

# Smart Home – Current Perspective

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**Abstract:-** To design a Smart Home system, work is to be done on three layers of its architecture: physical layer, network layer and application layer. This paper covers functioning done at each layer and process of designing the system. First part is physical layer comprising of all main sensors required to build the system. Second Part is about network layer and the technologies possible at this layer like: Zigbee, Z-Wave, Wi-Fi, Bluetooth, X10, Insteon. And third part covers about available tools to develop various apps. This papers covers design process of a home automation system.

Key-words: Zigbee, sensors, Z-wave, OpenHAB.

## Introduction

Smart home is a dwelling equipped with many IoT enabled devices. Smart home is an intelligent environment which can adjust according to its owner's requirements[1]. Iot based architecture is primarily based upon layered architecture comprising of: sensing layer, network layer and application layer. As depicted in Fig 1.

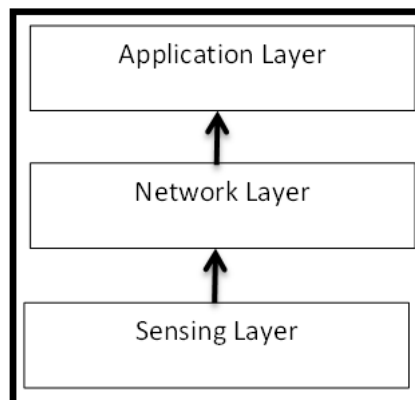


Fig.1 Layered Architecture of Smart Home [2]

To develop a smart home system we are to work at these three layers.

### A. Sensing layer

Sensing layer has all the sensors and actuators of the system. Many commonly used sensors are: smoke sensors, water sensors, motion sensor, window/door opener sensor, smart thermostat, video doorbell etc. [3][4].

Various sensors commonly used in Smart home.

1. PIR Motion Sensor

Motion sensor detects motion in approx. 10 m range. Generally its range is between 5m to 12m. It is based on infrared radiations. Motion sensor can be used in parking area, garden lights, staircase, lift lobby. It requires 5V for its functioning[5].



Fig 2. Motion Sensor

2. Window/ Door open sensor

In the market many type of window door sensors are available having versatile features. Some sensors are capable to fire an alarm when somebody opens the door and window. And many are capable to send alerts on phones about the status of door or window. They can be included as a part to existing security system.

3. Gas sensors

Gas sensors are available to check presence of toxic gases like methane, ethane, LPG, smoke and many more. To detect a particular gas its relevant detector is required. In our household we use LPG, so we can apply LPG sensor to detect its leakage. Other gas sensors which can detect smoke and other poisonous gases can also be applied. Now a days, air pollution is also a great concern. Gas sensors can also be applied to check air quality and accordingly air purifier could be instructed.



Fig 3. Gas Sensor

4. Temperature Sensors

Temperature sensor reads hotness and coldness of the environment. And that can be further used to operate air conditioners or heaters. In extreme weather areas for comfortable living, a comfortable temperature is must. So without temperature sensor, home automation could not be complete.

5. Humidity Sensors

Humidity Sensors are also important in home automation, as it tells about moisture level in the air. It is an important part of HVAC system (i.e. heating, Ventilating and air conditioning systems). It is a part of cars as well as home automation.



Fig 4. Humidity Sensor

#### 6. Water Sensor and water level sensor

Water sensor is used to detect water leakages. Water level sensor used to detect level of water in a reservoir. Both sensors are important as water leakages can really create problem in a home.

#### 7. Smart Doorbell

Smart doorbell is an advanced version of motion sensor. Many versions are available, some starts playing video if any motion is detected. Even alerts can be send and home owner can take desired steps on the provided information.

#### 8. Weather Sensor

Weather sensors can really help when work with collaboration of another sensors. Like alters can be given to take an umbrella, if there will be forecast of rain. It can provide alerts about opened door and windows, if strong wind is possible.

#### 9. Soil Moisture Sensor

This sensor can help to tell need of water in gardens by sensing moisture level of soil. They can be combined with taps. So that smart watering can be done to plants or they can be used to give alerts for the need of watering.

There is long list of available sensors for smart home, widely used sensors are discussed as above.

