INTERNET OF THINGS AND BIG DATA IN THE CONTEXTS OF EDUCATION AND SCIENCE

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ABSTRACT
In this paper we discuss the IoT applications, challenges, communication models, layers of IoT, features of IoT, Big data V's models, big data platforms. In the contexts of education and science. We discuss that big data and IoT is an important factor in our lives. It has a significant impact on all fields of science. Every field like computer science, medical, education, entertainments industry etc. Even we communicate over the internet with our beloved once by the help of IoT communication models. Hence, in this paper we discuss IoT and big data in detail.

KEYWORDS
IoT challenges, IoT communication models, layers of IoT, big data applications, big data analytic platform.

INTRODUCTION
IoT (internet of thing) play a significant role in our lives. IoT has grown so important in our everyday lives that it will have a significant influence in the near future. The Internet of Things (IoT) is an idea based on networked physical things. It builds a network of devices capable of generating data. Sensors may gather data about our surroundings and can be found in automobiles, buildings, and cell phones (Aly, Elmogy, & Barakat, 2015). IoT can gather data from healthcare, smart homes, smart traffic management, aero planes, trains, weather forecasts, and agricultural sensors and so on. (Gulia & Chahal, 2020). IoT data is unstructured and lacks organization. One may discover hidden patterns, fresh information, hidden correlations, uncover trends, and other things by using the correct big data analysis approaches. (Gulia & Chahal, 2020), (Golchha, 2015.), (Hooda & Rana, 2020). Anyone may quickly get the

important information because of the Internet and network resources' availability, and its use is changing by the second. The Internet of Things (IoT) has emerged because of this the introduction of new technologies, gadgets, and the Wireless communication, digital electronics, and micro-electromechanical systems (MEMS) technologies are all coming together. (Shahdad, Khan, Bilfaqih, Sultana, & Hussain , 2018). To fully benefit from IoT, businesses need establish a platform capable of handling, managing, and analyzing huge volumes of data in a flexible and profitable way (Riggins & Wamba, 2015). The Internet of Things (IoT) is progressing because to technological advancements from remote monitoring to Nanotechnology, among other fields. These advancements enable concepts to become tangible applications or products. Existing IoT research focuses on enabling large things to see, hear, and smell the real environment on their own. It brings people closer together by allowing them to share their insights (Ding, Wang, & Wu, 2013), (Aly, Elmogy, & Barakat, 2015). The utilization of IoT devices demonstrates a constant data collecting. The results of gathering this information are amazing. Big Data works with a data set, analyses it, and gets useful information from it. There are a number of open-access data sets available online (Khare & Totaro, 2019). The firms that create these data are interested in Smart data production and massive data management (Zainab Alansari, et al., 2018). Big data has been changed by the fast development of Internet use, smartphone and social applications, and machine-to-machine (M2M) connection (Alansari, Z., Soomro, s. Belgaum, M. R., & Shamshirband, 2018). Weather, data from the field and data from the product collection is automated and correct in intermittent IoT. When data is acquired, however, professional advice is obtained before actions are done. Companies must be prepared for a variety of gadgets that link customers and items at any moment in time, in addition to the expanding amount of data and analysis required. Other challenges that the Internet of Things technology faces include the investment necessary in sensors, analytical capability, data security, and maintenance (Alansari, Z., Anuar,, , Kamsin, A.,, Soomro, S., Belgaum, & M. R., 2017).

Figure 1. Big data in IoT (Riggins & Wamba, 2015)

IoT (Internet of thing)

IoT has a variety of definitions and designs, according to researchers The Internet of Things is created when a collection of anybody, anything, anytime, anywhere, any service, and any network connects (IoT). IoT stands for a network of linked devices, items or machines (computing, mechanical, or digital equipment) that may link these machines or things without the need for human intervention. It's an M2M (Machine to Machine) communication system (Gulia & Chahal, 2020). Its applications, like as vehicles and residences that are smart, can offer a variety of services, including alerts, Security, energy efficiency, automation, computing, and entertainment and communication are all important factors to consider. (Gauer, A, 2015), (Saranya C. M & Nitha K. P., 2015).

