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Internet of Things Architecture and Applications : A Overview

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Abstract— Internet of Things (IoT) refers to objects that have unique identities and are connected to the internet. While many existing devices, such as networked computers or 4G-enabled mobile phones, already have some form of unique identities and are also connected to internet. Internet of Things is a new revolution of the internet that is rapidly gathering momentum driven by the advancement in sensor networks, mobile devices, wireless communications, networking and cloud technologies. Experts forecast that in future there will be all devices/ things connected to internet. The aim of the Internet of Things (IoT) is to enable things to be connected anytime, anyplace with anything. The IoT is comprised of smart machines interacting and communicating with other machines, environments and infrastructures. As a result, huge volumes of data are being generated, and that data is being processed into useful actions that can make our lives much easier and safer and to reduce our impact on the environment. Internet of Things architecture is capable enough to improve the understanding of related tool, technology, and methodology to facilitate developer's requirements. Various applications of IoT have been developed and researchers of IoT identified the opportunities and challenges used in IoT such as sensors, actuators, mobile phones. In this paper we discussed IoT, its architecture, and applications of IoT. The creativity of this new era is unlimited, with amazing potential to improve our lives. The following paper is an extensive reference to the utility, applications and an evolution of the Internet of Things.

Keywords— Internet of Things (IoT), Layered Architecture, Sensors & Actuators

I. INTRODUCTION

The Internet of Things(IoT) is a network of connected devices which communicate and interact over the Internet, and they do so autonomously, machine to machine, without the need for human intervention.

Smart System and the Internet of the Things can be developed with the combination of:

1. Sensors & Actuators
2. Connectivity
3. People & Process

Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts. IoT is a conceptual framework. Enabling connectivity using Internet of things in devices. Today, some of the devices are connected but not all. Not only machine-to-machine (M2M) also machine-to-people, people-to-machine, machine-to-objects, people-to-objects. Creates the ability to collect data from these devices.Data can be accessed using IoT, It can be used to provide unique value propositions and create complex information systems which are greater than the sum of the individual components. Using the cloud and analyzed using "big data" techniques.

II. IoT Definitions

• The Internet of Things, also called The Internet of Objects, refers to a wireless network between objects, usually the network will be wireless and self-configuring, such as household appliances. (Wikipedia)

• The term "Internet of Things" has come to describe a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects. (IoT 2008)

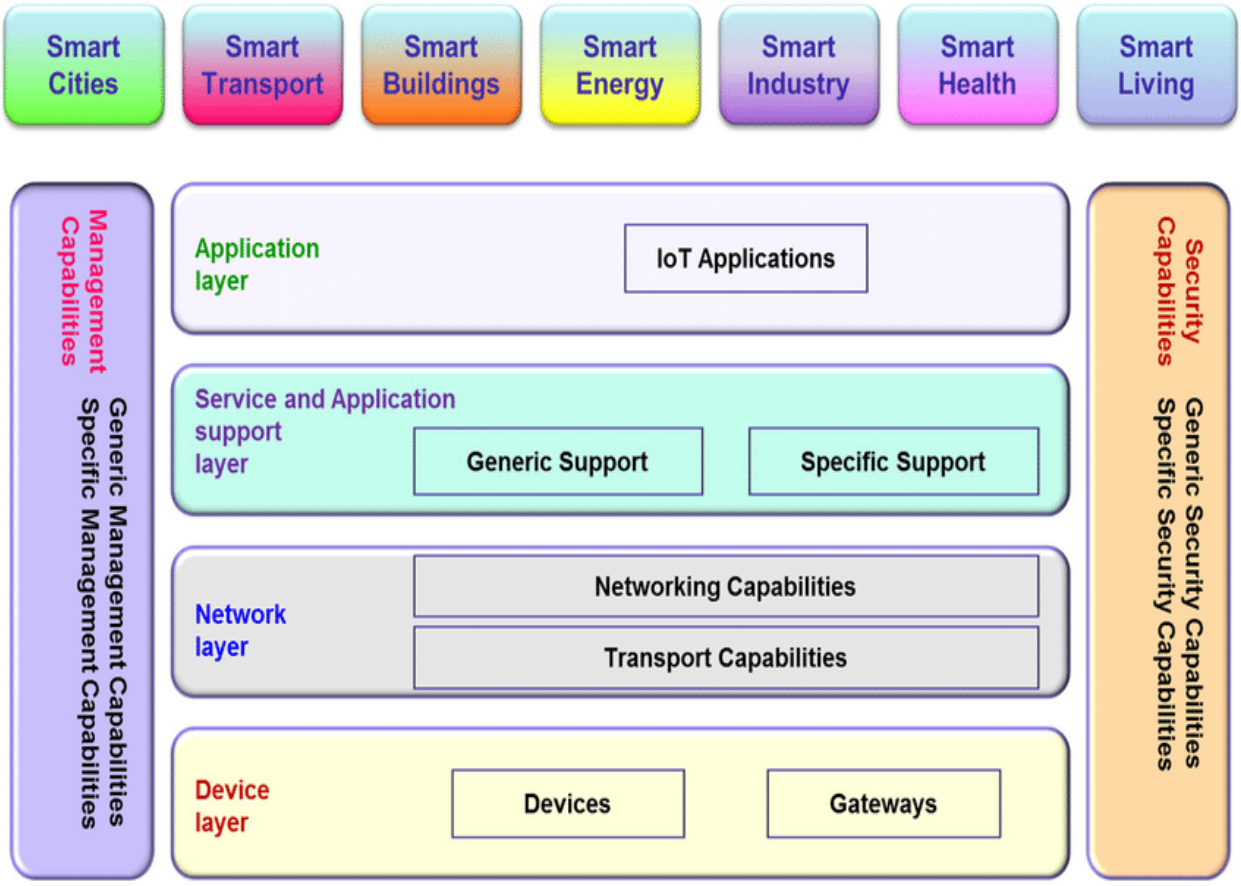
• "Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts". (IoT in 2020)

