

Advancements in IoT – A step towards Smart Cities and Smart Homes

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Abstract - The advancement in IoT has led a big step towards the smart cities and smart homes. A Smart City is an urban system that uses different collection methodologies to extract information which is used for efficient management of resources and to provide better services to the people in many prospects like power supply management, water supply management, medical facilities, etc. A Smart Home is a term used for home that uses minimum resources and provides cost efficient and productive environment with better facilities. This paper describes the contribution of IoT and challenges faced in the development of Smart Cities and Smart Homes and how the advancements in IoT have made this development possible.

I. Introduction

Internet of Things is a technology that is used to provide smarter and efficient services to the people by connecting the devices to the internet and enabling them to share the information. IoT is an emerging field and according to some prediction reports there will be \$457 billion annual global market for IoT by 2020 with approximately 40% share of Smart Cities and Smart Homes.

As the lifestyle of people is changing and there is an improvement in the living standards, the need and demand for Smart Cities and Smart Homes is increasing. The advancements in the IoT have made it

possible to develop such cities and homes. A smart city is an urban system that uses different collection methodologies to extract information which is used for efficient management of resources and to provide better services to the people in many prospects. The services may include waste management, power supply management, water supply management, medical facilities, law enforcement, transportation facilities, and education. The Smart Cities use Information and Communication Technology (ICT). ICT is a technology which integrates the telecommunication devices, computers, middleware, enterprise software, audio visual systems and databases to enable the users to access, transmit, store and manipulate the information. This provides an efficient system with enhanced quality and performance and also a more interactive environment for the people. The Smart City applications are being developed to provide real time services and responses. The smart sensors are used to collect the information from the people, assets and devices that is analyzed and processed to manage different services.

Smart Homes have intelligent networking device infrastructure and seamless integration of wired/wireless devices which

eases the household system usage. Smart Homes use minimum resources and provides cost efficient and productive environment with better facilities. Smart Homes also optimize the services and management. In Smart Homes, the devices are connected with each other using a network called Home Area Network (HAN). These devices may include smart TVs, printers, smart locks, humidity and temperature sensors, etc. All are connected to a network and provide optimized and enhanced functioning due to their ability to interact. This concept is called Home Automation.

II. Smart Cities

A smart city is an urban system that uses different collection methodologies to extract information which is used for efficient management of resources and to provide better services to the people in many prospects. The advancements in the IoT have made it possible to develop such cities. The services may include waste management, power supply management, water supply management, medical facilities, law enforcement, transportation facilities, and education. The Smart City applications are being developed to provide real time services and responses. The smart sensors are used to collect the information from the people, assets and devices that is analyzed and processed to manage different services.

a. Focus Areas of Smart Cities

To develop a Smart City, there are several fields that need to be focused on. These are:

Smart Homes: For providing facilities like health monitoring, conservation of resources, enhanced security and safety for the residents.

Smart Parking Lots: It helps in detecting vacant slots, auto routing of the vehicles in the parking lots, etc.

Smart Vehicles: For providing assistance to drivers during low visibility or bad weather, identifying the driving under influence of substances, detecting bad driving patterns, generating auto alert signals during crashes.

Smart Health: For availing cheaper and remote diagnosis and check-ups and on-body sensors for accurate and effortless health monitoring. Generating auto alerts in case of some medical emergency like seizures, heart attacks, etc.

Smart Energy: For proper allocation and distribution of energy and smart metering systems.

Pollution Monitoring: For monitoring pollution levels due to human activities and natural calamities.

Smart Agriculture: For monitoring crops health status and detecting crop infection. Automating the machines used in agriculture.

b. Challenges for IoT in Smart Cities

Heterogeneity: It includes integration of varying hardware platforms and specifications, integration of various software platforms and also radio specifications.

Security and Privacy: Securing from attacks or any other vulnerabilities, reducing the risk of data leakage.

Reliability: Device and sensor failure is a significant issue in establishing Smart Networks. Also there is a lack of reliable communication due to vehicle mobility.

Scaling: Deployment of devices is complex when is on large scale and causes unnecessary delay. Monitoring also becomes complex on large scale.

Legal Issues: Legal issues may be faced during implementation as the user provided information may subject to local or international laws.

Big Data: It is very expensive to store, transfer and maintain large volumes of data. Data filtering, sorting and processing is intensive and complex.

Sensor Networks: Selection of appropriate sensor for a particular task is very crucial. Proper planning of energy consumed by the sensors is very important. Proper placement of devices and network architecture is important for reliable implementation.