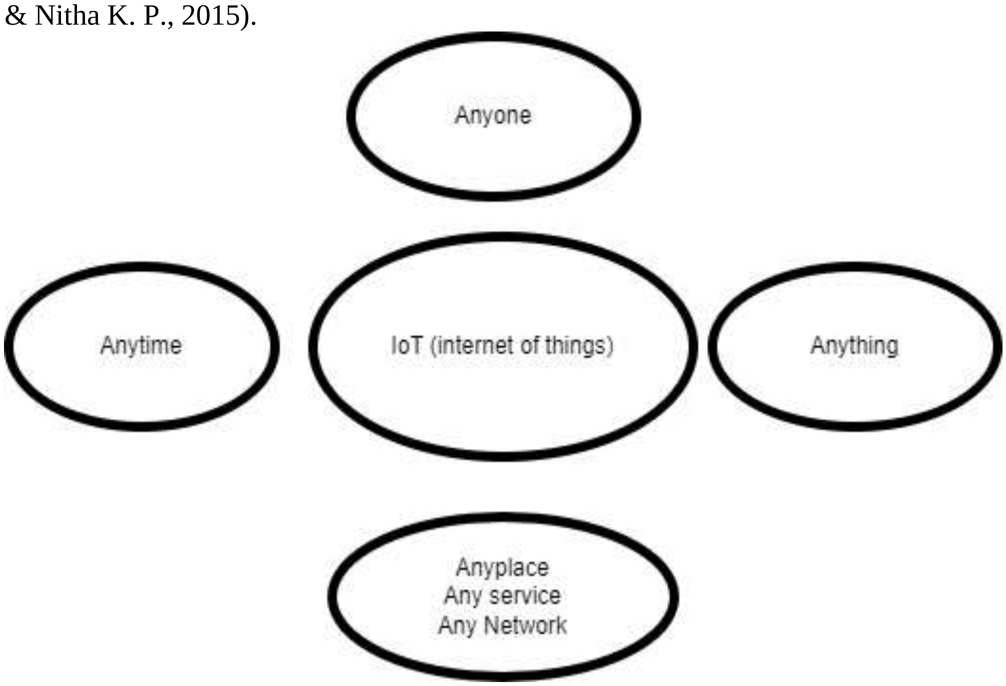

Figure 2. IoT (Internet of thing) (Shahdad, Khan, Bilfaqih, Sultana, & Hussain , 2018)

LAYERS OF IOT

There are two sides to IoT architecture. The first is the standard three-level perspective of IoT architecture. The second is a new paradigm that looks at the Internet of Things as a five-layer structure and three Layers Architecture

The layers are following:

1. Network layer

“Transmission layer” is another name for the network layer. Data from sensors on physical devices is sent to the subsequent layer through this layer. The communication route can be connected to the network, depends on the sensor items, and the technology used can be 3G, Wi-Fi, Bluetooth, ZigBee, or 6lowpan (Rafiullah Khan, Sarmad Ullah Khan, Rifaqat Zaheer, & Shahid Khan, 2012).

2. Infrastructure layer

There are multiple infrastructural pieces that might cause numerous difficulties for users. Infrastructure should be encouraged for simple and acceptable services as well as the increase of market velocity. Infrastructure refers to Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) (Digi.com, 2015).

3. Application layer

From a technological standpoint, this fundamental layer dictated the evolution of the Internet of Things (IoT). It's useful in the early stages of development. The application layer integrates IoT and manufacturing, integrating technology with industry needs to identify the industry, such as work social separation and human economy building. (Miao Wu, Ting-lie Lu, Fei-Yang Ling, & Ling Sun, Hui-Ying Du, 2010). The old architecture of the architecture is not suitable so that, the conclusion is that their made a new architecture that also define the pervious architecture with some new layers.

a) Five-layer architecture

Five-layer architecture are following:

1. Perception Layer

The perception layer's job is to convert data into digital signals. The data that are collected is gathered from perception layer to network layer. It is also called a “device layer”. Its duty is to gather objects features like location, temperature, motion etc. Sensors such as RFID, 2D barcodes, and other sensor types are used to do this (Miao Wu, Ting-lie Lu, Fei-Yang Ling, & Ling Sun, Hui-Ying Du, 2010).