Rest of the paper is organized as follows, Section I contains the introduction of IoT , Section II contain the related work of architecture of IoT, Section III contain the applications of

IoT, Section IV contain the conclusion of IoT and future directions.

III. ARCHITECTURE

In Fig.1 , the internet of things layered architecture is illustrated as supposed by the ITU-T (International Telecommunications Union - Telecommunication Standardization Sector) and is composed of four layers; the first layer is the IOT application layer which contains the application user interface, the second layer is the services and application support layer, the third layer is the network layer which contains the networking and transport capabilities, the bottom layer is the device layer, which contains the gateways and the hardware and sensors and RFID tags and others. Along the four layers, the security and management capabilities and functions are distributed.



The internet of things is a universal concept and it is defined in a common way. IoT has the huge background and various required technologies, from sensing device, communication systems, data aggregation and pre-processing to the object instantiation and finally service provision'. "Internet of things (IoT): A global infrastructure for the information society, enabling advanced services by interconnecting things. based on existing interoperable information technologies". Utilizing IoT by identification, data capture, processing and communication capability, the IoT makes full use of things to offer services to all kinds of applications. Ensuring that security and privacy requirements are fulfilled. The IoT has a vision with technological and societal implications." The IoT as "dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where objects have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network.

IV. Applications of IoT

1 Home

Smart Lighting

Smart lighting is lighting that you can control from an app, usually on your Android phone. The mobile application enables you to change the brightness of the bulbs and if the bulbs have colored LEDs you can change their colors too. Smart lighting uses mesh networking, where each smart bulb wirelessly connects to its nearest device. That network is controlled by a hub that plugs into router, it enables other networked devices - such as phone or tablet - to communicate with your bulbs. Smart appliances Generally,

the term "Smart Appliances" defines the automation in a home appliances, in which single components are networked together in order to form an intelligent system. For example, during heating, the current temperature of every room is an essential for the individual room temperature control. The sensors along with the set values predefined by the user and transmit appropriate commands to fitting actuators, such as lamps or radiator valves. Connection between individual components combined with intelligent control increases comfort, saves energy and ensures more safety in the house. Control can be handled over mobile devices such as smart-phones or tablets. At the same time, the user is also able to change settings through more classical means, for instance light switches, or through a remote control.

Intrusion detection

An intrusion detection system use security cameras and sensors (such as PIR sensors and Door sensors) to detect intrusions and raise alerts. Alerts can be in the form of SMS or an email sent the user. Advance system can even send detailed alerts such as an Image grab or a short video clip sent as an email attachment. A cloud controlled intrusion detection system uses location aware services, where the Geo-Location of each node is independently detected and stored in the cloud. In the event of intrusions, the cloud services alert the accurate neighbors or local police. The system uses Image Processing to recognize the intrusion and extract the intrusion subject and generate Universal-Plug-and-Play instant messaging for alert.

