



UG129: ZigBee® USB Virtual Gateway Reference Design (RD-0002-0201) User's Guide

The ZigBee USB Virtual Gateway Reference Design (RD-0002-0201) is designed to demonstrate ZigBee gateway functionality with the following Silicon Labs ZigBee reference designs:

- Lighting Reference Designs (RD-0020-0601 and RD-0035-0601)
- ZigBee Contact Sensor Reference Design (RD-0030-0201)
- ZigBee Capacitive Sense Dimmer Switch Reference Design (RD-0039-0201)

This user's guide refers to software release version 1.0.0.

KEY POINTS

- Describes ZigBee USB Virtual Gateway Reference Design.
- Provides step-by-step instructions for the installation and configuration process.
- Explains the ZigBee Gateway tabs.
- Offers troubleshooting solutions and references for common issues.

1. Introduction

The ZigBee USB Virtual Gateway Reference Design (RD-0002-0201) is designed to demonstrate ZigBee gateway functionality with Silicon Labs ZigBee reference designs, such as Lighting Reference Designs (RD-0020-0601 and RD-0035-0601), ZigBee Contact Sensor Reference Design (RD-0030-0201), and ZigBee Capacitive Sense Dimmer Switch Reference Design (RD-0039-0201). The Virtual Gateway runs on Ubuntu Linux, and is available for Windows and OS X host operating systems within a Virtual Machine. The Virtual Gateway includes a web server that presents a user interface to a desktop or mobile web browser. The web browser can run on the Virtual Machine or on a device on the local area network (LAN). A typical ZigBee system configuration with the Virtual Gateway is shown in the figure below.

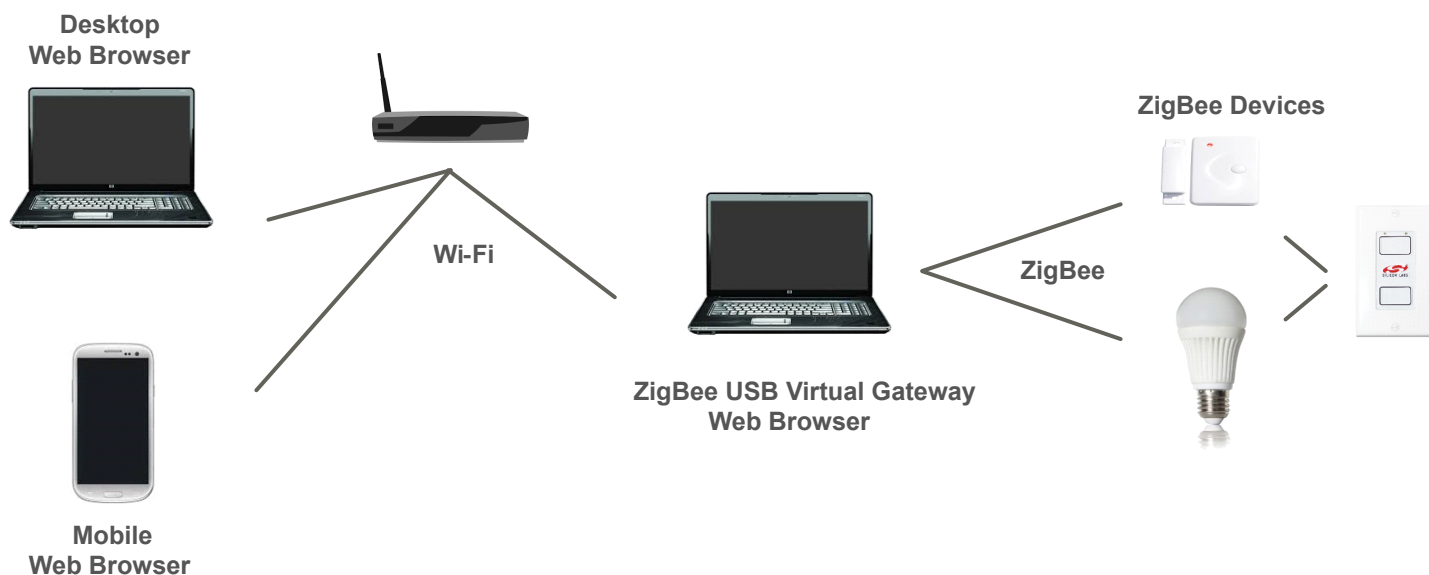


Figure 1.1. Typical ZigBee Virtual Gateway Configuration

2. Installation and Configuration

1. Install VirtualBox.

The ZigBee Virtual Gateway runs on Ubuntu Linux within a Virtual Machine for Windows or OS X. To begin, download and install VirtualBox 4.3.12. The installed executable is titled *Oracle VM VirtualBox Manager*.

VirtualBox 4.3.12 for Windows: <http://download.virtualbox.org/virtualbox/4.3.12/VirtualBox-4.3.12-93733-Win.exe>

VirtualBox 4.3.12 for OS X: <http://download.virtualbox.org/virtualbox/4.3.12/VirtualBox-4.3.12-93733-OSX.dmg>

Note: Do not install or use any other version of VirtualBox.