2. Network layer

“Transmission layer” is another name for the network layer. Data from sensors on physical devices is sent to the subsequent layer through this layer. The communication route can be connected to the network or remotely, depends on the sensor items, and the technology used can be 3G, Wi-Fi, Bluetooth, ZigBee, or 6lowpan (Rafiullah Khan, Sarmad Ullah Khan, Rifaqat Zaheer, & Shahid Khan, 2012).

3. Middleware layer

This layer is frequently referred to as the "processing layer." The middleware layer is in charge of processing, analysing, and storing data from network-connected devices.

(Miao Wu, Ting-lie Lu, Fei-Yang Ling, & Ling Sun, Hui-Ying Du, 2010).

4. **Application layer**

This essential layer controlled the evolution of IoT from a technology viewpoint. It's helpful when you're just starting off. The application layer integrates IoT and manufacturing, integrating technology with industry needs to identify the industry, such as work social separation and human economy building. (Miao Wu, Ting-lie Lu, Fei-Yang Ling, & Ling Sun, Hui-Ying Du, 2010).

5. **Business layer**

A manager of IoT is favoured by the business layer. Applications, system models, and services are all part of the management. Technology success is dependent on both a technological focus and a commercial plan that is innovative. (Miao Wu, Ting-lie Lu, Fei-Yang Ling, & Ling Sun, Hui-Ying Du, 2010).

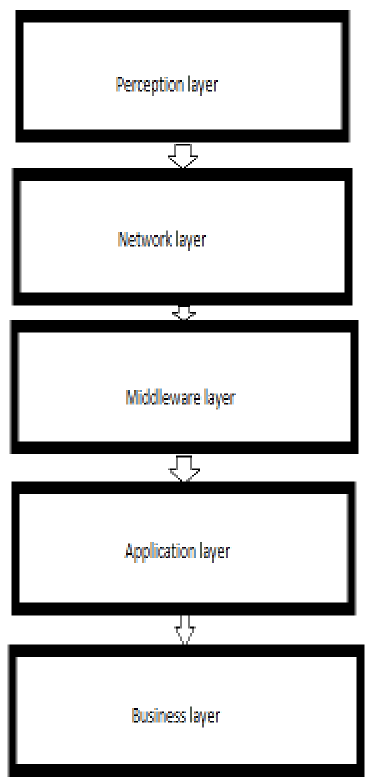

Figure 3 IoT layer architecture (Shahdad, Khan, Bilfaqih, Sultana, & Hussain , 2018)

CHALLENGES OF IOT

IoT face many challenges according to architecture, technology, hardware and environmental etc. Some of the challenges are following.

a) Architecture challenges

Many linked gadgets and sensors make up the Internet of Things. Each technology has its own set of guidelines and standards for communication. There are no well-defined communication standards or guidelines (Shanzhi Chen, HuiXu , DakeLiu, Bo Hu, Hucheng Wang, 2014).

b) Privacy and security challenges

The most important aspects are security and privacy that can face almost in every field of life. We must ensure the Internet-of-Things (IoT) safety and privacy. IoT is the largest field in the computer science, so we can manage the risks to security and privacy in IoT (Abhay Kumar Bhadani & Dhanya Jothimani, 2016).

c) Data privacy and security in educational IoT systems

IoT systems in education collect and generate vast amounts of data on students, teachers, and other stakeholders. Ensuring the privacy of this data is crucial. Protecting individuals' identities by anonymizing and de-identifying data can be challenging, especially when dealing with rich and diverse datasets. Robust anonymization techniques should be employed to mitigate privacy risks (Amr Adel).

d) Device security

IoT devices may have vulnerabilities that can be exploited by attackers. Ensuring secure configurations, regular software updates, and strong authentication mechanisms for IoT devices are essential (Amr Adel).