Smoke/Gas detectors

The use of fire and smoke detection systems results in reduction in fire deaths. As soon as a fire is detected, the better the outcome for saving lives. smoke detectors prevents unwanted nuisance alarms.

***2*. Cities**

Smart city is another powerful application of IoT. Efficient water supply, solution to traffic congestion, reliable public transportation, Energy-efficient buildings, public safety, Smart surveillance, smarter energy management systems and environmental monitoring all are examples of internet of things applications for smart cities. Using IoT major problems faced by the people living in cities can be solved such as pollution, traffic congestion and shortage of energy supplies etc. By installing sensors and using web applications, citizens can find free available parking slots across the city.

Smart Parking

Finding a parking space during rush hours in crowded cities can be time consuming and frustrating. Drivers blindly searching for parking spaces create additional traffic congestion. Smart parking make the search for parking space easier and convenient for drivers. Smart parking are powered by IoT systems that detect the number of empty parking slots and send the information over the internet to smart parking application back-ends. These applications can be accessed by the drivers from smart phones, tablets and in car navigation systems. In smart parking, sensors are used for each parking slot, to detect whether the slot is empty or occupied.

Smart Roads

Smart roads also known as smart highways. Smart Road is used to describe roads that use sensors and IoT technology which makes driving safer and greener. Without Smart roads Smart cities and self-driven cars would not be possible. Smart roads can provide real-time information to drivers. It provides information about weather conditions such as traffic information, congestion and parking availability. Smart roads are particularly useful on risky roads to make driving safer by warning about incoming traffic or landslides. Smart roads can also generate energy to use for street lights or to charge electric vehicles.

Structural Health Monitoring

Structural Health Monitoring systems use a network of sensors to monitor the vibration levels in the structures such as bridges and buildings. The data collected from these sensors is analyzed to assess the health of structures. By analyzing the data it is possible to detect cracks and mechanical break downs, locate the damages to a structure and also calculate the remaining life of the structure.

Emergency Response

IoT systems can be used for monitoring the critical infrastructure in cities such as buildings, gas and water pipelines, public transport and power substations. IoT systems for fire detection, gas and water leakage detection can help in generating alerts and minimizing their effects on the critical infrastructure. IoT systems for critical infrastructure monitoring enable aggregation and sharing of information collected from large number of sensors.

Environment Whether Monitoring

IoT based Weather monitoring systems can collect data from a number of sensors attached such as temperature, humidity, pressure etc and send the data to cloud-based applications and storage back-ends. The data collected in the cloud can then we analyzed and visualized by cloud based applications. Weather alerts can be sent to the subscribed users from such applications.

Air Pollution Monitoring

IoT Based Air Pollution Monitoring System can monitor emission of harmful gases (CO2 , CO, NO, NO2 , etc) by factories and automobiles using gaseous and meteorological sensors. The collected data can be analyzed to make informed decisions on pollutions control approaches. In a real-time air quality monitoring system is presented that comprises of several distributed monitoring stations that

communicate via wireless with back-end server using machine-to-machine communication.

Noise pollution Monitoring

Noise levels in cities are increased due to growing urban development. Noise pollution can cause health hazards for humans due to sleep disruption and stress. Noise pollution monitoring can help in generating noise maps for cities. Urban noise maps can help the policy makers in urban planning and making policies to control noise levels near residential areas, schools and parks. Iot based Noise pollution monitoring systems use a number of noise monitoring stations that are deployed at different places in a city. The data on noise levels is collected on servers or in the cloud. The collected data is then aggregated to generate noise maps.Sound pollution monitoring system that allows us to monitor and check live sound pollution in particular areas through IOT. System uses air sensors to sense presence of harmful gases in the air and transmit this data to microcontroller. Also system keeps measuring sound level and reports it to the online server over IOT. The sensors interact with microcontroller which processes this data and transmits it over internet. This allows authorities to monitor air pollution and take appropriate measures against it.

Forest Fire Detection

It has been found in a survey that 80% losses caused due to fire would have been kept away from if the fire was identified promptly. It uses a temperature sensor, a smoke sensor and signal. The temperature sensor detects the warmth and smoke sensor detects any smoke produced because of consuming or fire. buzzer associated with gives us an alert sign. At whatever level fire activated, it consumes protests adjacent and produces smoke. Candlelight or oil lights utilized as a part of a family which produces little smoke. Similarly, at whatever level warm force is high then additionally the alert goes on. Alert is stops at whatever level the temperature goes to ordinary room temperature and smoke level decreases.