2. Download the Virtual Appliance.

Download the Virtual Appliance .zip file from Silicon Labs and extract to a temporary directory. Notice the terms “Virtual Appliance” and “Virtual Machine” will be used interchangeably throughout this user’s guide.

3. Install the Virtual Appliance.

- a. Launch Oracle VM VirtualBox Manager and import the Virtual Appliance (“File” → “Import Appliance”).

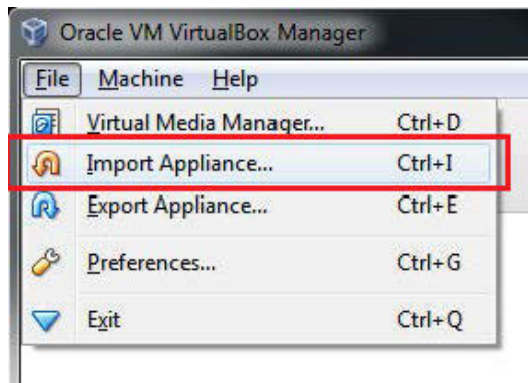


Figure 2.1. Import Appliance

- b. Select the `build.ovf` file in the unzipped Virtual Machine folder and press “Next”.

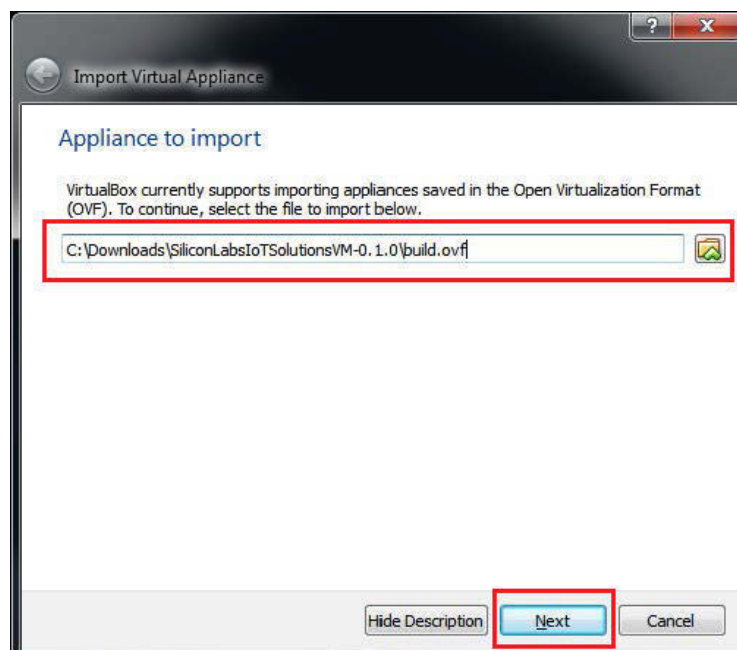


Figure 2.2. Import Appliance File Selection

c. Accept the default Appliance settings and select “Import.”

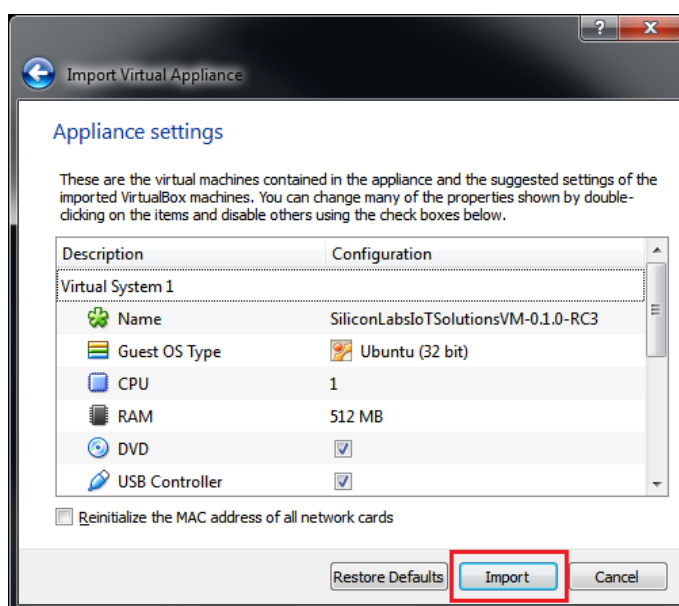


Figure 2.3. Import Appliance Settings

4. Install ZigBee USB Virtual Gateway Hardware.

Plug the ZigBee USB Virtual Gateway Hardware into an available USB port.



Figure 2.4. ZigBee USB Virtual Gateway Hardware

5. Select the ZigBee USB Virtual Gateway Hardware.

From the Virtual Box manager, select "Machine" → "Settings", select "USB", and add a USB Device Filter for the Silicon Labs CEL EM3588 Zigbee USB stick, as shown in the figure below. This setting will persist through power cycles.