e) Hardware challenges

Hardware challenges refer to the physical devices connected in the system. There are challenges like battery, cost, time consume etc. IoT is the large development, so it uses a low-cost battery that consume large time. The environment like humidity, heat etc. may not affect the system. The connection should be flexible. This can improve the hardware challenge (Engineeringforchange.org, 2015).

f) Technical challenges

IoT face technical challenge. Technical challenge includes software's and network that used in the IoT. The connection of network should be flexible and cost should be low of technologies that used in the IoT (Li, Shancang, Li Da XU, and Shanshan Zhao, 2014).

g) Development challenges

IoT face development challenge. IoT should be developed in smart cities with smear energy. Use of social network, apps, services lead to development of IoT. But the master plan is that this energy, apps networking should be successful (Li, Shancang, Li Da XU, and Shanshan Zhao, 2014).

h) Standard challenges

Standard challenge is the important factor in the IoT development. Standard challenge means all of the person have equal access. Standard challenges may also include which services, apps and devices are the best (Li, Shancang, Li Da XU, and Shanshan Zhao, 2014).

CHARACTERISTICS OF INTERNET OF THINGS (IOT)

There are many characteristics of IoT which are following:

1. Intelligence

IoT is very intelligent because in this there is a use of many algorithms, hardware and software's that make it intelligent. IoT solve the problem intelligently and give an easier solution. IoT goes beyond machine to machine (M 2 M) dialogue but also a user-to-user communication (U 2 U). So, IoT is very friendly and intelligent (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017).

2. Connectivity

IoT is not only machine-to-machine communication but also a user-to-user communication. So, IoT connects with the users very friendly. The connection between devices is very strong. This is the best characteristic of IoT (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017). With the help of IoT we can connect with the whole world easily. If we want to call anyone in the whole world, we can connect with him/her (Mohamed Abomhara and Geir M. Køien).

3. Security

Security is an important factor in all over the aspects. In IoT security is very strong and make it more secure for the users (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017). With the help of many security devices, we may secure our houses, shops and many more. Security devices cannot be easily unlocked and damaged.

4. Sensing

Sensing is an important characteristic of IoT. IoT is all about sensing. IoT consist of many sensors which provide the information about the data to connect with the environment (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017). Many remote devices are now available to check the heart rate, blood pressure, temperature etc. Now doctors collect data of patients and send to analyze it. If any of the patient have any problem than prepare him/her for treatment. Firstly, doctors diagnose the problem and found solution. These are all in sensing.

5. Dynamic nature

IoT is a dynamic nature. It means It can continuously change with time. The devices which provide the information to connect with environment can continuously changes the IoT like the temperature changes, the state of temperature on/off etc. (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017).

6. Heterogeneity

Homogeneity is the key characteristic of the IoT. IoT use different hardware's and software's to connect with different platforms through different networks. IoT can connect with different devices through different platform through different networks (L. Da Xu, W. He, and S. Li, 2014).

APPLICATIONS OF INTERNET OF THINGS (IOT)

Some advantageous applications of Internet of things which are following:

1. Connected health

IoT has numerous applications in healthcare. We can join sessions of doctor's and physicians by seating in our homes. In covid when there is ban outside than we can connect to doctors by seating in or house. These are all done with the help of IoT (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017). Many remote devices are now available to check the heart rate, blood pressure, temperature etc. Now doctors collect data of patients and send to analyze it. If any of the patient have any problem than prepare him/her for treatment. Firstly, doctors diagnose the problem and found solution to cure it and suggest the medicines according to the problem. (Mohamed Abomhara and Geir M. Køien).

