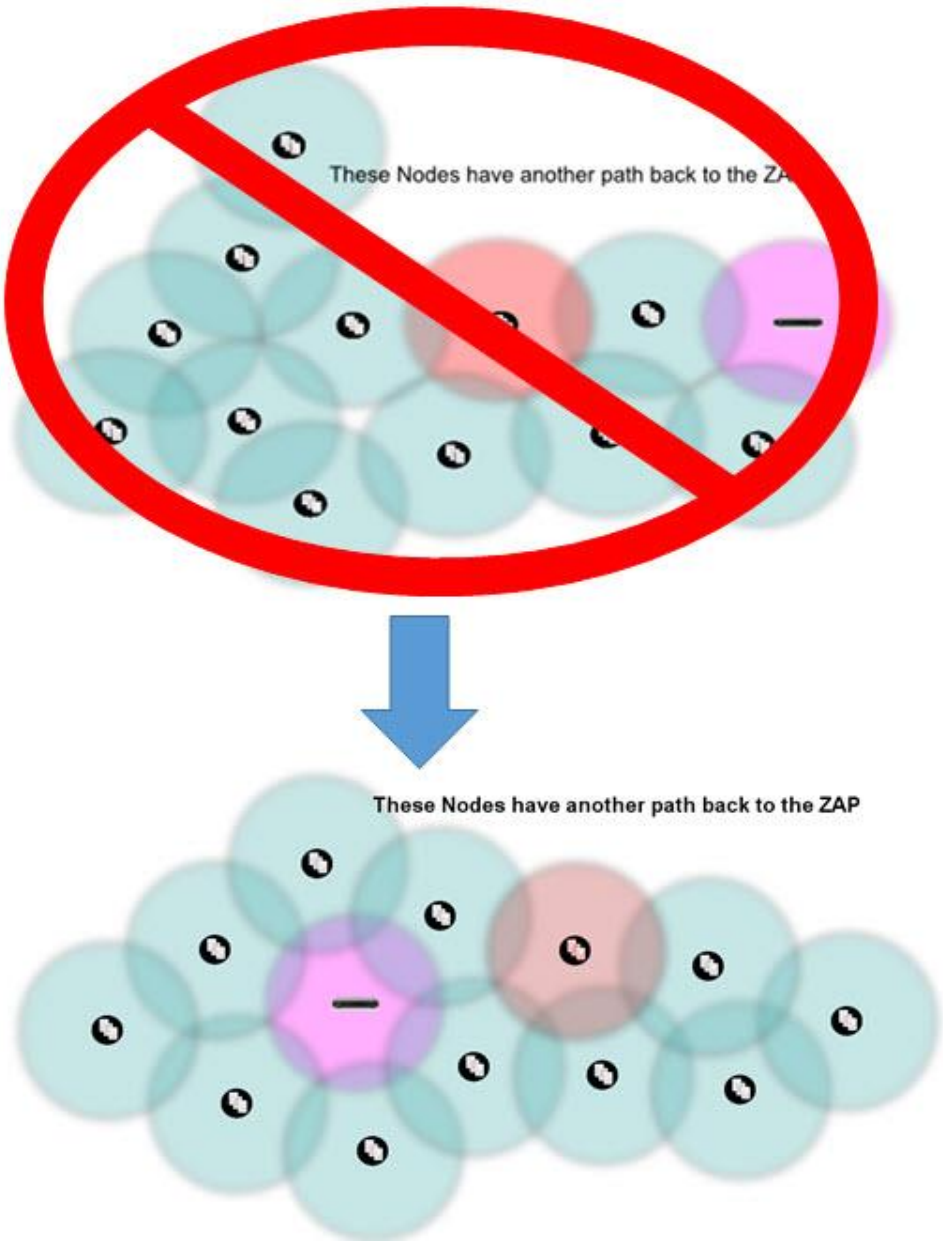


- On the same page, you can also enable an LED blink that will make the LEDs on the newer-generation ZigBee devices blink a color that indicates the signal strength (Green = good, Yellow = fair, Red = poor).



