

# Study of Smart Home Architecture Based on Internet of Things

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**Abstract:** Recently, internet of things has enlightened many readers for the innovation of smart house where, everything is controlled on our finger tips. Out of all the reviewed architectures, the most upcoming implementation is conducted on GSM and Cloud-based technology. The GSM architecture makes use of mobile communication technology for communication between users and devices. It makes use of an interface to intercept SMSes from users and decode it into a format understood by microcontrollers. Cloud-based technology provides data aggregation, big data analytics, data visualization, predictive analysis technologies to get more value out of IoT data which can be helpful in smart home development.

**Keywords:** Internet of Things, Smart Home, GSM, Cloud based architecture.

## I. INTRODUCTION

Increasing necessities for information being accessible at any time, from any place, regardless the type of planned operation or remote device, together with the need of complete control of a specific scenario or device has paved the way towards the next technological revolution namely Internet of Things. The most awaited goal of robotics researchers is home based architecture. Unfortunately, no single group has solved the problem of making robots that will perform a number of tasks adequate enough to warrant the cost to the end consumer. Numerous advances and improvements in communication, computing and related robotic technologies are directed towards the Internet of Things [1]. Smart home is a home equipped with heating, lighting and electronic devices that can be controlled remotely by smart phone or computer.

There are many definitions that can be attributed to the Smart Home concept, and these change as time and technology advances. Where previously a Smart Home may have been one with multiple devices independently connected to the Internet, a much precise explanation now would be one where multiple devices might be connected in the same instance to a central hub which could possibly be a cloud interface and the operations could be performed through a GSM service. Formerly numerous controllers were required to interconnect with each device, today's Smart Home is more geared for central control [2]. The following services need to be provided by smart home:

- Intruder detection (Is anyone at home?)
- Keeping track of persons i.e. if no one is at home the switch off all electronic devices, close doors and windows.
- Temperature measurement for comfort (switch on/off AC/Heater), adjust accordingly.
- In case of Smoke and fire detection notifies the fire-brigade and house members.

Internet of things is a novel concept, evolved lately. It aims at connecting people with objects around them by

making use of an interface. Objects react autonomously to the real world events and deliver facilities with or without direct human intervention, thereby making life simpler.

“Internet of Things” connects “alive and lifeless things” via internet. In 21st century the people wants the world on their hands. As far as the scope of the Internet of Things, there are more than 12 billion devices that can currently connect to the internet, each and every thing is uniquely distinguishable through its embedded computing system but is able to inter operate within the existing Internet infrastructure.

Researchers estimate that by 2020 there will be 26 times more connected things than people i.e. Experts estimate that the IoT will consist of almost 50 billion objects by 2020. The analysis made of IoT products developed in different fields based on categories is shown below [16]:

Table I: Internet of Things Units Installed based on Category [16]

Source: Gartner (November 2014)

Category	2013	2014	2015	2010
Automotive	96.0	189.6	372.3	3,511.1
Consumer	1,842.1	2,244.5	2,874.9	13,172.5
Generic Business	395.2	479.4	623.9	5,158.6
Vertical Business	698.7	836.5	1,009.4	3,164.4
Grand Total	3,032.0	3,750.0	4,880.6	25,006.6

The world of new features connected appliances offer will continue to cultivate and advance as technology improves and new customer needs are recognized and met. It won't be long before appliances like these, which already are being manufactured, become common sights in homes.

- Ovens that can prompt you when your dinner is ready
- Clothes dryers that can direct you an alert when the dryer vent needs to be cleaned
- Appliances that can be repaired remotely, without anybody visiting your home
- Electric toothbrushes that monitor whether children devote enough time brushing
- If you forget to turn dishwashers on before leaving home, they can be operated remotely
- When supplies run low, refrigerators can order new groceries by directly informing the supplier.

**II. LITERATURE SURVEY**

IoT allows people and things to be connected Anyplace, Anytime with anyone and anything, by using ideally in any network/path and any service. IoT has come as a bonus to a variety of sectors like transport, education, energy, business, home and many more. IOT's possibility is unrestricted only to smart homes, but it encompasses huge application domains. The following figure 1 represents the various application of IoT.