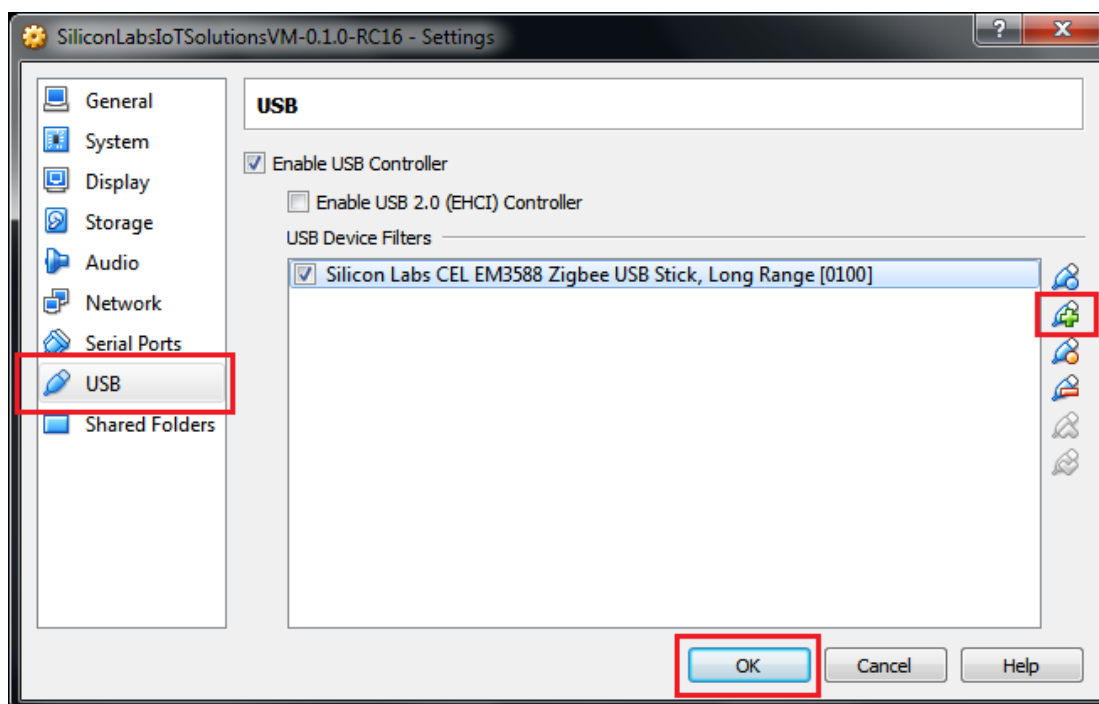


Figure 2.5. Select the ZigBee USB Virtual Gateway Hardware

6. Configure the Network.

From the Virtual Box manager select "Machine" → "Settings", then "Network". Change the "Attached to:" selection from "NAT" to "Bridged Adapter" and select the desired network adapter "Name:". This setting will persist through power cycles.

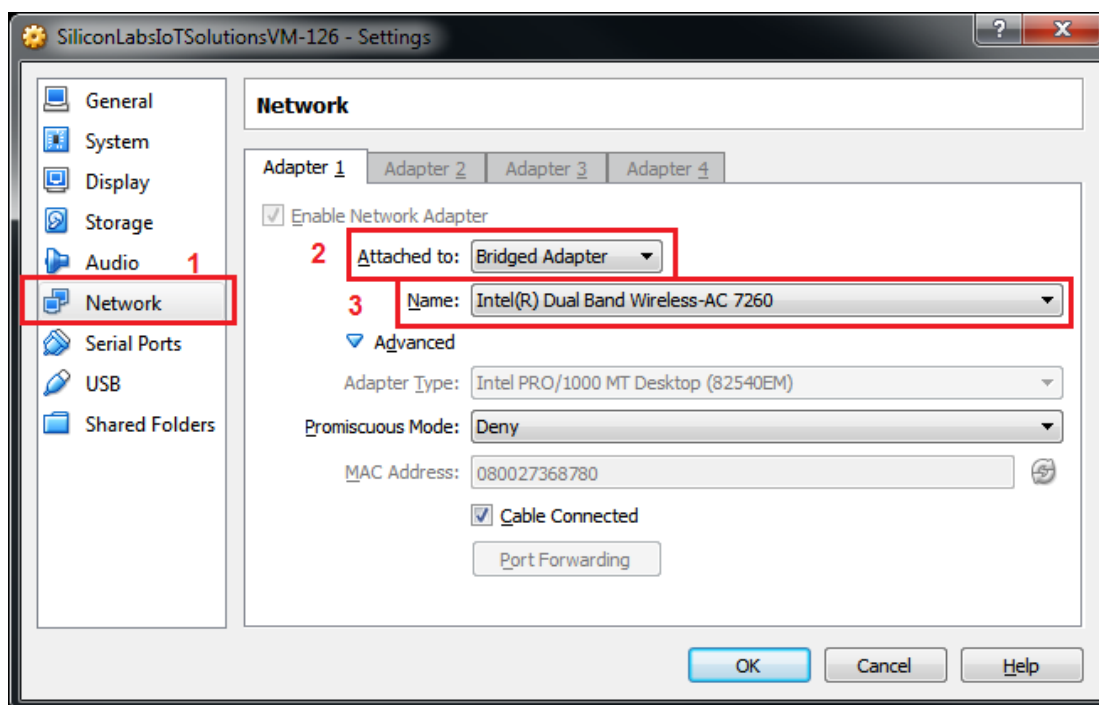


Figure 2.6. Attach to Bridged Adapter and Select Name of the Desired Adapter

7. Run the Virtual Appliance.

Launch VirtualBox 4.3.12, select the virtual appliance, and press "Start". After configuration steps 1–5, it's possible to move directly to this step the next time you launch the virtual appliance.