- It's best for ZigBee devices to have multiple paths to a ZAP. If a group of devices are all communicating to one Parent Node, it will create a communication bottleneck. Also, if that node stops working for some reason, then all of those nodes parented to that node will fall offline.

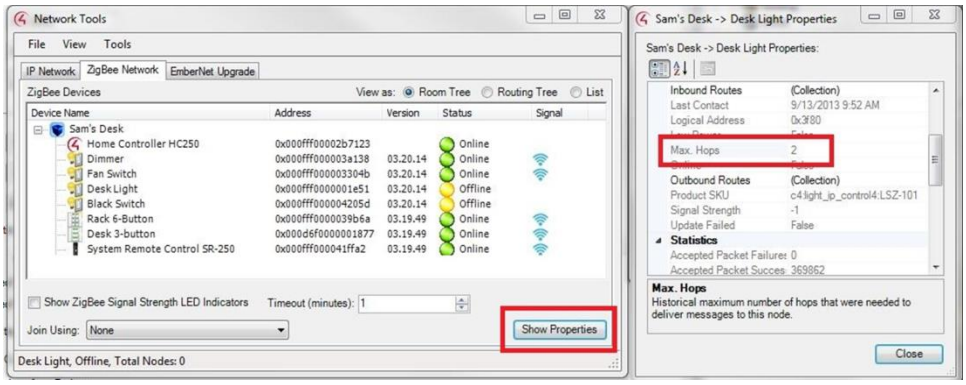




NOTE: The images above are not the full mesh; rather, a section of a larger mesh that shows how nodes would have another path to a ZAP.

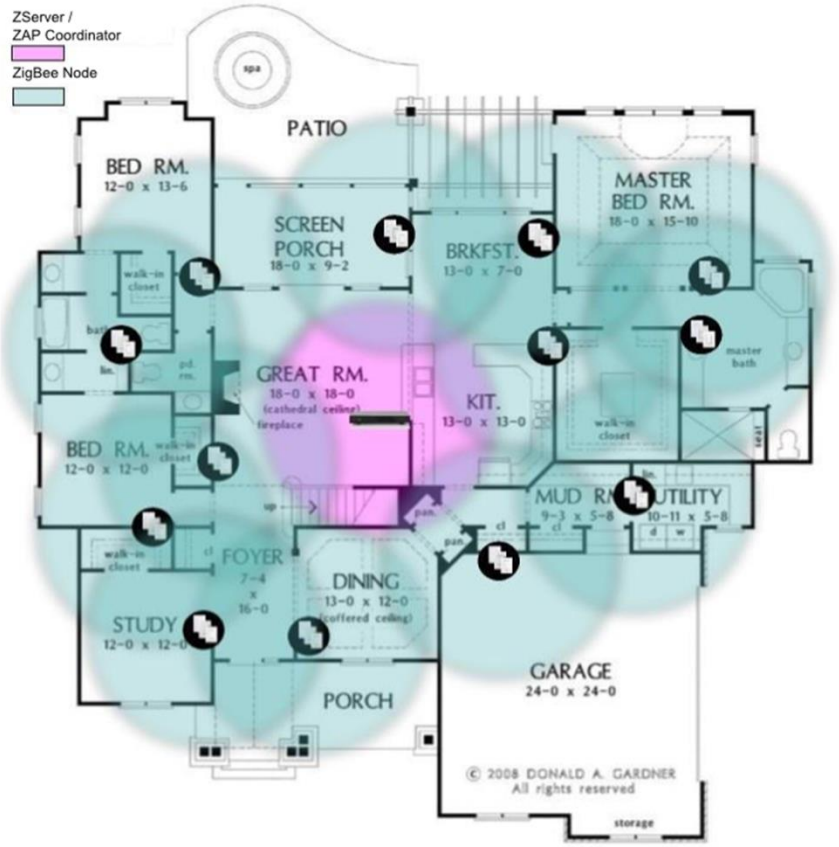
- Some devices have better range. Newer-generation dimmers and switches have more range than Outlet Switches or Outlet Dimmers.
- Each Parent Node device can only have six (6) child End Node devices in ZigBee Pro. Newer-generation devices (for example, Next-Generation Lighting) support up to 64 child End Node devices for each parent. The same applies to newer-generation controllers as a ZAP. Previous generations of devices and controllers support six (6) child End Node devices for each parent. Adding sufficient End Node devices to a network to reach this limit can introduce communications problems as child devices attempt to negotiate a best parent.
- For best results, each ZigBee device should have no more than five (5) hops to a ZAP. This can be viewed in the Composer Pro Properties pane of the ZigBee device as Max Hops (see below). Hops of one (1) to three (3) 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>Network Tools>ZigBee Network>Show Properties>Max Hops.

