



ORIGINAL RESEARCH PAPER

Computer Science

INTERNET OF THINGS (IOT): KEY FEATURES, TECHNOLOGY, PROTOCOLS & COMMON USES

KEY WORDS: IoT (Internet of Things), Sensors, RFID (radio-frequency identification), NFC (near-field communication), Wi-Fi-Direct.

Prof. Chandrakant R. Gujar

Assistant Professor, WKBSM Dr. Suryakanta R. Ajmera MCA College for Women Deopur Dhule Maharashtra India

ABSTRACT This Paper explains IoT primarily exploits standard protocols and networking technologies. However, the major enabling technologies and protocols of IoT are RFID, NFC, low-energy Bluetooth, low-energy wireless, low-energy radio protocols, LTE-A, and Wi-Fi-Direct. These technologies support the specific networking functionality needed in an IoT system in contrast to a standard uniform network of common systems. Also Explains IoT has applications across all industries and markets. It spans user groups from those who want to reduce energy use in their home to large organizations who want to streamline their operations. It proves not just useful, but nearly critical in many industries as technology advances and we move towards the advanced automation imagined in the distant future.

1. INTRODUCTION

IoT is network of interconnected computing devices which are embedded in everyday objects, enabling them to send and receive data.

IoT (Internet of Things) is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system.

IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment. They enhance data collection, automation, operations, and much more through smart devices and powerful enabling technology. [1]

Main components used in IOT:

Low-power embedded systems:

Less battery consumption, high performance are the inverse factors that play a significant role during the design of electronic systems.

Sensors :

Sensors are the major part of any IoT applications. It is a physical device that measures and detect certain physical quantity and convert it into signal which can be provide as an input to processing or control unit for analysis purpose.

Control Units :

It is a unit of small computer on a single integrated circuit containing microprocessor or processing core, memory and programmable input/output devices/peripherals. It is responsible for major processing work of IoT devices and all logical operations are carried out here.

Cloud computing:

Data collected through IoT devices is massive and this data has to be stored on a reliable storage server. This is where cloud computing comes into play. The data is processed and learned, giving more room for us to discover where things like electrical faults/errors are within the system.

Availability of big data:

We know that IoT relies heavily on sensors, especially in real-time. As these electronic devices spread throughout every field, their usage is going to trigger a massive flux of big data.

Networking connection:

In order to communicate, internet connectivity is a must where each physical object is represented by an IP address. However, there are only a limited number of addresses

available according to the IP naming. Due to the growing number of devices, this naming system will not be feasible anymore. Therefore, researchers are looking for another alternative naming system to represent each physical object. [2]

There are two ways of building IoT:

1. Form a separate internetwork including only physical
2. Make the Internet ever more expansive, but this requires hard-core technologies such as rigorous cloud computing and rapid big data storage (expensive).

In the near future, IoT will become broader and more complex in terms of scope. It will change the world in terms of "anytime, anyplace, anything in connectivity."

IoT Enablers:

RFIDs:

uses radio waves in order to electronically track the tags attached to each physical object.

Sensors:

devices that are able to detect changes in an environment (ex: motion detectors).

Nanotechnology:

as the name suggests, these are extremely small devices with dimensions usually less than a hundred nanometers.

Smart networks: (ex: mesh topology).

1.1 IoT – Key Features

The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use. A brief review of these features is given below –

AI- IoT essentially makes virtually anything "smart", meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. This can mean something as simple as enhancing your refrigerator and cabinets to detect when milk and your favorite cereal run low, and to then place an order with your preferred grocer.

Connectivity –

New enabling technologies for networking, and specifically IoT networking, mean networks are no longer exclusively tied to major providers. Networks can exist on a much smaller and cheaper scale while still being practical. IoT creates these small networks between its system devices.

Sensors –

IoT loses its distinction without sensors. They act as defining

instruments which transform IoT from a standard passive network of devices into an active system capable of real-world integration.

Active Engagement –

Much of today's interaction with connected technology happens through passive engagement. IoT introduces a new paradigm for active content, product, or service engagement.

