# Internet of Things (IoT) and Big Data: A Review

**Pankaj Mudholkar[1] and Megha Mudholkar[2]**

[1]Dy. Director, Thakur Institute of Management Studies, Career Development & Research, Kandivali (E), Mumbai, Maharashtra, India

[2]Asst. Professor, Thakur Institute of Management Studies, Career Development & Research, Kandivali (E), Mumbai, Maharashtra, India

[1]mudholkarpankaj@gmail.com, [2]meghakunte2000@gmail.com

**Abstract**

*The evolution of Internet of Things (IoT) makes the life of human being very easier. IoT makes it easy to control any device in a bit. Several IoT applications like smart homes, manufacturing, transportation, and consumer goods like wearables, smartphones are available. IoT is actually the network of devices that contain sensors, electronics, softwares, actuators, and connectivity which allows these things to connect, interact and exchange data.*

*IoT made easy way to control the devices, collect the information from such devices, disseminate such information and transfer this information to analyze the same and to predict or prescribe the solution for the problems might exist.*

*The large quantity of data is collected from IoT devices through the sensors where the Big Data came into picture. The paper reviews the relationship between IoT and Big Data.*

***Keywords:*** *IoT, Big Data*

## 1. Introduction

IoT makes it possible to connect number of devices with each other and these devices are now linked to the internet, which transmits the data through sensors for the purpose of analysis. IoT devices are built to make a positive impact on our lifestyle, energy conservation, smart agriculture, transportation, and health. The data collected from these devices are used to learn more about trends and patterns that can be utilized. The data and IoT are closely interlinked with each other. These are closely intertwined and although they are not the same thing, it is very hard to talk about one without the other. This paper tries to provide a basic understanding of the relationship between IoT and Big data.

The advancement in Information Technology provides a new infrastructure through IoT which includes software and hardware applications as well as an OS; organizations must handle the influx of data that begins flowing in and examine it in real-time as it evolves by the minute.

The generation of voluminous data through IoT devices must needs to be collected for the proper analysis; big data analytics tools have the capacity to handle large volumes of data generated from IoT devices that create a continuous stream of information. But, in order to differentiate between them, IoT provides data from which big data analytics can extract information to generate insights required of it.

However, IoT conducts data on a completely different scale, so the analytics solution must accommodate its needs of processing and rapid ingestion followed by a fast and accurate extraction.

IoT and Big Data are interconnected with each other. IoT is going to generate huge amounts of data that must be analyzed if the IoT networks are going to operate accurately. The networks may generate some redundant data and that is why it becomes important for

Big Data organizations to spend their analytics power on the data that is important. So, a new element of data categorization will be added so that the Big Data Analytics tools deliver better performance.

## 2. Review of Literature

The Internet of Things (IoT), firstly coined by Kevin Ashton as the title of a presentation in 1999 [1], is a technological revolution that is bringing us into a new ubiquitous connectivity, computing, and communication era. The development of IoT depends on dynamic technical innovations in a number of fields, from wireless sensors to nanotechnology [2]. For these ground-breaking innovations to grow from ideas to specific products or applications, in the past decade, we have witnessed worldwide efforts from academic community, service providers, network operators, and standard development organizations, etc (see, e.g., the recent comprehensive surveys in [3]–[5]).

Although IoT has created unprecedented opportunities that can help increase revenue, reduce costs, and ameliorate efficiencies, collecting a huge amount of data alone is insufficient. To generate benefits from IoT, enterprises must create a platform where they can collect, manage, and analyze a massive volume of sensor data in a scalable and cost-effective manner [6].

Rizwan et al. [7] study the strengths and weaknesses of various traffic management systems. They propose a low cost, real-time traffic management system that deploys IoT devices and sensors to capture real-time traffic information. Specifically, low-cost traffic detection sensors are embedded in the middle of the road for every 500 or 1000 m. The collected data are then sent to analytics tools to analyze traffic density and to provide solutions via predictive analytics. Compared with the existing systems, the proposed system provides a better alternative method for managing traffic.

Zhang et al. [8] propose Firework, a new computing paradigm that allows distributed data processing and sharing in an IoT-based, collaborative edge environment. Firework combines physically distributed data by providing virtual data views to end users using predefined interfaces. These interfaces come in the form of a set of functions and a set of datasets. Firework aims to minimize data access latency by moving the processing closer to the data producers in the edge network. Firework instance has multiple stakeholders who must register their datasets and corresponding functions that are abstracted as data views. These data views are available to all participants of the same framework instance such that they can merge multiple data views into a single job to perform detailed data analytics. They illustrate such concept by performing case studies of connected health and find the lost.