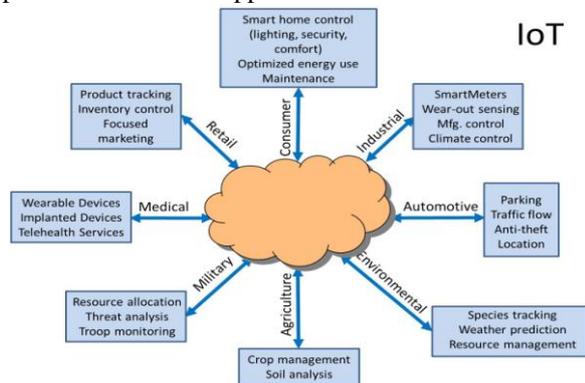


Fig. 1. Various Applications of IoT

IoT represents the next advancement of the Internet, taking an enormous hike in its ability to gather, analyse, and distribute data that we can turn into facts, info and eventually, wisdom. Such data-analysis, distribution, information and knowledge can be very helpful for an application such as a smart home. These [IoT] applications become platforms for innovative commercial services, and with these added services you can also generate new revenue streams [5]. The following figure 2 shows the worldwide smart homes managed service revenues upto the year 2017:

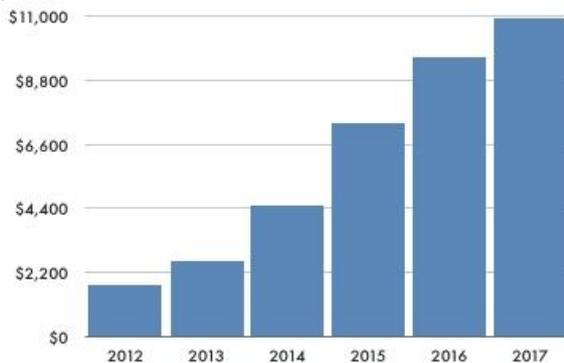


Fig. 2. Worldwide smart home managed service revenues

Following are the benefits of smart homes:

**1. Adding Convenience to your Daily Life**

When your home is converted into a smart home, you'll have all of your products programmed to your specific needs. Additionally being able to governor your home, no matter where you are, can be extremely beneficial.

**2. Customization**

There are numerous smart products in the marketplace currently and you definitely don't need to buy all of them at once. As the consumer it's up to you to select which product you want most, determine if you like it, and then add on to your collection of smart home products as you go. A decent item to begin with would be a thermostat or home security system if you're in the market for either of those.

**1. Security**

Smart home security systems allow you to view your home irrespective of where you are. You can have motion detectors, locks, cameras installed, etc. and you will be notified immediately if something is out of the ordinary. Various systems will even let you know of any unexpected temperature changes so that you're warned if there is a probable fire.

**2. Ease of Use**

Almost all smart home products can be installed without much hassle, countless of them don't even want you to bring someone into your home. Additionally if you're already someone who has technical knowledge, learning how to use most of these products becomes easy.

**3. Save Money and the Environment**

Smart homes feature products like air conditioners, thermostats and lighting. Having the ability to put these things on a timer, or switch them on and off when you're not at home will likely help you save money on your electricity bills. Several of these products permit you to track your energy usage and costs.

A few technologies used for smart homes are described below:

Mobile controlled home mechanisation structure provides a easier solution of a Global System for Mobile GSM network. It will aid to turn-off the entire system, improves the convenience and comfort of the user while it provides energy efficiency and safety. GSM is used to digitalize a signal or data and transmit signal or data to the receiver. GSM component can be used to direct the signal over a mobile in a fixed frequency to other mobile phone connected with the receiver [3].

Cloud computing is the practice of using remote servers on the internet to store, manage and process data as an alternative to a personal computer. Cloud computing is a general term that is better divided into three categories: Infrastructure-as-a Service, Software-as-a Service and Platform-as-a-Service [4]. These services can be exploited in the implementation of smart homes where all device information can be stored on the cloud and accessed by the user.

### III. SMART HOME BASED ARCHITECTURES

Smart home architecture is mostly implemented using GSM and cloud based technologies. The basic architectures are explained as follows:

#### A. GSM-Based Architecture

Global System for Mobile Communication is an effervescent communication technology. It is one of the medium most widely used for communication. Such a proposed system is basically used to connect the home to an IoT agent. The user commands from the web are inferred by the IoT managers and are converted into GSM-SMS commands. The microcontroller deciphers the SMS instructions and connects with the respective device [6]. The following figure 3 shows the GSM based architecture.