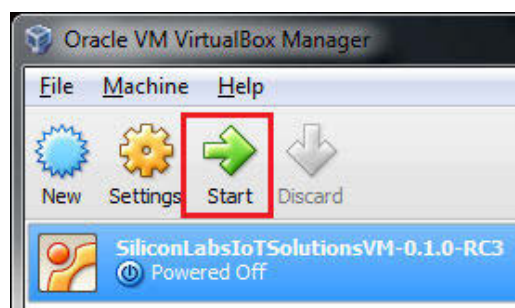


Figure 2.7. Run the Virtual Appliance

8. Confirm the ZigBee USB Virtual Gateway Hardware is selected.

Right-click to open the USB devices menu on the Virtual Machine system tray and confirm the "Silicon Labs CEL EM3588 ZigBee USB Stick" is selected.

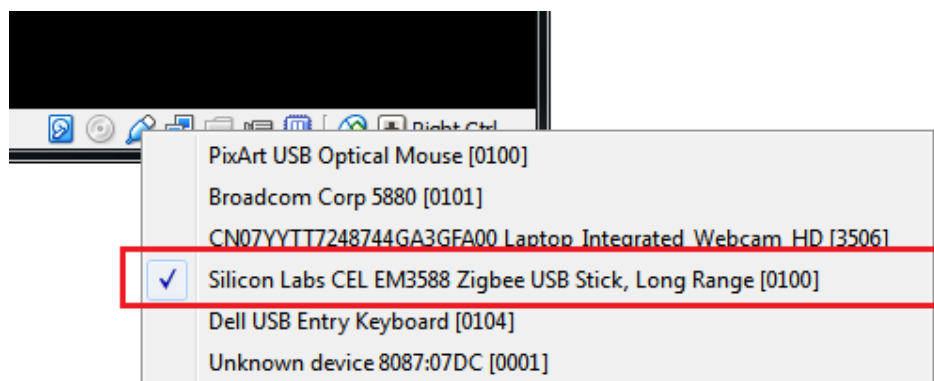


Figure 2.8. Select the ZigBee USB Virtual Gateway Hardware

9. Confirm network connectivity.

The adapter will indicate a successful connection by displaying the icon, as shown below.

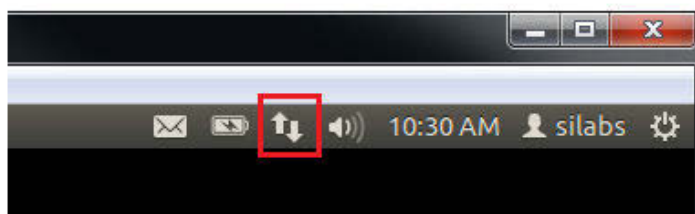


Figure 2.9. Network Connection Successful

3. Run the ZigBee Gateway

To launch the ZigBee Gateway, double-click the icon on the desktop. The first time the gateway is launched, you will be directed to localhost: 3001/update to accept a license agreement and install software. You can return to this page to check for periodic updates. After software is installed, you will be directed to localhost.

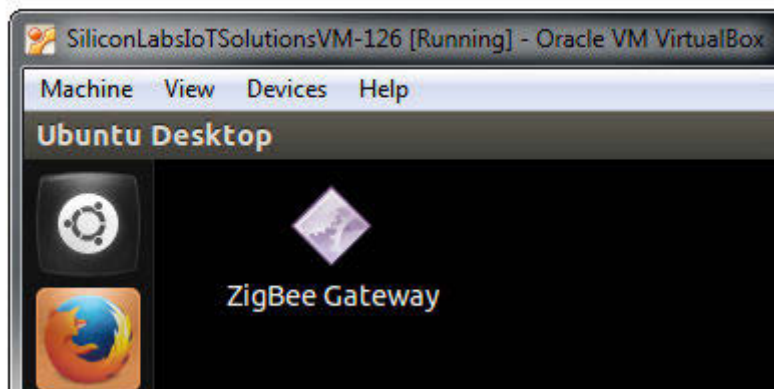


Figure 3.1. Launch the ZigBee Gateway

3.1 Setup

In the Network Maintenance section of the Setup tab, confirm that "ZigBee Network: Up" is shown, and if not, refer to Section 4. [Troubleshooting](#) for possible solutions. On first boot the PAN ID is randomly assigned, the channel is set to 11, and the power is set to 20 dBm. This configuration can be changed in the "Extended Network Form Settings" section, and on subsequent boots the settings are restored. The PAN ID is a 16-bit number expressed in hexadecimal format, the channel can be set to any valid ZigBee channel (11-26), and the valid power level range is -20 dBm to 20 dBm. Note that range checking is enforced.