## B. Network Layer

Second layer of smart home architecture is network layer. And for network layer many protocols are available like : Zigbee, Z-Wave, Wi-fi, Bluetooth etc. Detail description of the following technologies are :

### 1. Zigbee

Zigbee is a wireless protocol (IEEE 802.15 standard) and similar to Bluetooth and wi-fi [13]. Zigbee has layered architecture of four layers: Physical layer, Medium Access Control Layer, network layer and application layer. Useful for low range devices as it is based on mesh topology. Zigbee has range from 10-100 m. Terminals of Zigbee can be characterized as: coordinator, router and end device[14]. It uses 128 bit AES encryption system [15]. It offers security but security needs has to be compared with its provisions. Its Versions are backward compatible and to provide compatibility compromises are to be done. Network size could be of 64000 [16]. Three possible data rates are there (20 Kb/s, 40 Kb/s, 250 Kb/s) [16]. Interoperability is a hurdle for this, before integrating a new device its compatibility has to be checked. This can work with three frequency bands (2.4 GHz, 915 MHz, 868 MHz) [16]. Reliability features are also added into this but not full proof.

### 2. Z-Wave

Z-wave is a wireless, low cost and mesh based protocol which is mainly used for home automation. Its architecture has four layers: transfer layer, MAC layer, Routing Layer and Application Layer[17]. Its layered structure is described in Fig. 5

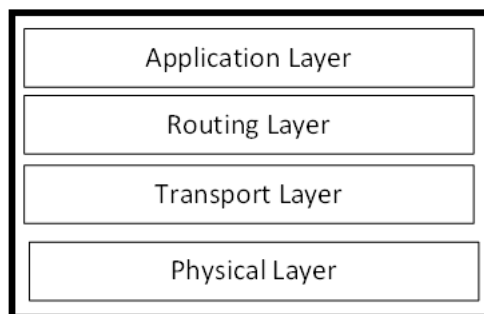


Fig 5. Layered Structure of Z-Wave[18]

Z-wave comprises of two types of nodes: controllers and slaves. Thinkable data rates are 9.6 Kbps, 40 Kbps and 200Kbps [16]. For security it has 128 bit AES encryption. For reliability eight bit CRC is there [17]. For providing interoperability special version has been introduced. A smart home network can have 232 different devices in this network[19]. Its range is around 100 meters. Main advantage is low cost and lesser energy is required. Home automation is its main area.

### 3. *X10*

Initially X10 was a wired network which is advanced to wireless. X10 is a slow protocol as equated to other protocols. It provides limited functions. No security measures have been taken. Signal interference and loss in signal strength are the major issues. No measures taken for security and privacy.

### 4. *Insteon*

Insteon protocol is based on dual mesh topology. Every node act as peer in the insteon network and any node can transfer data. Data rate of insteon is 38.4 Kbps[20] and range is limited. 256 nodes are being supported. Reliability mechanisms have been engaged by eight bit checksum. Public key encryption is being maintained, so while installing a automation system, security requirements are to be examined properly[21]. Insteon is based on radio frequency as well as wired system. It works on 904 MHz.

### 5. *Bluetooth*

Bluetooth is IEEE 802.15.1, radio frequency based protocol. It works on 2.4 GHz[24]. Range of Bluetooth is of 10 m. Bluetooth provides security with authorization. Latest version of Bluetooth like BLE (Bluetooth low energy) needs lesser power to operate. Even enhanced security features like AES has been included[25].

In Table I these protocols (Zigbee, Z-Wave, Insteon, X10, Bluetooth) has been compared on the parameters of security, interoperability, power requirement, range and no of node supported. Currently Z-wave and Zigbee is widely used for home automation. comparison of various Technologies

	Security	Interoperability	Nodes	Range	Power Requirement
Zigbee	AES	Backward compatibility is there but not fully interoperable	64000	10-100 mtrs	Low

Z-Wave	128 bit AES	For interoperability, measures has been taken	232	100 mtrs	Low
Insteon	Public Key	Yes	256	45	Low
X10	No	No	Limited	Limited	More
Bluetooth	Yes	Yes	8	10	Low of BLE

TABLE I

### C. Application Layer

For developing applications for smart home many tools are available like: MIT App Inventor, Node Red, OpenHAB, Home Assistant etc.

1. MIT App Inventor: it is an open source, helpful in developing apps for smart home too. It is having many inbuilt facilities like Bluetooth, wi-fi. It is a graphical tool which can really help to develop an App. Initially this is a project of Google and later on managed by MIT.
2. Node RED : An Open source, really help to connect IoT devices. It is a visual tool capable of connecting devices, APIs, and services. It is a product of IBM.
3. OpenHAB : is a java based open platform to develop smart home applications. Many vendors are covered.
4. Home Assistant: A platform which is open source and platform to have solutions of Home Automation.

### Conclusion

This paper covers all the three layers to develop a smart home system. To design a smart home firstly we are to be clear about which devices we want to make smart for that an analysis of requirements is to be done. Accordingly sensors are to be picked. Afterwards their communication protocol(s) are to be decided by checking the requirements. Then an interface is required (App or web interface) to operate the devices. This paper covers requirements of all the layers and subsequently help in developing a smart home system.

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