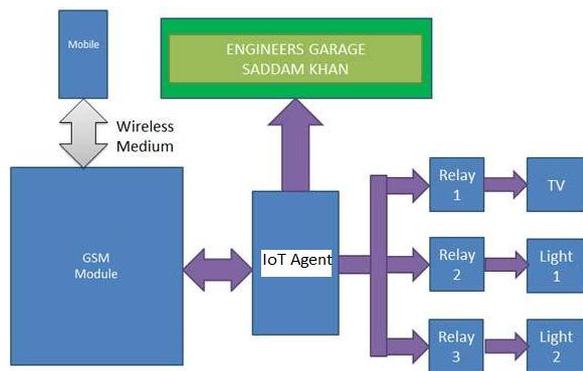


Fig. 3. GSM based Architecture

The actors within the system are:

- A) Users: They are common people who understand basic device functionality like (ON/OFF). They indirectly operate the device by sending the signals through a WIFI based network, which are actually commands to the IoT Agent who translates them based on devices.
- B) Server Machines: These are web servers that store the data pertaining to devices e.g. Device status, failure, functional performance, speed, etc. They do not perform tasks based on knowledge, however a simple request-response (RR) protocol is used for servicing user based queries.
- C) IoT Agent: It monitors Web server and GSM module for incoming SMS from smart home. Its main task is to parse, analyse and interpret and create SMS commands. The SMS received must be special i.e. always start and end with special symbol like “#”, “@”, “&”, etc. The IoT Agent parses the data based on <SPACE> or <ENTER> or whitespaces [6].

In a nutshell, the GSM receiving module acts as a gateway in communication unit. This reception unit can be a GSM/GPRS mobile phone, modem or any SMS send/receiving device. 3

This device attaches with microcontroller and computer through USB or serial cable. In this way a smart home can be operated based on finger-touch [7].

#### D. Cloud-Based Architecture

In a device-to-cloud message prototype, the IoT device connects directly to an Internet cloud facility like an application service provider to interchange data and control message traffic. This method often takes benefit of prevailing communication mechanisms like traditional wired Ethernet or Wi-Fi connections to establish a connection between the IP network and the device, which eventually connects to the cloud service [8].

The Cloud can offer an effective answer to implement IoT service management and configuration as well as applications that exploit the data or the things manufactured by them. On the other hand, the Cloud can benefit from IoT by extending its possibility to agree with actual things of the world in a more distributed and dynamic manner, and for delivering new services in a large number of real life scenarios[9]. The following figure 3 shows the cloud based architecture.

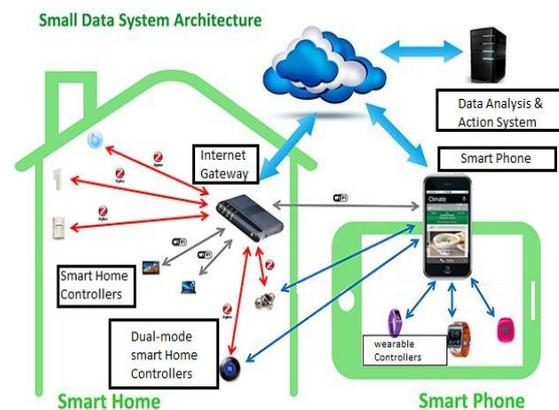


Fig. 4. Cloud based Architecture

Cloud medium:

The Cloud acts as intermediate layer between the things and the applications, where it hides the complication and the functionalities necessary entirely to implement the latter. This framework will impact future application development, where information processing, assembling and transmission will produce new challenges to be addressed, also in a multi-cloud environment [9].

New paradigms: The adoption of the Cloud IoT paradigm enables new scenarios for smart facilities and uses based on the extension of Cloud through the things [13], [14]:

- SaaS (Sensing as a Service) [13], [15], [11], providing ubiquitous access to sensor data.
- SAaaS (Sensing and Actuation as a Service) [13], enabling automatic control logics implemented in the Cloud.
- SEaaS (Sensor Event as a Service) [13], [11], dispatching messaging services triggered by sensor events.
- SenaaS (Sensor as a Service) [15], enabling ubiquitous management of remote sensors.
- DBaaS (DataBase as a Service) [15], enabling ubiquitous database management.
- DBaaS (DataBase as a Service) [15], enabling ubiquitous database management.

- DaaS (Data as a Service) [15], providing ubiquitous access to any kind of data.
- EaaS (Ethernet as a Service) [15], providing ubiquitous layer-2 connectivity to remote devices.
- IPMaaS (Identity and Policy Management as a Service) [15], enabling ubiquitous access to policy and identity management functionalities.
- VSaaS (Video Surveillance as a Service) [12], providing ubiquitous access to recorded video and implementing complex analyses in the Cloud.