Network Maintenance

ZigBee Network: Up

Channel: 11

Pan: 0xC3FD

Power(dBm): 20

Reform Network



Figure 3.2. Network Maintenance

Select the “+ Device” button and initiate the network join procedure for the desired devices. The lighting demo board enters join mode by pressing S1 ten times rapidly, the contact sensor by pressing S1 for more than two seconds, and the dimmer switch by pressing S3 for more than two seconds. Additional information can be found in the user's guide for each device. Devices will appear in the list with their name, unique device ID, and state. The name is reported by each device and the unique device ID is assigned each time the device joins a ZigBee network.

If a device is on a network and communicating with the gateway, its state will be labeled as “joined”. A device failing to respond will be labeled “unresponsive”. The request to leave the network is sent by selecting the “X” next to the device, and will be labeled “leave sent” if there is no response from the device. Devices may become unresponsive or indicate leave sent because they are asleep, turned off, or out of range. When the device wakes, turns on, or comes back into range, the unresponsive device will be labeled as “joined” and a device labeled “leave sent” will be removed from the device list.

The ZigBee Contact Sensor Reference Design (RD-0030-0201) will indicate open/close state, active/alarm state, temperature, and the join/leave-sent/unresponsive state. The open/close state is sent by the contact sensor immediately upon change of state to indicate the magnet away (open) or near (closed) the reed switch. The alarm state is sent by the contact sensor immediately upon change of state when the tamper alarm is activated by pressing button S1 for more than four seconds and then releasing.

The ZigBee Lighting Demo Board Reference Design (RD-0020-0601 and RD-0035-0601) will present a toggle button to toggle the state of the light and indicate the join/leave-sent/unresponsive state. The toggle button sends the ZCL light toggle command.

The ZigBee Capacitive Sense Dimmer Switch Reference Design (RD-0039-0201) will show the joined/leave sent/unresponsive state.

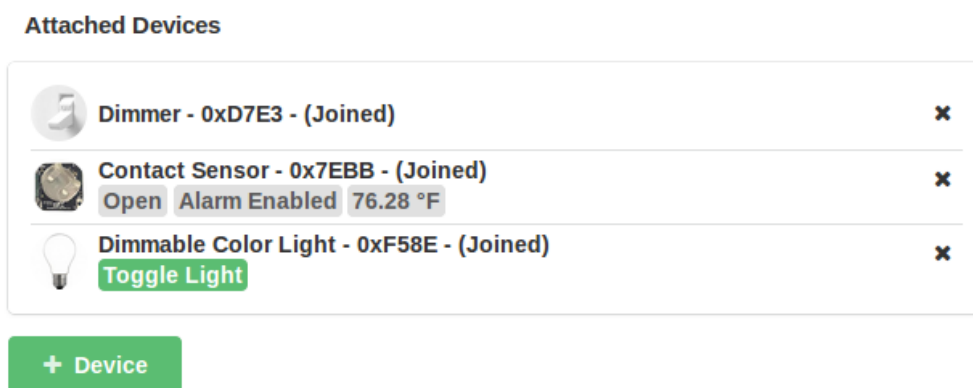


Figure 3.3. Attach Devices

The USB Virtual Gateway Reference Design allows the user to create rules to bind one device to another. To create a rule, select the “+ Set Rule” button, choose the desired input node and output node, and select “Bind”. Multiple rules can be set for both Input Nodes and Output Nodes. For example, both the contact sensor and dimmer switch input nodes can bind to the dimmable color light, shown below. If two input nodes send a command to an output node, the commands are executed in the order received.

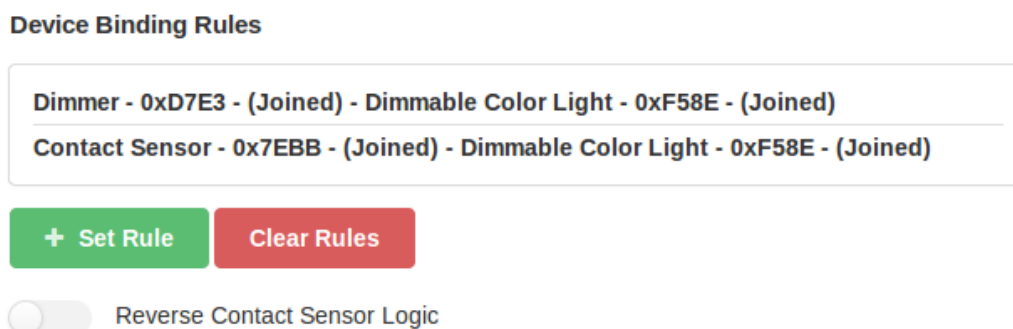


Figure 3.4. Device Binding Rules

3.2 Home

The home tab duplicates the setup information and offers extended information with the Show Extended Info button. An HA Color Light also shows on/off and dimming, color temperature, and hue/saturation controls. The extended information includes:

- Node EUI
- Gateway EUI
- Node State (joined, leave sent, unresponsive)
- Firmware version
- Firmware Image type
- Manufacturer ID
- OTA bytes sent
- Updating indicator (via OTA)
- Endpoint 1 device ID
- Available OTA images list

Available OTA update images are located here: `/opt/SiliconLabsGateway/webserver/ota_avail_file`

Note: The OTA update process will take approximately ten minutes for non-sleepy devices and up to several hours for sleepy devices.