Energy Smart Grids

Smart grid is a data communication network integrated with the electrical grid that collects and analyzes data captured in near-real-time about power transmission, distribution and consumption.Smart grids collect data regarding electricity generation, consumption, storage, distribution and equipment health data. Smart grid uses high-speed, fully integrated, two-way communication technologies for real time information and power exchange between service provider and consumer. Smart Grids employ various devices for the monitoring, analysis and control of the grid, deployed at power plants, distribution centers and in consumers' premises in a very large number. Hence, a Smart Grid requires connectivity, automation and the tracking of such devices. This is achieved with the help of Internet of Things (IoT).

Renewable Energy Systems

Renewable energy grow at a faster rate during this period. The Renewable energy system refers to the online display of the power usage of solar energy as a renewable energy. This monitoring is done through flask framework. Smart Monitoring displays daily usage of renewable energy. This helps the user to analysis of energy usage. That analysis impacts on the renewable energy usage and electricity issues.

Prognostics

Energy systems (smart grids, power plants, wind turbine, for instance) have a large number of critical components that must function correctly so that the system can perform their operations correctly. For example , a wind turbine has a number of critical components ,like bearing ,turning gears, for instance ,that must be monitored as wear and tear in such critical components or sudden change in operating conditions of the machines can result in failure .It is also used in health management system, power grid management system etc.

Retail Inventory Management

Inventory management for retail has become increasingly important in the recent years with the growing competition. While over-stocking of products can result in additional storage expenses and risk, under –stocking of products can lead to loss of revenue. Cloud-based inventory management systems are able to track items in real-time.IOT systems using Radio Frequency Identification (RFID)tags can help in inventory management and maintaining the right inventory levels. These tags can be scanned and identified by the system. It gives all information about product such as expiration dates, product location, and more. With the IoT, the ability to track and communicate with products will greatly increase. For example, RFID tags will hold more info about an object, and communicate that to an inventory system. Built-in RFID tags can send information about temperature, weather, damage to the object, traffic, etc. Built-in GPS location gives you to know exactly where every item is. Every object have its own unique identifier. So we are able to keep track on each and every item. Using IOT you know which product are less/many in stock ,Which products are have great sale in which area.

Smart Payments

Smart Payment solution such as contact-less payments powered by technologies such as Near Field Communication (NFC) and Bluetooth. Near Field Communication (NFC) is a set of standards for smart phones and other devices to communicate with each other by bringing them into proximity or by touching them. Customers can store the credit card information in their NFC-enabled smart phones and make payments by bringing the smart phones near the point of cell terminals.

Smart Vending Machines

Smart Vending Machines connected to the internet allow remote monitoring of inventory levels, elastic pricing of products , promotions, and contact-less payments using NFC. Smart phone applications that communicate with smart vending machines allow user preferences to be remembered and learned with time .When a user moves from one vending machine to the other and pairs the smart-phone with the vending machine, a user specific interface is presented. Users can save their preferences and favorite products.

3 Logistics

Route Generation and Scheduling

Modern transportation systems are driven by data collected from multiple sources which is processes to provide new services to the stakeholders. By collecting large amount of data from various sources and processing the data into useful information, data-driven transportation systems can provide new services such as advanced route guidance, dynamic vehicle routing, anticipating customer demands for pickup and delivery problem, for instance. Route generation and scheduling systems can generate end-to-end routes using combination of route patterns and transportation modes and feasible schedules based on the availability of vehicle.

Fleet Tracking

The IoT Platform is a fast and reliable way to make Fleet tracking. Vehicle fleet tracking systems use GPS technology to track the location of the vehicle in real-time. Cloud-based fleet tracking systems can be scaled up on demand to handle large number of vehicle. Alerts can be generated in case of deviation in planned routes. The vehicle location and route data can be aggregated and analyzed for detecting bottlenecks in the supply chain such as traffic congestions on routes, assignments and generation of alternative routes, and supply chain optimization. It avoids the unexpected accidents. Fleet tracking is also used to track - sensors, items, containers, equipment, vehicles - so that the entire logistics infrastructure can be tracked and managed as a consolidated business unit.