Data Handling: It is very difficult to handle and maintain enormous volumes of data that is produced in a smart city daily. Quality, precision and accuracy are also one of the major challenges faced in smart cities. Data Fusion enables optimum utilization of the large volumes of data collected.

c. Information and Communication Technology (ICT)

ICT is a technology which integrates the telecommunication devices, computers, middleware, enterprise software, audio visual systems and databases to enable the users to access, transmit, store and manipulate the information. This provides an efficient system with enhanced quality and performance and also a more interactive environment for the people. The Smart City applications are being developed to provide real time services and responses. The smart sensors are used to collect the information from the people, assets and devices that is analyzed and processed to manage different services.

ICT focuses on designing the applications and user interfaces which are user friendly and easier to understand. It also ensures interoperability, standardization and flexibility. It also focuses on cost effectiveness of the system making it efficient.

D. ICT Architecture

ICT has a seven layer architecture. These layers include Access Layer, Security Layer, Application & Intelligence Layer, Data Layer, IoT/M2M Layer, Communication Layer and Instrumentation Layer. Access Layer provides multichannel access to the stake holders (businesses, citizens & city management). Security Layer provides comprehensive security framework, policies and standards. Application Layer avails the applications to enable smart city domains like energy, water transportation, etc. Data Layer provides data management capability, analytics, dash boarding etc. IoT layer

provides device management, connectivity, sensor management and enables to manage, monitor and control the connected sensors and devices. Communication Layer provides the connectivity medium. This medium can be wired or wireless like Wi-Fi, GSM, GPRS, etc. Instrumentation Layer consists of the devices, sensors, controllers, etc.

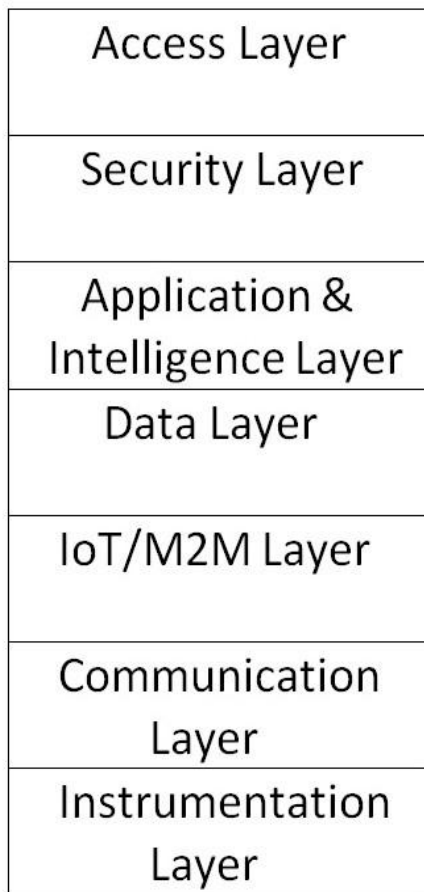


Figure: ICT Architecture

III. Smart Homes

A Smart Home is a term used for home that uses minimum resources and provides cost efficient and productive environment with better facilities. Smart Homes have

intelligent networking device infrastructure and seamless integration of wired/wireless devices which eases the household system usage. Smart Homes use minimum resources and provides cost efficient and productive environment with better facilities. Smart Homes also optimize the services and management. In Smart Homes, the devices are connected with each other using a network called Home Area Network (HAN). These devices may include smart TVs, printers, smart locks, humidity and temperature sensors, etc. All are connected to a network and provide optimized and enhanced functioning due to their ability to interact. This concept is called Home Automation. Many corporations like GE, Google, Cisco, etc. are indulging in developing smart home systems.

- a. Home Area Network (HAN)

The Home Area Network enables remote access and devices and systems and provides integration of various systems like communication, security system, etc.

- b. HAN Elements

There are three elements in a home area network. This includes Internet Protocol (IP), wired HAN and wireless HAN. The Internet Protocol is a multiprotocol gateway that bridges non IP networks to the IP networks. Wired HAN includes the usage of coaxial cables, power lines, optical fibers, telephone lines and other technologies to connect the devices. Its integration with the existing house architecture is easy and thus is low in cost.