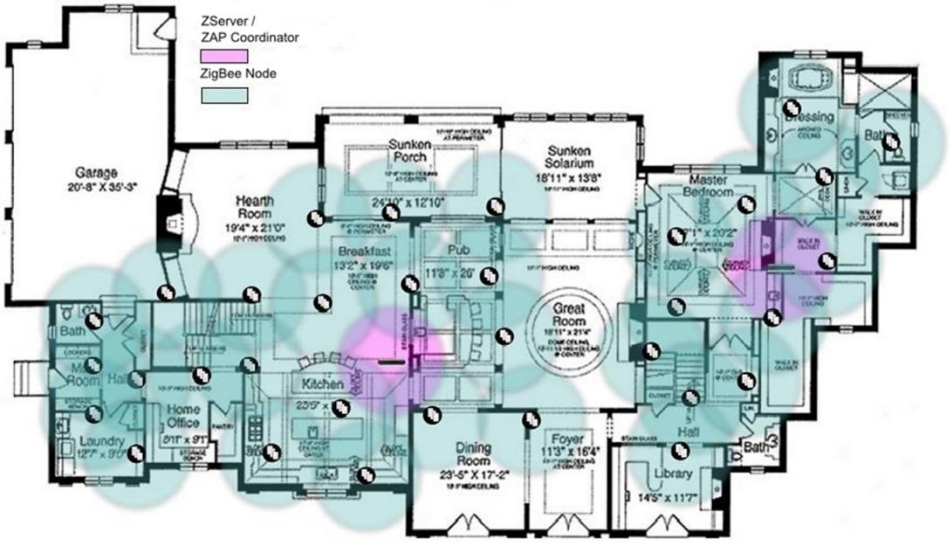


ZServer/ZAP Coordinator examples

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.

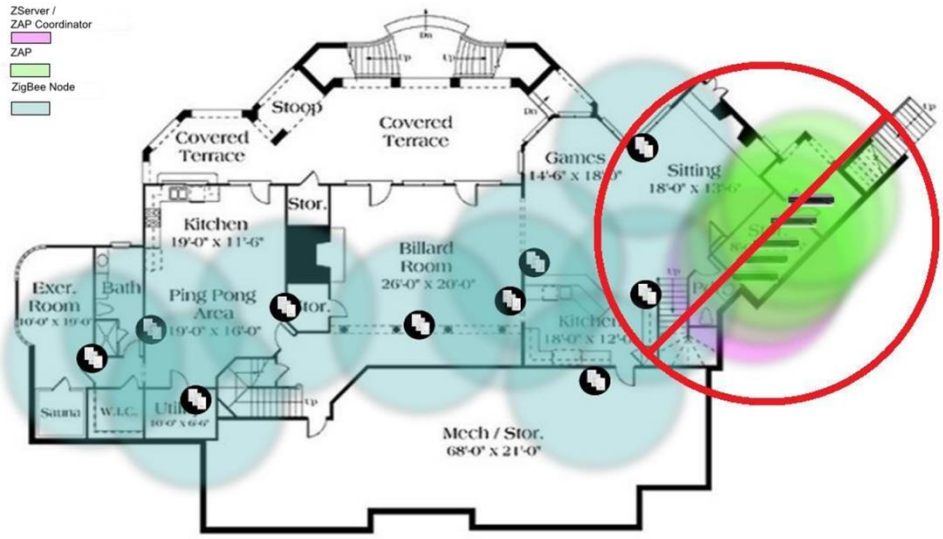


Following is an example of multiple ZServers/ZAPs in a system.



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

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



Additional information

Additional ZigBee Pro training is 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