Shipment monitoring

Shipment monitoring Solutions for transportation systems allow monitoring the conditions inside containers for example containers carrying fresh food produce can be monitored to prevent spoilage of food. IoT based shipment monitoring systems use sensors such as temperature, pressure, humidity, for instance, to monitor the conditions inside the containers and send the data to the cloud, where it can be analyzed to detect food spoilage.

Remote Vehicle Diagnostics

Remote Vehicle Diagnostics monitors the health of the vehicle, find the problem / failure and provides real time information of vehicle parameters to assess its performance against benchmarks. The solution monitors the health of the electric vehicle, commercial vehicle, utility vehicle and provides insight to field support staff to determine the root cause of the problem. It also enables the customers to access information about the vehicle. Commercial / Utility vehicles being driven across the country extensively over time for various purposes are in need of a diagnostic check which is automated through the offering. These services relate specifically to the operation of the vehicle. The key applications are remote diagnostics and remote door unlock. Remote access to vehicle information on performance, component reliability, fuel economy, and other variables should yield important data for new product development.

4 Agriculture

Smart Irrigation

Smart irrigation systems can improve crop yields while saving water. Smart irrigation systems use IoT devices with soil moisture sensors to determine the amount of moisture in the soil and release the flow of water through the irrigation pipes only when the moisture levels go below a predefined threshold. Smart irrigation systems also collect moisture level measurements on a server or in the cloud where the collected data can be analyzed to plan watering Schedules.

Green House Control

The greenhouse industry is worldwide the fastest growing area. The greenhouse protect the crop from the environment, thus providing some way of shelter from the direct influence of the external weather conditions. The greenhouse permits the manipulation of the crop environment. Green houses are structures with glass or plastic roofs that provide conducive environment for growth of plants. The climatological conditions inside a green house can be monitored and controlled to provide the best conditions for growth of plants. The temperature, humidity, soil moisture, light and carbon dioxide levels are monitored using sensors and climatological conditions are controlled automatically using actuation devices. Various greenhouse automation equipment like computer software and sensors are connected and used to collect data in the greenhouse environment to boost crop yields.

5 Industry

Machine Diagnosis & Prognosis

Machine Prognosis refers to predicting the performance of a machine by analyzing the data on the current operating conditions and how much deviations exist from normal operating conditions. Machine diagnosis refers to determining the cause of a machine fault. IoT plays a major role in both Prognosis and Diagnosis of industrial machines. Indoor Air Quality Monitoring Indoor Air Quality IAQ refers to the good or bad contents of air inside a building, which can affect the occupant's health, physical reaction, comfort and work performance. Good IAQ is defined as the content of air contaminants in a building do not exceed certain level either in the form of chemical (gaseous), biological (mould, fungi or bacteria) or physical contaminants like dust. The level of contaminants that are allowed to be in the air is set by several authorities such as American Society of Heating, Refrigerating and Air Conditioning Engineers and Occupational Safety and Health Act.

6 Health and Lifestyle

Health and Fitness Monitoring

Health and Fitness Monitoring allows non-invasive and continuous monitoring of Physiological parameters using wearable devices. These wearable devices may can be in various forms such as belts and wrist-bands

Wearable Electronics

Wearable electronics such as wearable gadgets and fashion electronics provide various functions and features to assist us in our daily activities and making us lead healthy lifestyles. Smart Watches that run mobile operating systems provide enhanced functionality beyond just time keeping. With smart watches, the users can search the internet, play audio/video files, make calls, play games and use various kinds of mobile applications.

IV Conclusion and Future Scope

Internet of Things refers to physical and virtual objects that have unique identities and are connected to the internet. This allows the development of intelligent applications that make energy , logistics, industrial control, retail, agriculture and many other domains of human endeavour "smarter". we analyzed IoT domain by considering its architecture and applications. IoT allows different types of devices, appliances , users and machines to communicate and exchange data. Then applications of IoT span a wide range of domains including homes , cities , environment, energy systems, retail, logistics, industry, agriculture and health. IoT has several applications such as smart lighting that adapt the lighting to suit the conditions, smart appliances that can be remotely monitored and controlled, intrusion detection systems and smart smoke detectors. For cities, applications of IoT include smart parking systems that provide status updates on available slots , smart roads that provide information on driving conditions and structural health monitoring systems. For environment , we learned about IoT applications including weather monitoring , air and noise pollution, forest fire detection systems, This also covers IoT applications for energy systems including smart grids. In future applications generate much value to the end users and also provide new revenue opportunities to service and systems providers when integrated to rating, billing and financial applications.

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