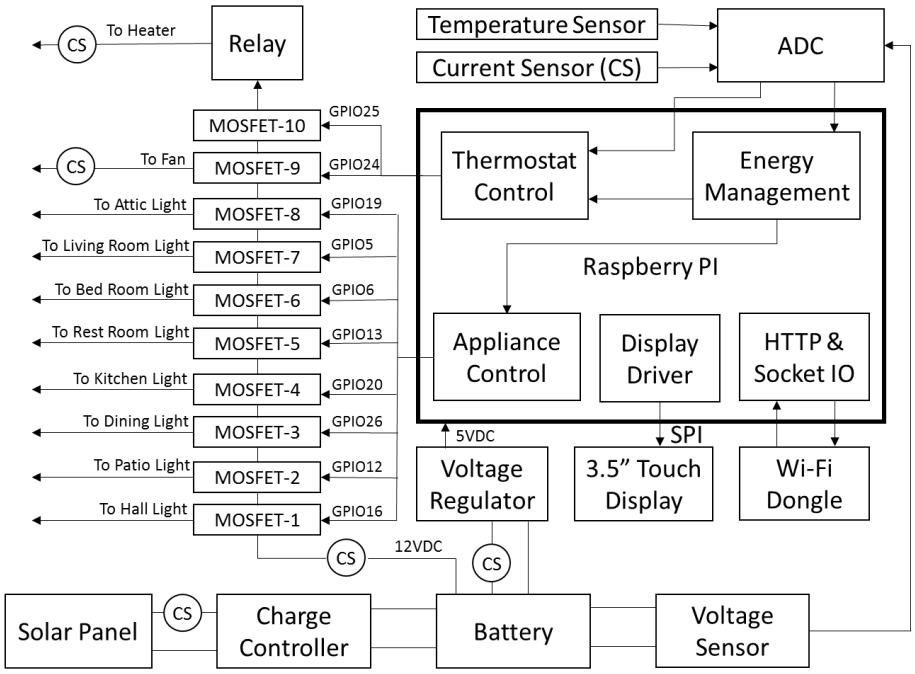
ASCC MINIATURE SMART HOME

This document describes our home automation framework that runs on node.js. It provides a common extensible platform for home control and automation tasks.

Introduction

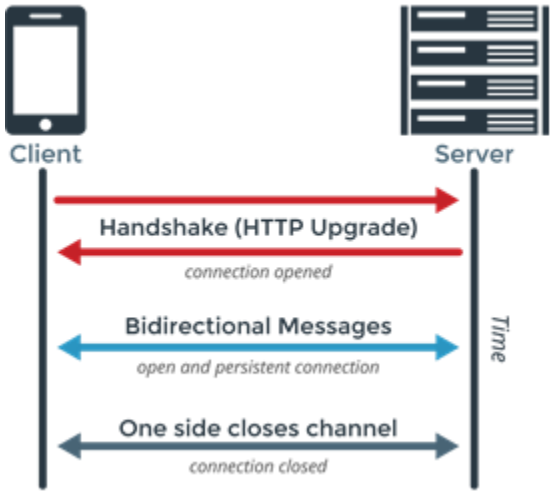
A Smart-Home is typically made up of number of sensors, actuators and control units. A central management server receives data from various sensor nodes. The management server contains the program with predefined logic. Depending on the various sensor values the server decides the values of different appliance. The value assigned by the server for any particular actuator can be accessed by the clients using HTTP request or web sockets.

The block diagram of smart-home circuit is shown in the figure below.