Rathore et al. [9] propose a smart city management system based on IoT that exploits big data and analytics. The data are collected by deploying different sensors, including weather and water sensors, vehicular networking sensors, surveillance objects, smart home sensors, and smart parking sensors. The implementation process involves several steps, including data generation, data gathering, data combining, data categorization, data preprocessing, and decision making. Smart systems are utilized as sources of city data to develop a smart city as an implemented system. However, the developed smart system is yet to be deployed and its accuracy remains untested.

Vuppalapati et al. [10] examine the role of big data in healthcare and find that body sensors generate massive amounts of health-related data. Two challenges are analyzed in this context, namely, integrating these massive data points with

electronic health records (EHR) and presenting these data to doctors in real time. Based on these observations, they propose a sensor integration framework that suggests a scalable cloud architecture that can provide a holistic approach to the EHR sensor system. Apache Kafka and Spark are used to process large amounts of data in a real-time manner. Although visualizing the health of patients in real time can help detect urgent situations, this model lacks a security solution. Ahmad et al. [11] analyze human behavior by using big data and analytics in the social IoT paradigm [12]. They propose an architecture that comprises three operational domains. They also analyze an ecosystem that is created by smart cities and big data. Collaborative filtering techniques can be used in the future to accurately analyze human behavior.

Mourtzis et al. [13] reveal that the adoption of IoT in the manufacturing industry can transform traditional systems into modern ones. Moreover, such transformation leads to a data production process that turns industrial data into industrial big data, which are rendered useless without analytics power. Adopting data analytics can empower enterprises to derive new data-driven strategies that can easily manage competitive pressure. They also demonstrate how the IoT paradigm can be implemented in a simple case of a company with almost 100 machines.

A Study conducted by Ejaz Ahmed, Ibrahim Abaker and Targio Hashem and Imran Khan [14] on the role of Big Data analytics in IoT states that IoT is one of the biggest sources of big data, which are rendered useless without analytics power. IoT interacts with big data when voluminous amounts of data are needed to be processed, transformed, and analyzed in high frequency.

## 3. IoT and Big Data

Internet of Things (IoT) is the way of connecting devices using sensors and monitored by internet. But the data produced by the IoT is growing rapidly because of the large scale development of various applications. As the data is turned and crossed over terabytes and leading to petabytes, there should be a solution to manage the overwhelming increase in data. Big data is the solution for the data problem and it is considered as the future's data dream. As by using big data, we are able to store unlimited amount of data in a secured manner, the demand for Big Data is increasing more. As IoT and Big Data are two trends in the present era, combining those will really create a technical revolution for the future generations. [15]

IoT is a network consisting of physical devices, which are also implanted with sensors, electronics, and software, thereby allowing these devices to exchange data. Figure 1 illustrates the process of data collection through IoT devices, monitoring those data and data analytics.

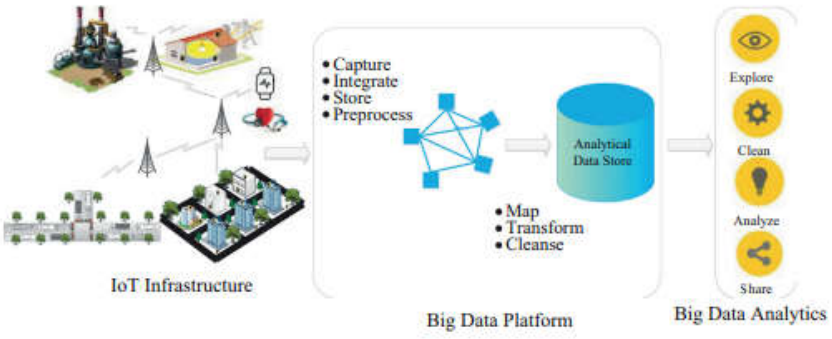


**Figure 1. Big Data Flow and IoT [14]**

The key necessities of big data storage are that it can handle very huge amounts of data and continuous balancing to keep up with expansion and that it can provide the input/output operations per second (IOPS) necessary to deliver data to analytics tools. The data is of different form and format and thus, a datacenter for storing such data must be able to handle the load in changeable forms. Obviously IoT has a direct impact on the storage infrastructure of big data.

Data analytics is the science of examining raw data with the idea of coming to conclusions about that information. Data analytics is used in many industries to allow them to make better business decisions and in the sciences to verify or disprove existing models or theories. IoT Big data analytics is very much needed to end up in a optimized decision. Big data analytics will help you understand the business value it brings and how different industries are applying it to deal with their sole business necessities. According to the Gartner IT dictionary, Big Data is variety of information assets, high-volume, and high-velocity and, innovative forms of information processing for enhanced approach and decision making.