Small Devices –

Devices, as predicted, have become smaller, cheaper, and more powerful over time. IoT exploits purpose-built small devices to deliver its precision, scalability, and versatility.

IoT – Advantages

Improved Customer Engagement –

Current analytics suffer from blind-spots and significant flaws in accuracy; and as noted, engagement remains passive. IoT completely transforms this to achieve richer and more effective engagement with audiences.

Technology Optimization –

The same technologies and data which improve the customer experience also improve device use, and aid in more potent improvements to technology. IoT unlocks a world of critical functional and field data.

Reduced Waste –

IoT makes areas of improvement clear. Current analytics give us superficial insight, but IoT provides real-world information leading to more effective management of resources.

Enhanced Data Collection –

Modern data collection suffers from its limitations and its design for passive use. IoT breaks it out of those spaces, and places it exactly where humans really want to go to analyze our world. It allows an accurate picture of everything.

1.2 IoT – Disadvantages

Security –

IoT creates an ecosystem of constantly connected devices communicating over networks. The system offers little control despite any security measures. This leaves users exposed to various kinds of attackers.

Privacy –

The sophistication of IoT provides substantial personal data in extreme detail without the user's active participation.

Complexity –

Some find IoT systems complicated in terms of design, deployment, and maintenance given their use of multiple technologies and a large set of new enabling technologies.

Flexibility –

Many are concerned about the flexibility of an IoT system to integrate easily with another. They worry about finding themselves with several conflicting or locked systems.

Compliance –

IoT, like any other technology in the realm of business, must comply with regulations. Its complexity makes the issue of compliance seem incredibly challenging when many consider standard software compliance a battle.

Internet of Things - Technology and Protocols

1.3 NFC and RFID

RFID (radio-frequency identification) and NFC (near-field communication) provide simple, lowenergy, and versatile options for identity and access tokens, connection bootstrapping, and payments.

- RFID technology employs 2-way radio transmitter-receivers to identify and track tags associated with objects.

- NFC consists of communication protocols for electronic devices, typically a mobile device and a standard device.

1.4 Low-Energy Bluetooth

This technology supports the low-power, long-use need of IoT function while exploiting a standard technology with native support across systems.

1.5 Low-Energy Wireless

This technology replaces the most power hungry aspect of an IoT system. Though sensors and other elements can power down over long periods, communication links (i.e., wireless) must remain in listening mode. Low-energy wireless not only reduces consumption, but also extends the life of the device through less use.

1.6 Radio Protocols

ZigBee, Z-Wave, and Thread are radio protocols for creating low-rate private area networks. These technologies are low-power, but offer high throughput unlike many similar options. This increases the power of small local device networks without the typical costs.

1.7 LTE-A

LTE-A, or LTE Advanced, delivers an important upgrade to LTE technology by increasing not only its coverage, but also reducing its latency and raising its throughput. It gives IoT a tremendous power through expanding its range, with its most significant applications being vehicle, UAV, and similar communication.

1.8 WiFi-Direct

WiFi-Direct eliminates the need for an access point. It allows P2P (peer-to-peer) connections with the speed of WiFi, but with lower latency. WiFi-Direct eliminates an element of a network that often bogs it down, and it does not compromise on speed or throughput.

1.9 IOT – Common Uses

1.10 Engineering, Industry, and Infrastructure

Applications of IoT in these areas include improving production, marketing, service delivery, and safety. IoT provides a strong means of monitoring various processes; and real transparency creates greater visibility for improvement opportunities.

The deep level of control afforded by IoT allows rapid and more action on those opportunities, which include events like obvious customer needs, nonconforming product, malfunctions in equipment, problems in the distribution network, and more.

1.11 Government and Safety

IoT applied to government and safety allows improved law enforcement, defense, city planning, and economic management. The technology fills in the current gaps, corrects many current flaws, and expands the reach of these efforts. For example, IoT can help city planners have a clearer view of the impact of their design, and governments have a better idea of the local economy.