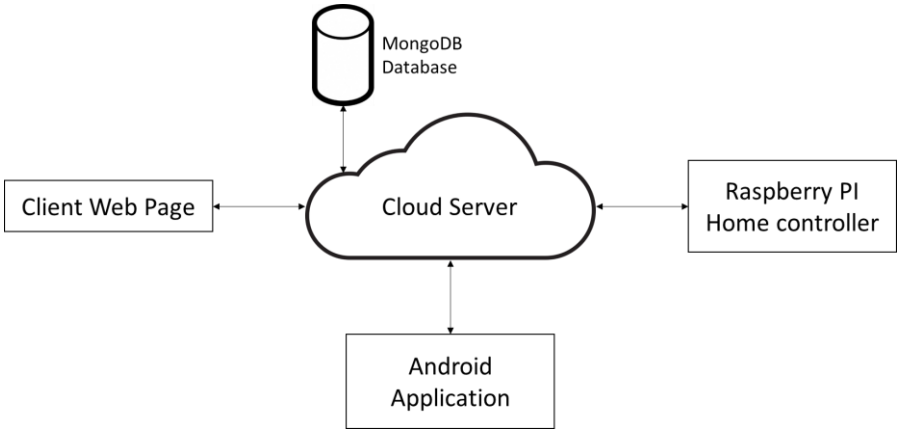


Raspberry PI is used for client side control. The control circuitry is connected to a touch display to display the thermostat values. Different sensors such as temperature, current and voltage sensors are connected to ADC (analog to digital converter). The lights, heater and fan are controlled using MOSFET and relays.

The server needs to be polled using HTTP to obtain the instantaneous room temperature of the smart-home. Whenever a request is made to the server a new port/socket gets opened and data transfer takes place. Once the data has been transferred the port gets closed as shown in figure below. This adds lot of overhead to the system. Further, it is not possible for the server to initialize the communication with any of the client. Hence, client has to request the server for updated information for every few seconds. On the other hand, WebSockets are extension of the traditional sockets. The server opens up the socket for clients and will be able to broadcast messages without any request from the clients thus avoiding the polling operation.



The overall system design is shown in the diagram below,



The central management system is on the ASCC cloud server and it is linked to a database. All the sensor and actuator values are stored in the database. A number of client devices can communicate with the server using a set of predefined APIs. The sensor and actuator values can be accessed and changed using the APIs provided.

Getting Started

1. Installation

STEP 1 – INSTALL NODE.JS

Go to the Node.js website and click the green Install button. It'll detect your OS and give you the appropriate installer (if for some reason it doesn't, click the downloads button and grab the one you need). Run the installer. That's it, you have installed Node.js and, equally important, NPM – Node Package Manager – which lets you add all kinds of great stuff to Node quickly and easily.

- Open a command prompt
- cd to the directory in which you wish to keep your test apps

STEP 2 – INSTALL EXPRESS GENERATOR

Now that we have Node running, we need the rest of the stuff we're going to actually use to create a working website. To do that we have to install Express, which is a framework that takes Node from a barebones application and turns it into something that behaves more like the web servers we're all used to working with (and actually quite a bit more than that). We need to start with Express-Generator, which is actually different than Express itself ... it's a scaffolding app that creates a skeleton for express-driven sites. In your command prompt, type the following:

- C:\node>npm install -g express-generator

The generator should auto-install, and since it (like all packages installed with -g) lives in your master NPM installation directory, it should already be available in your system path. So let's use our generator to create the scaffolding for a website.

STEP 3 – DOWNLOAD THE PROJECT

If you do not have this project you can clone a copy from here. Make sure all the files are downloaded properly.

STEP 4 – INSTALL DEPENDENCIES

We've defined our dependencies and we're ready to go. Note that the version numbers for those two modules are current as of the latest update, but new versions of NPM modules are frequently rolled out. These versions are proven to work with this tutorial; if you go with the latest versions, I'm afraid you're on your own.

Return to your command prompt, cd to your node_modules/cron directory, and type '*npm install*'

It's going to print out a ton of stuff. That's because it's installing all the stuff listed in the dependencies object (yes, including Express – we installed the generator globally, but we still have to install the actual module inside this one particular project). Once NPM has run its course, you should have a node_modules directory for each dependency.

You now have a fully-functioning app ready and waiting to run. Before we do that, though, we need to do one quick thing to prepare for setting up our database. Still in your nodetest1 directory, type '*mkdir data*'. This where we are going to save our MongoDB data. If it does not exist the database server will not run.

STEP 5 – INSTALL MONGODB

Again we're going to our web browser, pointing it to http://mongodb.org/ and downloading Mongo. Click the downloads link in the main menu and snag the production release that fits your system. For Windows 8 on a 64-bit processor, we want "64-bit *2008R2+". This will give you an MSI file that will run through a standard Windows install. It will default to installing into your Program Files directory (in a \server\3.0\ subfolder), which is fine.