Note: Only one device should be in the "Attached Device" list prior to beginning the OTA update process.

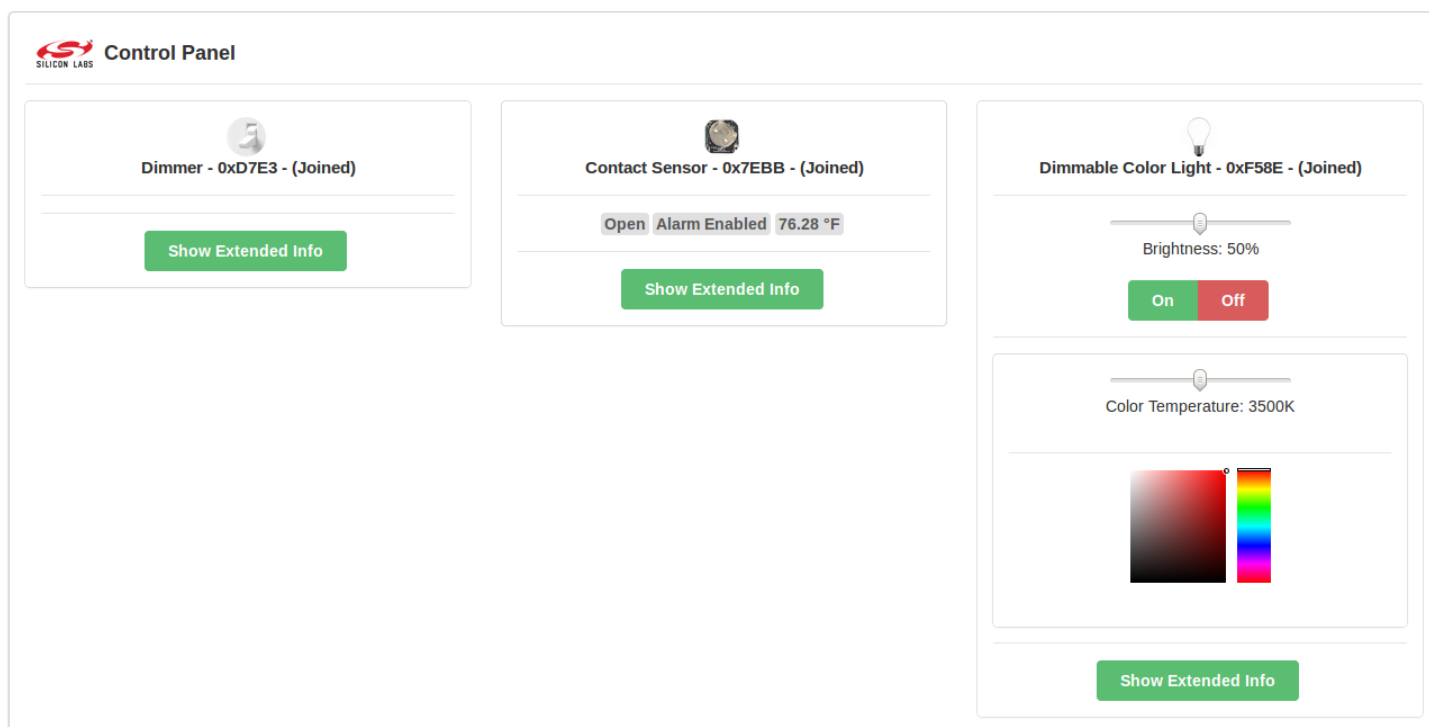


Figure 3.5. Home Tab

3.3 Diagnostics

The diagnostics tab offers a network test and logging options.

The network test sends rapid on/off commands to a selected light in order to determine several key performance metrics of the ZigBee network. It is configured by selecting the desired light, setting the period (ms) and iterations, and selecting "Run Network Test". The test measures network throughput and RF conditions. The "Refresh Log" button will update the test output tab.

The result is shown in the Test Output log tab, and the log file is located here: `/opt/SiliconLabsGateway/webserver/logs/CustomerTest.log`

The backend output tab displays all web server command routing. The "Console Log Streaming" option enables log updates to the backend output tab. The "Advanced Callback Logging" option enables extra statistic logging such as: message time stamps, acknowledgement errors, link quality (LQI), and receive signal strength (RSSI). In typical use, logging this information is not necessary, and disabling this option reduces gateway overhead.

The backend output log file is located here: `/opt/SiliconLabsGateway/webserver/logs/GatewayTransport.log`

The gateway output tab shows all ZigBee gateway commands and data. The "Console Log Streaming" option enables log updates to the gateway output tab. In typical use, logging this information is not necessary, and disabling this option reduces gateway traffic and overhead. The gateway output tab can also be used to send command line interface (CLI) commands.

The gateway output log file is located here: `/opt/SiliconLabsGateway/logs/gateway.log`

3.4 About

The About tab shows all versions and displays the web server IPv4 address for the purpose of connecting a mobile handset, tablet, or another computer to the gateway.

Note: The "Running on IP" address is updated when refreshing the browser window.

3.5 Shutdown

To properly close the gateway, from the Virtualbox Manager select "Machine" → "Close" as shown in the figure below, or close the web browser and all active terminal windows on the desktop.

