**This home automation system can measure temperature, relative humidity, light intensity and control two electrical equipment on Cayenne IoT (Internet of Things) platform. The two electrical equipment can be a light bulb and a ceiling fan, or any other electrical devices.**

# Basic IoT components

An IoT system has some basic components, such as sensors, actuators, embedded system, network link, user interface and Big Data storage.

**Sensors :** In this project, two sensors are used. One is a light-dependent resistor (LDR) to sense ambient light intensity, and the other is DHT11 temperature and relative humidity sensor.

**Actuators :** Relays connected to output pins are used as actuators here. Electrical loads like lights and fans are connected to contacts of the relays, which are controlled remotely through a Web interface or mobile app.

**Embedded system :** Wi-Fi module ESP8266 (NodeMCU) used here is an embedded controller that is programmed through Arduino, to handle analogue or digital data received from sensors and to transmit over the Internet. At the same time, it accepts commands from the Web and accordingly actuates connected devices or actuators.

**Network link :** The Internet works as a network link to connect the embedded system to the outer world.

**User interface :** Cayenne platform supports Message Queue Telemetry Transport (MQTT) protocol for communication. MQTT protocol is a lightweight messaging protocol for use over TCP/IP protocol. It is designed for low-power devices that work on low bandwidth. Cayenne platform has a simple drag-and-drop feature to create a dashboard in a few minutes. This saves time and effort for programming the user interface.

**Big Data :** This is also managed by Cayenne platform. Big Data is basically huge data that is collected from all connected devices, where type of data varies from device to device and data flow is at a very high speed. For example, Facebook gets more than 600TB of data daily from different posts (image or video), text messages, likes and so on.

**Circuit and working :** The circuit diagram of ESP8266-based home automation system. It is built around NodeMCU (ESP8266), an LDR, DHT11 sensor, opto-coupler 4N33 (IC2 to IC3), two relays (RL1 and RL2) and a few other components.The circuit has two input channels—analogue input to measure light intensity through LDR1 and digital input to read values of temperature and relative humidity through DHT11. For measuring a wider range of temperature and humidity, replace DHT11 with DHT22 and then replace DHT11 with DHT22 in the source code.The circuit is powered by 12V DC supply, as it needs to drive 12V relays. 5V output is derived from 7805 regulator from the 12V input to power ESP8266 NodeMCU module. NodeMCU V1.0 (ESP8266 ESP-12) has 11 GPIO pins and one ADC input pin with 10-bit resolution.The pin details of NodeMCU module. It has 3.3V inbuilt voltage regulator and CP2102-based USB-to-serial converter that gives an easy interface with the PC for loading Arduino code to NodeMCU. NodeMCU has a 30-pin (2×15) male header. Components around it are wired on a general-purpose PCB or on the designed PCB layout. The LDR (LDR1) is used to sense the intensity of light around it, which is displayed as percentage on Cayenne dashboard. This is connected to A0 pin of NodeMCU module to read analogue voltage generated based on ambient light. DHT11 sensor is used to read ambient temperature and relative humidity through digital I/O pin D5 (GPIO14). This sensor can split the data for temperature and relative humidity, and send it one at a time through the same output pin.

Two 12V relays are driven by two BC547 transistors through MCT2E/4N33 opto-isolators. Each relay can drive AC/DC load through the terminal headers connected to it.

# Software

The software (ESP8266\_HA.ino) is written in Arduino programming language, which allows writing the code within a few lines. The program makes the device communicate with Cayenne platform when connected to the Internet through an access point or Wi-Fi router.To add board for ESP8266 in Arduino IDE, go to File Preferences and paste the link in Additional Board Manager URLs.Open Boards Manager from Tools ®Board menu and install esp8266 platform. (Do not forget to select your ESP8266 board from Tools®Board menu after installation.) For programming NodeMCU module, three unique identities are required from Cayenne website, namely, MQTT user name, MQTT password and Client ID. When the device is connected to the network, these IDs help Cayenne website to find the device and start communicating with it.Other IDs required are your Wi-Fi SSID and password, if any, to connect with the local Wi-Fi network. Before compiling and loading the code to NodeMCU module, install the following libraries in Arduino IDE as described below. Cayenne-MQTT-ESP8266 library

## This allows NodeMCU to communicate with devices on Cayenne platform.

DHT library

This allows DHT11 sensor to communicate with NodeMCU. Search Unified under Library Manager and install Adafruit Unified Sensor. To add the above two libraries to Arduino IDE, go to Sketch®Include Library®Add .ZIP Library… Locate and install the files. Alternatively, you can directly download and copy these libraries to Arduino/library folder of Arduino IDE.