1. **Volume** refers to the size of data. Data sources can be social media, sensor and machine-generated data, structured and unstructured networks, and much more. Enterprises are flooded with terabytes of big data.
2. **Variety** refers to the number of forms of data. Big data deals with numbers, 3D data and log files, dates, strings, text, video, audio, click streams.
3. **Velocity** refers to the speed of data processing. The rate at which data streams in from sources such as mobile devices, click streams, machine-to-machine processes is massive and continuously fast moving. Big data mining and analytics helps to reveal hidden patterns, unidentified correlations, and other business information.

## 4. Few Examples on IoT and Big Data

Nowadays, IoT is used in everything starting from home automation, agriculture, healthcare, transportation etc. Few of the examples are,

### 4.1 Smart Agriculture/ Smart Farm:

Smart agriculture is just getting underway and involves exploiting data from many sources – sensors on farm equipment and plants, satellite images and weather tracking. The use of water and fertilizers will be measured and monitored in detail sometimes on plant by plant basis.

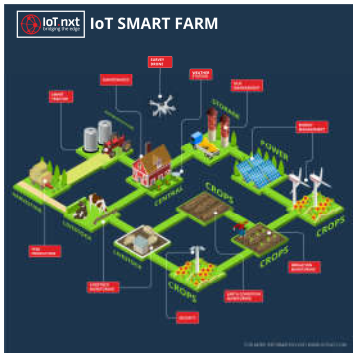


**Figure 2. IoT Smart Farm issued by IoT.nxt**

As shown in Fig. 2 every IoT device is connected to a farm which generates information which is used to manage the farm.

The IoT is set to push the future of farming to the next level. Smart agriculture is already becoming more commonplace among farmers, and high-tech farming is quickly becoming the standard thanks to agricultural drones and sensors.

IoT sensors report weather conditions and monitor soil moisture and acidity while animal farmers track the movement and behavior of livestock remotely via embedded devices. Industrial IoT applications are also useful for monitoring indoor agricultural facilities such as silos, dairies and stables.

IoT agriculture application areas include farm vehicle tracking, livestock monitoring, large and small field farming, and storage monitoring. Drones have become an invaluable tool for farmers to survey their lands and generate crop data.

Farmers can use their smartphones to remotely monitor their equipment, crops, and livestock, as well as obtain stats on their livestock feeding and produce. They can even use this technology to run statistical predictions for their crops and livestock.

**4.2 Smart Transportation:**

Transportation today allows us to access public transit, shipping, ride sharing, and an unquantifiable amount of convenience.

Whether by air, ground or sea, transportation and logistics are essential components to many enterprises' productivity, and access to real-time data is critical.

Many businesses have already discovered the advantages of using mobile technologies; however, the unpredictable nature of fuel costs, rising labor rates, increased traffic and a changing regulatory environment, continue to make operations challenging.

With the advent of today's mobile technologies and the Internet of Things (IoT), enterprises can accelerate productivity, profitability and operations with solutions designed specifically for their processes. With the right IoT solution in place, enterprises can connect all devices across a centralized cloud network, and capture and share their mission-critical data, allowing them to gain real-time visibility of their operations.

**4.3 Magic Bands:**

Magic bands provide us information about the required fields as required by the human beings. Disney World's proprietary MagicBand is a great example of IoT and big data working together. The MagicBand is a wearable, sensor-laden, wristband that vacationers use to do everything from check into their hotel room, buy their lunch, go through the turnstiles at the amusement parks, and reserve a spot for specific attractions.

Wearers use the band to 'check in' at certain posts by tapping it against a receiver, and it tracks their movement via RFID, so Disney collects data on visitor movement throughout the park. Leveraging this data, Disney can accommodate more guests, properly staff rides and attractions, and better regulate inventory at highly-trafficked shops and restaurants.

**4.4 Smart Hospitals:**

Hospitals can use IoT to collect, transmit and analyse patient's data for further investigation. The Clermont-Ferrand University Hospital in France has

deployed an IoT and big data initiative by partnering with Microsoft and Capsule Technologie. The hospital built a proprietary system to collect and organize data that is secure and compliant, and uses connected medical devices to transmit more data to the system.

After the nurses authenticate on a mobile app, they can send patient data directly from their medical devices and tools. The hospital has a fuller, more robust data set and the medical professionals can collect more data in less time, making their jobs easier.

## 5. Conclusion

Many of the conversations taking place around the Internet of Things (IoT) are incomplete without a mention of big data. Connected devices, sensors, and algorithms all operate in ways that involve massive amounts of data.

As organizations step into IoT, they must understand the symbiotic relationship between IoT and big data. For IoT deployments to really make an impact, they must provide some sort of useful tool or service, while also collecting relevant data.

Just like with any big-data play, merely collecting the data isn't enough. The data must be processed and analyzed to glean insights, and those insights must drive actionable steps that can improve the business.

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