#### Working:

The owner should be able to have access to remote devices, however he/she must be authorized. The authenticity of a user is guaranteed through the registration with the cloud and the user must trust the service-provider as all decision making strategies lie within the server.

When the individual leave for work and if there is no one at home, the AC is turned off and the doors and windows are closed locking system is then enabled. At any certain time the home system goes in surveillance mode depending upon the busyness of the system, looking for daily routine eating products and clothes for washing. The sensors in refrigerator provides with the quantity of available items. If the cloud determines that there is a scarcity of quantity in any particular product, it will then decide to order it or not depending upon the schedule of present day and next day. The individual will place the cloth into washing machine as soon as they get dirty, then the sensors in washing machine provide Cloud server with the data that details about the quantity of clothes present. Cloud server will direct the washing of clothes after considering various factors like energy consumption, time etc. At evening the temperature of outside environment cools and by using the data from temperature sensors and light sensors the cloud server will direct the slave for the watering of plants and garden. At any pleasant evening if the individual is at his home, cloud will check the data from temperature sensors, light sensors and sound sensor, if all conditions are favourable for the individual it will open the windows letting cool air to enter. If the individual is travelling (which is known by the identifier received of the tag placed in car), the cloud will check the schedule of the individual if there is any meeting or appointment at any particular place the cloud will direct the individual by updating the status of traffic in his path. If the individual is coming back to home from office or anywhere else, the cloud will calculate the estimated time of arrival. It will also check the outside temperature through temperature sensors and will switch ON the AC depending upon the arrival of the individual. At evening the individual arrives from the work; as he enters the compound of the house, the tag situated there is read by the reader of mobile and communicated to the cloud. The cloud server then directs the slave server, ascertaining the presence of the individual. The slave then initiates appropriate sensors as directed. As the individual enters, the living room lights open up slowly and he finds the room temperature that is comfortable for him. Slow music starts in background for

some time just to relieve stress. At the same time, the cloud server will generate a report that states the energy consumption for last 24 hours. At night when the individual is preparing dinner music starts impulsively in background. When the individual sits to eat dinner the TV in living room starts automatically playing his favourite program from where he ended the last time. When the individual moves to the bedroom to sleep, he will find favourable environment with dim lights. The lights in living room and TV are turned OFF. After specified amount of time and sensing no motion in home, all the devices moves into sleep mode [10].

## IV. SHORT-COMINGS WITHIN SMART HOMES

### 1. Cost

Most families are able to purchase smart home products, but that doesn't mean it won't leave a dip in your wallet. You can buy the products one at a time and it won't seem like too much, \$50 here, \$300 there, but by the period you have the smart home system you need, you will likely have spent a larger sum than you would have if you had purchased non-smart products.

### 2. Slight Learning Curve

It has been stated in the advantages that most smart home systems are essentially very friendly to use, but at the same time there is still somewhat of a learning curve for many persons. For someone previously engrossed in technology, converting your smart home will be a breeze, but for anyone not having technical knowledge, it may take a lot of time spent reading manuals. If you think you might have trouble learning how to utilize a smart home device, the response may be easy. Request for help! Asking someone to show you how to run your smart home can far less puzzling than trying to make heads or tails of an instruction manual.

### 3. Reliability

A smart home will be tremendously dependent on your internet connection. If your connection drops you'll be left with a lot of smart products that would not work. Furthermore, wireless signals can possibly be interrupted by other electronics in your home and cause several of your smart products to function slowly or not at all. There are plenty of pros and cons to reflect when determining whether you'd like to convert your home into a smart home. Smart homes aren't for everyone. They can help simplify your daily tasks, bring down your electricity bills and help to give you a feeling of safety. But for specific people smart home product will simply turn into an economic burden. It's ultimately up to you to decide which category you fall into.

## V. CONCLUSION

Smart homes have proven to work satisfactorily by connecting simple appliances to it and the equipment's were effectively controlled remotely through internet. Both the Technologies GSM, Cloud can be used for home automation which are unique in their own way. Based on the need of the application we can choose either of them.

Cloud-based technology stores the sensor parameters in the cloud in a timely manner. This will help the user to examine the state of various restrictions in the home anytime, anywhere while GSM makes use of messages to communicate with remote devices through an IoT agent, which reduces user's burden.

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