1.12 Home and Office

In our daily lives, IoT provides a personalized experience from the home to the office to the organizations we frequently do business with. This improves our overall satisfaction, enhances productivity, and improves our health and safety. For example, IoT can help us customize our office space to optimize our work.

1.13 Health and Medicine

IoT pushes us towards our imagined future of medicine which exploits a highly integrated network of sophisticated medical devices. Today, IoT can dramatically enhance medical research, devices, care, and emergency care. The integration

of all elements provides more accuracy, more attention to detail, faster reactions to events, and constant improvement while reducing the typical overhead of medical research and organizations.

The applications of IoT in media and advertising involve a customized experience in which the system analyzes and responds to the needs and interests of each customer. This includes their general behavior patterns, buying habits, preferences, culture, and other characteristics.

IoT(internet of things) enabling technologies are

1. Wireless Sensor Network
2. Cloud Computing
3. Big Data Analytics
4. Communications Protocols
5. Embedded System

1.Wireless Sensor Network(WSN) :

A WSN comprises distributed devices with sensors which are used to monitor the environmental and physical conditions. A **wireless sensor network** consists of end nodes, routers and coordinators. End nodes have several sensors attached to them where the data is passed to a coordinator with the help of routers. The coordinator also acts as the gateway that connects WSN to the internet.

Example –

- Weather monitoring system
- Indoor air quality monitoring system
- Soil moisture monitoring system
- Surveillance system
- Health monitoring system

2.Cloud Computing :

It provides us the means by which we can access applications as utilities over the internet. Cloud means something which is present in remote locations. With Cloud computing, users can access any resources from anywhere like databases, web servers, storage, any device, and any software over the internet.

Characteristics –

1. Broad network access
2. On demand self-services
3. Rapid scalability
4. Measured service
5. Pay-per-use

Provides different services, such as –

IaaS

(Infrastructure as a service) Infrastructure as a service provides online services such as physical machines, virtual machines, servers, networking, storage and data center space on a pay per use basis. Major IaaS providers are Google Compute Engine, Amazon Web Services and Microsoft Azure etc. Ex : Web Hosting, Virtual Machine etc.

PaaS

(Platform as a service) Provides a cloud-based environment with a very thing required to support the complete life cycle of building and delivering Web based (cloud) applications – without the cost and complexity of buying and managing underlying hardware, software provisioning and hosting. Computing platforms such as hardware, operating systems and libraries etc. Basically, it provides a platform to develop applications. [3] Ex : App Cloud, Google app engine

SaaS (Software as a service)

It is a way of delivering applications over the internet as a service. Instead of installing and maintaining software, you simply access it via the internet, freeing yourself from complex software and hardware management. SaaS Applications are sometimes called web-based software on demand software or hosted software.

SaaS applications run on a SaaS provider's service and they manage security availability and performance. Ex : Google Docs, Gmail, office etc.

3. Big Data Analytics:

It refers to the method of studying massive volumes of data or big data. Collection of data whose volume, velocity or variety is simply too massive and tough to store, control, process and examine the data using traditional databases. Big data is gathered from a variety of sources including social network videos, digital images, sensors and sales transaction records.

Several steps involved in analyzing big data –

1. Data cleaning
2. Munging
3. Processing
4. Visualization

Examples –

- Bank transactions
- Data generated by IoT systems for location and tracking of vehicles
- E-commerce and in Big-Basket
- Health and fitness data generated by IoT system such as a fitness bands

4. Communications Protocols:

They are the backbone of IoT systems and enable network connectivity and linking to applications. Communication protocols allow devices to exchange data over the network. Multiple protocols often describe different aspects of a single communication. A group of protocols designed to work together is known as a protocol suite; when implemented in software they are a protocol stack. They are used in

1. Data encoding
2. Addressing schemes

5. Embedded Systems:

It is a combination of hardware and software used to perform special tasks. It includes microcontroller and microprocessor memory, networking units (Ethernet Wi-Fi adapters), input output units (display keyword etc.) and storage devices (flash memory). It collects the data and sends it to the internet. Embedded systems used in

Examples –

1. Digital camera
2. DVD player, music player
3. Industrial robots & Wireless Routers etc.

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