

# Web and Cloud Based Home Automation Systems: An Overview

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**Abstract** - Home automation is the control of most if not all electrical and electronic devices in our home, whether we are there or away. With the IOT spreading over our daily lives to allow different devices to be connected to the internet, it's now possible to monitor, manage and control our home remotely which saves us the physical effort involved.

The web server based approaches allow controlling devices and appliances remotely, two methods are being used one is to develop an embedded web server using dedicated hardware, the other is to use cloud based services (Application server) and develop your application on it without the need for hardware. These client/server mechanisms using different protocols to convey messages and control signals through the internet made it more convenient for home automation systems providing an easy and secured way of accessing, monitoring and controlling houses from any desired location and at any time.

Following the great growth of IoT, web and cloud based Platforms a remote access with no dependency on specific device/machine for controlling house appliances was introduced.

**Key Words:** cloud computing, embedded web server, IoT, web services

## 1.INTRODUCTION

Internet of Things (IoT) is extension of current internet to provide communication, connection, and internetworking between various devices or physical objects, also known as "Things". IoT term represents a general concept for the ability of network devices to sense and collect data from the world around us, and then share that data across the Internet where it can be processed and utilized for various interesting purposes [1].

Those systems managed to give us a good control over the appliances even from remote locations, and with the availability of cloud networks it's now possible to have a complete monitoring and controlling over appliances and systems at home using different devices such as PC, Mobile Devices and Tablets ...etc.

This recent widely adopted technology in home automation paved the way for researchers and designers to invest more effort in order to provide better solutions and designs. With the excessive adoption of smart homes and IoT, and the emergence of cloud computing to provide services such as Information technology, remote access and Data analysis, It

makes a complete sense to utilize these huge, scalable systems and use their services and platforms in designing smart homes, which will give us more satisfaction about our home environment.



Fig-1: Internet of Things (IoT) [10]

The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data [2]. and as the IoT is widely adopted and more devices with various technologies at home are connected to the internet, it became difficult to centralize different systems under one network.

The proposed system in [3] consists of an Arduino board acting as the main controller with a Wi-Fi shield to allow internet connectivity, a relay circuit was interfaced with the Arduino to perform the desired actuation upon home appliances.

An HTML web page was created to act as the interface between the user/client and the appliances which will be remotely controlled using a browser of a PC/Tablet/Smart phone via the Wi-Fi module.

The system was a basic model for the IoT with the use of the dedicated WiFi module to allow internet connectivity which adds more hardware to the system.

Another scenario for IoT is described in [2] the proposed system based on the sensor network which senses and monitors the home environment and activities, with the Raspberry Pi as the central unit for data collection and processing in order to

automatically control appliances at home depending on sensors reading over the web.

The X10 protocol was used as a mean to allow the communication between devices and the network as the control commands like switching ON/OFF appliances are sent via radio frequency through the existing wiring system.

An android application was designed to allow controlling of devices remotely from a smart phone. Also a security system is integrated through the use of NFC technology using different NFC cards to allow only authenticated people to open and close the door using an Arduino motor shield for the opening/closing process.

The paper showed the integration of different technologies and communication protocols to control the various connected systems and devices.

Web Server is a computer program that's hosted on a machine known as a server, it issues web pages upon client requests and display the contents of that page, it's main role is to respond to clients queries and exchange data between client and server using the HTTP (Hypertext Transport Protocol).It can also handle requests from other protocols like the SMTP for mailing and FTP for file transferring and storing [4].

HTTP uses number of operations known as methods such as GET which retrieve a resource (file) of the specific requested location (URL), another method is POST which is used to submit the data from web Browser to the server. Since the web server has no intelligence embodied in it because the HTTP have no decision making ability it will not know what to do with the data coming from Browsers so another program/utility has to be implemented with it in order to process the data [4].