Wireless HAN on the other hand uses now technologies like Wi-Fi, 6LoWPAN, ZigBee and others. It is also easy to implement.

c. HAN Standards

UPnP (Universal Plug and Play) is one of the HAN standards. It is an application layer technology and is mainly web-based. It provides support for automatic discovery and zero-configuration networking and has transparent networking. DLNA (Digital Living Network Alliance) is another HAN standard. It is a trade organization created by Microsoft, Intel and Sony. It connects cable based networks with wireless networks to increase the sharing of media, control and access. Another HAN standard is Konnex which is an open standard used for home and building networks. It uses coaxial cables, twisted pair cables, power lines, etc. LonWorks (Local Operation Networks) is also a HAN standard which is used handle control applications. In it each device consists of a neuron chip which is a SoC (System on Chip) containing RAM, ROM, multiple microprocessors and IO interface ports. It divides the device groups into intelligent elements, which then communicate through a physical medium. ZigBee is also a HAN standard which is used for low data rate WPAN (Wireless Personal Area Network) and low cost. It includes four layers-Physical Layer, MAC (Media Access Control), Network Layer and Application Layer. ZigBee is used in wireless sensor networks using mesh topology. HAN standards also include X-10. It defines transmission procedures for bits over the AC carrier signals. It also enables the remote control of the complaint transmitters and receivers over the power lines in homes. It is used when low data rate and low speed in required. It is also used in security sensors and appliance networks.

d. HAN Architecture

HAN has two architectures-DomoNet and Jini. DomoNet uses XML (Extensible Markup Language) for web services

control. It follows a SOA (Service Oriented Architecture). It is platform and well as language independent. It is a central gateway to connect with different technologies. Jini connects different devices that share their resources with auto installation and auto configuration. It is based on JAVA environment and thus Jini apps use bytecode to run JVM and are portable. It follows the Object Oriented Paradigm. Jini provides an organized distribution system which does not have a central node.

e. HAN Initiatives

Project Hydra: Project Hydra is a middleware that allows the developers to integratedifferent physical devices to their applications by providing easy to use web interface to control various devices irrespective of the communication technology like Bluetooth, WiFi, RF, ZigBee, etc. It connects a Service Oriented Architecture Network.

Amigo: Amigo is also a middleware used for embedded intelligent systems. It is also used for home network systems. It has a friendly user interface and interoperability. It provides the feature of automatic discovery of devices and services.

IV. Conclusion

In the development of smart cities there are several areas which must be focused in order to successfully implement the concept of 'Smart City' which use the IoT based devices and sensors in the different areas.

Smart Cities are the urban systems that use different methodologies to obtain information and analyze it to give some useful results. Smart Cities must aim for efficient use of resources and to provide better services to the citizens in multiple prospects. These services may include waste management, power supply management, water supply management, medical facilities, law enforcement, transportation facilities, and education. The ICT (Information and Communication Technology) is used in the Smart Cities to integrate computers, middleware, telecommunication devices, databases, enterprise systems, audio visual systems, etc. There is a need to develop systems that must provide real time responses and services. The applications and concepts involved in ICT are evolving constantly on daily basis. There are various areas that must be focused in order to develop a smart city. This includes Smart Homes, Smart Parking Lots, Smart Health, Smart Vehicles, Smart Energy, Pollution Monitoring and Smart Agriculture. There are various challenges that may arise in the development of a smart city. This includes Heterogeneity, Privacy & Security, Reliability, Scaling, Legal Issues, Big Data, Sensor Networks and Data Handling.

Smart Homes have an intelligent networking device infrastructure and seamless integration of wired/wireless devices which eases the household system usage. Smart Homes also optimize the services and management. Smart Homes use minimum resources and provides cost efficient and productive environment with

better facilities. The Home Area Network enables remote access and devices and systems and provides integration of various systems like communication, security system, etc. HAN uses both wired and wireless technologies to communicate. The wired technologies include coaxial cables, power lines, optical fibers, telephone lines, etc. The wireless technologies include the usage of Wi-Fi, 6LoWPAN, ZigBee and others. All are connected to a network and provide optimized and enhanced functioning due to their ability to interact. This concept is called Home Automation. Many corporations like GE, Google, Cisco, etc. are indulging in developing smart home systems. There are a few HAN initiatives that have been taken to develop Smart Homes- Project Hydra and Amigo.

Smart Cities are the future of the modern cities and so does the Smart Homes. All the prospects and areas must be focused in order to develop them. Smart Cities and Smart Homes provide new opportunities for employment and also enhance the standard of living. In the near future, the Smart Cities and Smart Homes will be the inseparable part of the modern society.

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