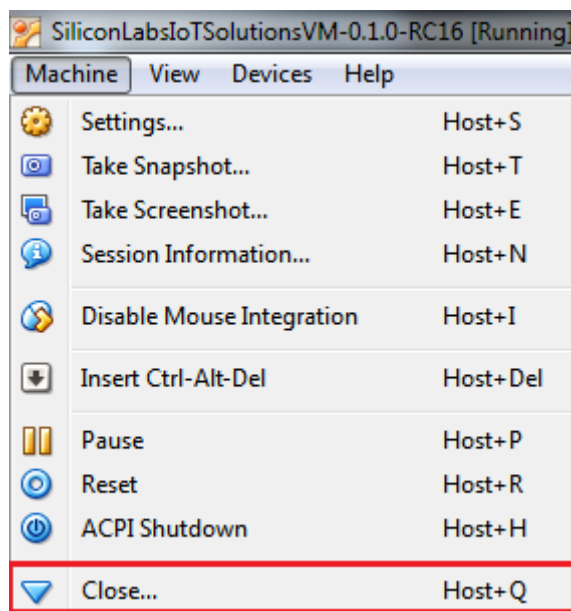


Figure 3.6. Shutdown

4. Next Steps

The ZigBee USB Virtual Gateway Reference Design (RD-0002-0201) is designed to demonstrate ZigBee gateway functionality with Silicon Labs ZigBee reference designs such as Lighting Reference Designs (RD-0020-0601 and RD-0035-0601), ZigBee Contact Sensor Reference Design (RD-0030-0201) and ZigBee Capacitive Sense Dimmer Switch Reference Design (RD-0039-0201). For next steps, refer to the user's guides for each of these reference designs.

The ZigBee USB Virtual Gateway is also designed as a reference to demonstrate the software functions and can be used as a baseline for further development and porting to a Linux platform. To aid in the understanding of the software architecture, refer to the figure below.

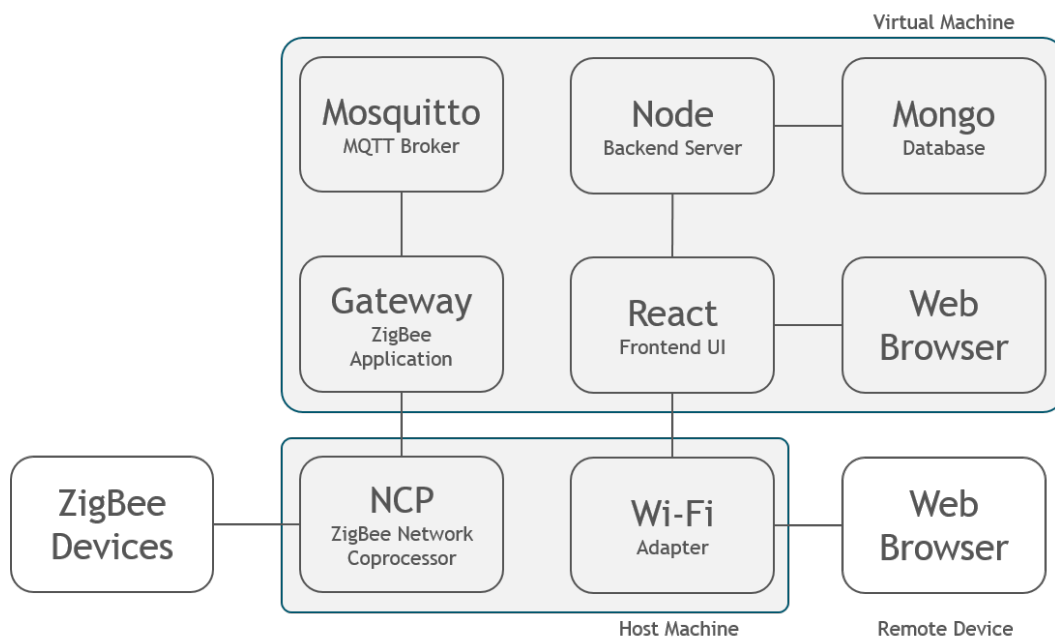


Figure 4.1. Software Architecture

The virtual machine environment includes the EmberZNet Pro ZigBee stack binaries and server software source code. To modify the binaries it is necessary to acquire a ZigBee development kit EM35x-DEV. You can learn more about purchasing and using a ZigBee development kit at: <https://www.silabs.com/products/wireless/zigbee/Pages/zigbee-getting-started.aspx>. The server source code is available for study and modification within the virtual machine. The directory structure is as follows:

```

/opt/SiliconLabsGateway/bin/siliconlabsgateway
    ZigBee gateway manager executable (source available from Silicon Labs)
/opt/SiliconLabsGateway/webserver
    Backend node.js source files, interpreted by npm
/var/www
    Webserver react.js source files, served by Apache
  
```


5. Troubleshooting

5.1 ZigBee Network Down

Confirm the ZigBee USB Virtual Gateway Hardware is available, as shown in the figure below.