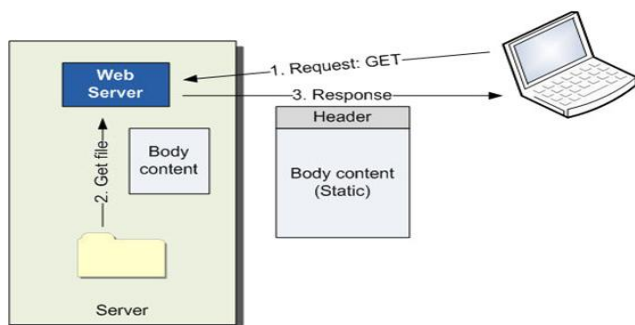


Fig-2: GET Request [11]

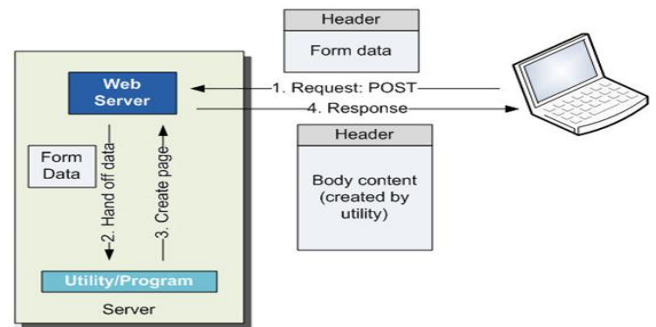


Fig-3: POST Request [11]

A web server is basically a system that hosts a web site to provide services for requesting clients to help monitoring and controlling the internet- connected devices at home remotely ,it processes, stores and delivers web pages to requesting clients using the basic information distribution network protocol HTTP (Hypertext Transfer Protocol) .It can be used in the WWW (World Wide Web) or embedded in another devices to serve a local network where it must have a web page or an application and a huge amount of memory to store data [4].

## 2.EMBEDDED WEB SERVER

The conventional way of building an automated system using an embedded web server as in [4] instead of using a PC Based web server which requires the PC hosting the web server to be on all the time .The Embedded web server basically is an electronic chip with an embedded Ethernet networking protocol to allow devices to communicate without using a computer ,it enables users to access , control and monitor systems at home via a web browser .The web server hosts a web site and provides services for the requesting clients , it has an application or web page and a large memory to store data .

It has basically a built in TCP/IP to allow the automation commands to be sent and received by the user who interacts with the system components using a standard web browser for monitoring and controlling various devices. A WIZ220IO chip is an embedded I/O module that enables the remote control and monitoring of I/O ports via Internet, it operates as an HTTP server to allow clients to monitor sensors and control the appliances at home .The system can be accessed from any PC, Tablets, PDA or a smart phone with internet connectivity.

Another implementation is in [5] developing an embedded web server Interface using a PIC24FJ256GB106 16-bit microcontroller along with ENC28J60 Ethernet controller in order to remotely automates homes/buildings as shown in Fig.4 .

A microcontroller is used as the central processing unit to manage the system components and provide the control over devices at home. In order to store the web pages and its operating factors storage is required, which was a USB in this project.

A web development tool was used to debug and develop the web pages that can be accessed using different web browsers. As the client login to the web page an authentication process is held with a user name and a password which is encrypted later using XXTEA block cipher (an encryption method) to ensure security, the client can easily then control any device at home. These designs require a large amount of memory to store the web pages and its operating parameters, also the web page hosting machine should be on all the time.

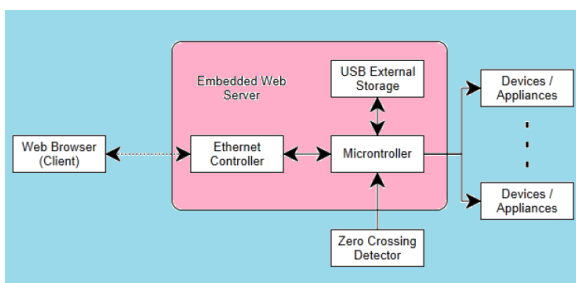


Fig-4: System Architecture [5]

### 3.CLOUD COMPUTING

Cloud Computing is basically providing Computing as services rather than hardware or products where services, shared resources like memories and software are being delivered over the network using different Internet protocols, clients/users are able to use applications or web browsers from their local machines / Mobiles to benefit from the services provided. Cloud Computing layers typically include SaaS (Software as a service) which aims to deliver web based applications to users/customers , PaaS (Platform as a service) which provides platforms for creating applications as a service and IaaS (Infrastructure as a service) and the latter offers Infrastructures and storage resources as a service like the virtual machines [7].

The cloud based approach provides a secured real time monitoring and controlling via internet over different systems at home from any desired location, without the need for a large memory to store devices data, or any added hardware.