STEP 6 – RUN MONGOD

Add mongod to system path. Then, in the command prompt enter

- mongod --dbpath c:\node\nodetest1\data\

You'll see the Mongo server start up. This is going to take a while if it's the first time, because it has to do some preallocating of space and a few other housekeeping tasks. Once it says "[initandlisten] waiting for connections on port 27017", you're good. There's nothing more to do here; the server is running.

- To view database open a new command window and enter mongo.
- Select Database using use 'database-name(licensedb)'.
- Example to view user collection type 'db.usercollection.find().pretty()'.

LINUX installation

sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv 7F0CEB10

echo 'deb http://downloads-distro.mongodb.org/repo/ubuntu-upstart dist 10gen' | sudo tee /etc/apt/sources.list.d/mongodb.list

sudo apt-get update

sudo apt-get install mongodb-org mongodb-org-server

sudo apt-get install python-software-properties

sudo apt-add-repository ppa:chris-lea/node.js

sudo apt-get update

sudo apt-get install nodejs

sudo npm install mongoose

2. Running

The server can be started with

- sudo node app.js

This starts server with app.js instead of "start": "node ./bin/www" (from package.json)

To daemonize this application

- sudo node app.js start

Note: You can also use status, stop, restart.

3. Auto starting

FOREVER: runs application forever https://www.npmjs.com/package/forever

install: npm install -g forever

usage: start - forever start app.js

stop - forever stop

For running MongoDB as child process use command:

START: sudo mongod --dbpath /home/ubuntu/mongoDBlicense/data/ --fork --logpath /var/log/mongodb.log

STOP: sudo mongod --dbpath /home/ubuntu/mongoDBlicense/data/ --shutdown

API

The smart home server features a rich API for external scripting or frontends. The API can be accessed in two ways:

- The REST-API: Using standard HTTP-Requests.
- The websocket-API: Using websockets and the socket.io protocol.

REST-API

The REST-API fits best for simple tasks because it is easy to use and implement. You could for example read the value of the variable `$the-answer` by a simple HTTP-Request using curl:

```
curl \
  -X GET \
  --user "user:password" \
  http://your-pimatic/api/variables/the-answer
```

This yields:

```
{
  "variable": {
    "name": "the-answer",
    "readonly": false,
    "type": "value",
    "value": 42
  },
  "success": true
}
```

You can also create (using 'POST') or update (using 'PATCH') the value of a variable:

```
curl \
  -X PATCH \
  --header "Content-Type:application/json" \
  --data '{"type": "value", "valueOrExpression": 1337}' \
  --user "user:password" \
```

```
http://your-pimatic/api/variables/the-answer
```

WebSocket-API

The websocket-API is the second method to interact with server. The Advantage over the REST-API is that you get live events, if something in server changes. On top of websockets, our server is using the socket.io Protocol to send and receive messages.

A simple example:

```
var io = require('socket.io-client');


var host = 'your-pimatic';
var port = 80;
var u = encodeURIComponent('your-username');
var p = encodeURIComponent('your-password');
var socket = io('http://' + host + ':' + port + '/?username=' + u + '&password=' + p, {
  reconnection: true,
  reconnectionDelay: 1000,
  reconnectionDelayMax: 3000,
  timeout: 20000,
  forceNew: true
});


socket.on('connect', function() {
  console.log('connected');
});


socket.on('event', function(data) {
  console.log(data);
});
```

```
socket.on('disconnect', function(data) {
  console.log('disconnected');
});

socket.on('devices', function(devices){
  console.log(devices);
});

socket.on('rules', function(rules){
  console.log(rules);
});

socket.on('variables', function(variables){
  console.log(variables);
});

socket.on('pages', function(pages){
  console.log(pages);
});

socket.on('groups', function(groups){
  console.log(groups);
});
```

You can also call actions from the socket.io connection:

```
socket.emit('call', {
  id: 'update-variable-call1',
  action: 'updateVariable',
  params: {
    name: 'the-answer',
    type: 'value',
    valueOrExpression: 1337
  }
});

socket.on('callResult', function(msg){
  if(msg.id === 'update-variable-call1') {
    console.log(msg.result);
  }
});
```

The table below shows the list of all available functions.