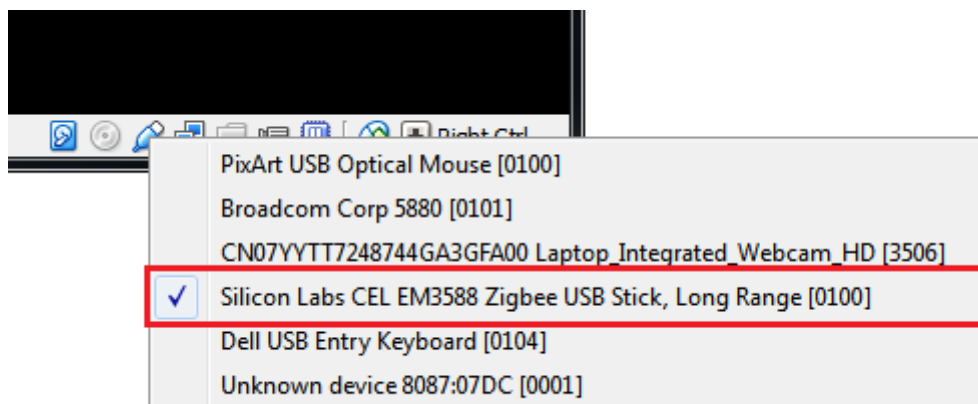


Figure 5.1. Confirm ZigBee USB Virtual Gateway Hardware Availability

If the ZigBee USB Virtual Gateway Hardware does not appear as an option, or if an error such as shown in the figure below, it may be in use by the Windows or OS X host operating system. Close the Virtual Machine and Oracle VM VirtualBox Manager, remove the ZigBee USB Virtual Gateway Hardware, and confirm in Device Manager (Windows) or System Information (OS X) that the device is no longer present. If not, repeat steps 7–9 from Section 2. [Installation and Configuration](#).

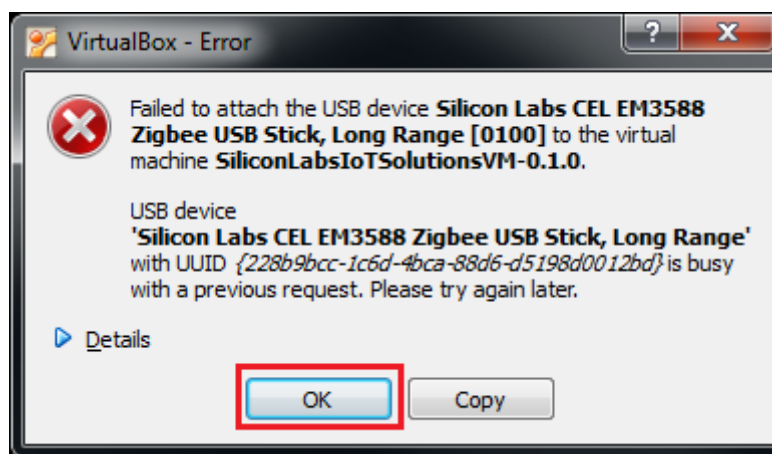


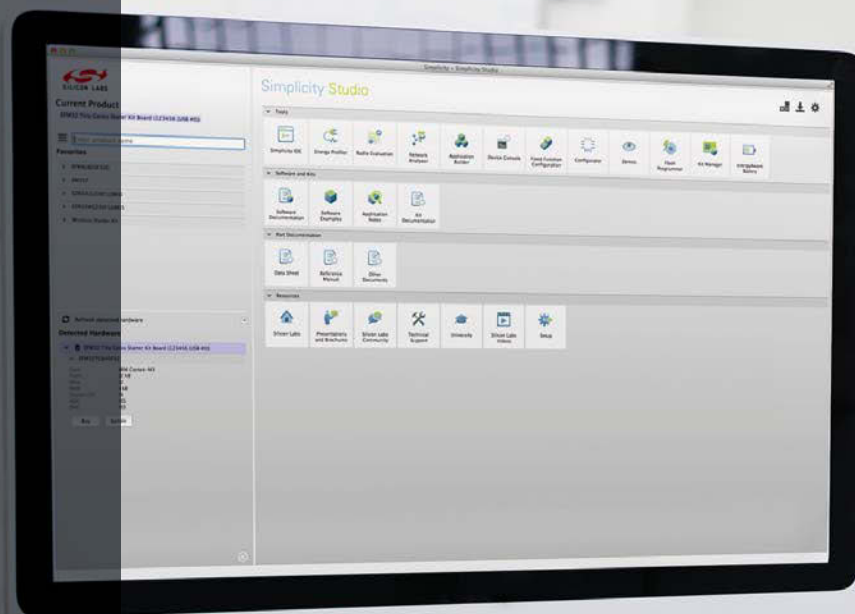
Figure 5.2. Error Condition

5.2 Unable to Add Devices

The ZigBee end node may not be in the active network search state. Refer to the user's guide for each device and verify network search mode.

5.3 Unable to Remove Devices

When attempting to remove ZigBee end nodes by selecting the “X” next to the device name, the message “leave sent” may appear but the device remains in the device list. The device may be powered down or out of range, and unable to acknowledge the request. Once powered up and in range, the end node will acknowledge the request to leave and disappear from the device list.



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