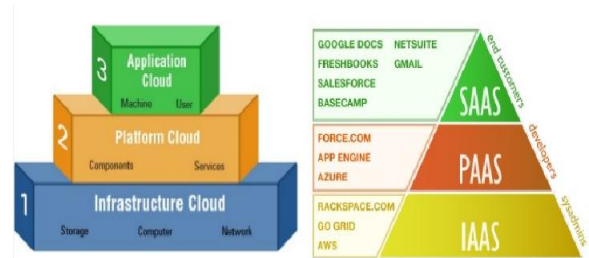


Fig-5: Architecture of Cloud Computing [12]

Smart Home can merge into the Clouds to provide more services and get more information provided by the Clouds.[7] The system in [8] demonstrate An approach to integrate Mobile devices with cloud networking using wireless communication for home automation, where users use mobile applications as an interface with the cloud in order to control different appliances at home.

Available (HAS) can be divided into two categories : the locally controlled systems in which a local network is used to control house appliances from within the house ,and the remotely controlled systems which provide a remote control of appliances and systems using internet facility. The design uses Pachube service which is a real time data infrastructure that allows management of different data points. To create home control user interface Pachube’s APIs were used. Operating under different protocols such as: XML, CSV, JSON, and EEML.

Pachube contains data streams, each unit in the house is treated as a data point with its own data stream and own unique identification number which allow separate control and monitoring over units in the house. The status of units after each setting is placed in a network package and sent to the cloud. Pachube APIs provide a monitoring graph for the different units so whenever a request for monitoring is issued the data of the particular unit will be extracted and a graph will be plotted.

Using a mobile application as a user interface and a microcontroller to connect different X10 devices at home the user can control the devices using the Pachube cloud networking .The system can be controlled using other methods like a visual C# PC program from a personal computer using the cloud network, another method is locally from within the house through a remote control using Zigbee wireless communication. An Arduino board was used to enable the communication between system components, with attached Ethernet shield for interaction with the Pachube cloud.

Despite the different methods for controlling appliances and devices the model still need a powerful storage system to handle the web pages.

A scalable system and a powerful storage is provided by Cloud computing allowing developing, running and managing home services at any time and from everywhere under the Software as a service concept (SaaS). The system in [9] basically does the following: It Measures home conditions using sensors, Manages and controls home appliances according to the commands sent via cloud using actuators and stores sensors and cloud data for further analysis.

In order to maintain the authorized access to the home a number of RFID cards were used to track users' presence at home. A web application is created (using Google App Engine platform) as a cloud service to allow clients access and control home appliances remotely from their smart phones. It's divided into a front end part and a back end part, the front end which is the client side (user interface) and the back end is for computing, processing and storing data.

Two Arduino boards were used, a central receiver to connect actuators and server data base using an Ethernet shield, and a central transmitter to connect various sensors in the system. The communication protocol between sensors, actuators and the boards was through the widely used ZigBee technology, and JSON is used for storing and exchanging data with the cloud which is light weighted data representation Syntax XML alike.

The paper demonstrated the use of multiple Arduino boards in order to allow the complete functionalities to be met, which is not advisable for a low cost system.

#### 4. CONCLUSIONS

The aim of the paper was to demonstrate various implementations of automated homes using embedded web servers which were costly in terms of memory and power consumption. A dedicated hardware to host the server and a powerful storage for web pages are required, in addition to a continuous power supply to keep the server on at all times.

Another topic was integrating the cloud computing services which appeared to have better solutions as it can provide the necessary storage and no worries about the continuous power supply for the increasingly scalable smart home systems.

Many companies offer cloud services and IoT platforms for customers/developers to create their own application and have their data stored and managed remotely.

These cloud services are quiet helpful specially when provided as E-healthcare services allowing patients who require continuous health monitoring to have their medical data collected, and monitored by their healthcare givers in real time and even take actions if a serious condition is detected by

different bio sensors or wearable devices used to monitor patients' health condition.

We are looking to have a complete cloud based systems in the upcoming time which will spare residents of smart homes the headache of having a secured, remotely controlled system and continuously powered on servers. The cloud offers a huge amount of memory which will be helpful for storing devices data, users can follow their systems' condition and analyzed the data collected at all times.

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