HTTP-Post

1. Function Name: updateLight
   Data: { “light” : light_name,
   ”state” : ”light_state” }

2. Function Name: updateAllLight
   Data: { “light” : “lights”,
   ”state” : ”light_state” }

3. Function Name: updateMode
   Data: { “room” : “home”,
   ”mode” : auto/cool/heat }

4. Function Name: updateSetTemp
   Data: { “room” : “home”,
   ”setTemp” : integer_value }

5. Function Name: updateCurrTemp
   Data: { “room” : “home”,
   ”currTemp” : integer_value }

SocketIO-Broadcast

1. Broadcast Name: updateLight
   Message: { “light” : light_name,
   ”state” : ”light_state” }

2. Broadcast Name: updateThermostat
   Message: { “curTemp” : integer_value,
   ”setTemp” : integer_value ,
   ”mode” : auto/cool/heat }

3. Broadcast Name: updatePowerDisp
   Message: { “room” : “home”,
   ”solarPower” : integer_value ,
   ”lightPower” : integer_value ,
   ”acPower” : integer_value ,
   ”piPower” : integer_value ,
   ”batteryPercentage” : integer_value }

Development

1. Requirements / Readings

- You should know JavaScript and know how to write JavaScript code.
- You should know node.js and have some basic knowledge about asynchronous programming.
- node.js Introduction to Node.js with Ryan Dahl (old but the basic.)
- http://socket.io/get-started/chat/

2. Developing Environment

The project structure is shown below

```
todo
|-- node_modules
|   |-- ejs
|   |-- ejs-locals
|   |-- express
|   `-- mongoose
|
|-- public
|   |-- images
|   |-- javascripts
|   `-- stylesheets
|       |-- style.css
|
|-- routes
|   `-- index.js
|
|-- views
|   |-- index.ejs
|   `-- layout.ejs
|
|-- .gitignore
|
|-- app.js
|
`-- package.json
```

1. node_modules
   All the project dependencies are installed under these directories. They are automatically controlled by the dependency list. Do not disturb this folder.
2. public
   Assets which are accessible by the end users are stored here. It contains images, web applications and front-end script.
3. routes
   Actions, including logics are contained in these files. They form the backend application with node.js.
4. views
   Action views, partials and layouts are the different templates stored under this folder. When any request is done, the server returns the HTML file by rendering these templates using engines. In our project we use Jade programming for templates.
5. app.js
   Contains configurations, middlewares, and dispatch routes. This is the file from which the server program begins its executions. Most of the information related to ports and configuration are programmed here.
6. package.json
   This files contains the configuration for the dependencies.

3. Clients

The clients need to install required dependencies to make all the API calls. Since we use both REST-API and WebSocket-API, both the packages must be installed.

Android

The first step is to install the Java Socket.IO client with Gradle.
For this app, we just add the dependency to build.gradle:

```
// app/build.gradle
dependencies {
   ...
   compile 'com.github.nkzawa:socket.io-client:0.3.0'
}
```

We must remember adding the internet permission to AndroidManifest.xml.

```
<!-- app/AndroidManifest.xml -->

<manifest xmlns:android="http://schemas.android.com/apk/res/android">

   <uses-permission android:name="android.permission.INTERNET" />
```

...

</manifest>

Now we can use Socket.IO on Android!

Python

Install the package in an isolated environment.

- VIRTUAL_ENV=$HOME/.virtualenv

Prepare isolated environment

- virtualenv $VIRTUAL_ENV

Activate isolated environment

- source $VIRTUAL_ENV/bin/activate

Install package

- pip install -U socketIO-client

C++

- Install boost library
- Use git clone --recurse-submodules https://github.com/socketio/socket.io-client-cpp.git to clone your local repo.
- Add <your boost install folder>/include,./lib/websocketpp and ./lib/rapidjson/include to headers search path.
- Include all files under ./src in your project, add sio_client.cpp,sio_socket.cpp,internal/sio_client_impl.cpp, internal/sio_packet.cpp to source list.
- Add <your boost install folder>/lib to library search path, add boost.lib(Win32) or -lboost(Other) link option.
- Include sio_client.h in your client code where you want to use it.