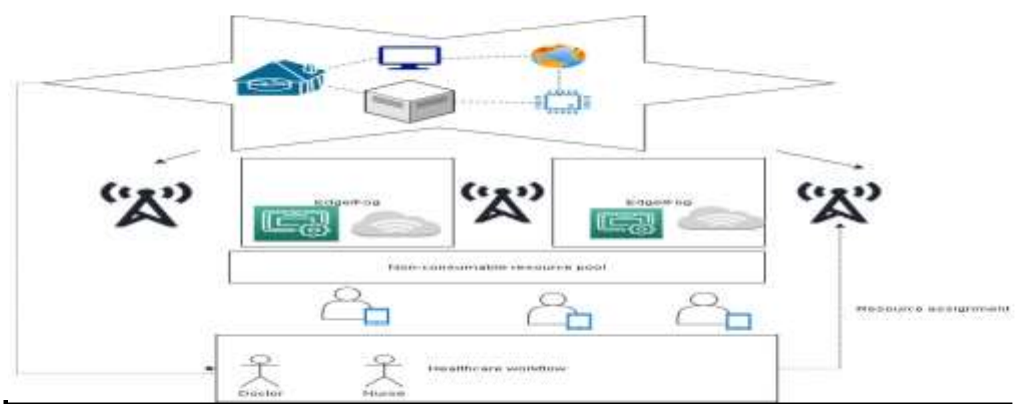

Figure 4: ***Health care in IoT*** (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017).

2. Smart cities

In the urban areas people face many difficulties like pollution, traffic noise etc. In this difficult life IoT is best option to use. IoT play an important role in urban areas and even in ruler areas also. People connect with their beloved ones with the help of IoT and any applications used by IoT. In short IoT make the world even smart (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017). IoT even make the cities smart with help of smart devices like smart meters, smart transportation, smart grids etc. In cities now people use smart meters to save energies and lights. To save the bills of electricity they use smart meters. It may reduce of bills. In cities and even villages now people use solar panels for households and to storage of energy (Mohamed Abomhara and Geir M. Køien).

Figure 5*: Smart cities (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017)*

3. Connected cars

Now IoT used in automobiles like cars, bus, train etc. Now we can heir a taxi near our house. We can do reservation of seats of train, bus, aeroplane etc by seating in our home. We can see the duration path in our smart phones by seating in our home (S. De, P. Barnaghi, M. Bauer, and S. Meissner, Service modelling for the internet of things, 2011).

Connected cars means that connect to the internet to communicate the outside world. Now driver life is easier. Now we can only update software's. Connected cars used apps to unlock the car (S. De, P. Barnaghi, M. Bauer, and S. Meissner, Services modelling for the internet of things, 2011).

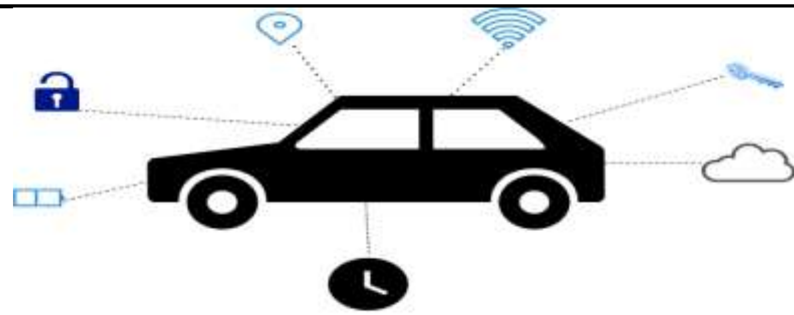

Figure 6: ***Connected car*** *(Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017)*

4. Smart home

IoT is now used in home appliances. Now we can used sensor taps, door, cameras in our home. Even now there are smart kitchen in our homes in which smart heating and cooling system, smart stove. We have smart security system and smart doors and windows etc. These are all done with the help of IoT. IoT make the world smart. Now we made smart homes in which everything is smart. We use cameras in our home, we can check their footage in our smart devices. IoT make the world efficient and smart (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017).

Figure 7: ***Connected home (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017)***

5. Smart retail

With the help of IoT, we can use smart retail. Smart retail means now we can use many apps and sensor that can detect the information about the product like its price, number etc. It can help shopkeeper about the product. Foer example one Product is about to finish. With the help of sensor or application shopkeeper detect this information about the product (J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, 2013). With the help of retail devices, they can collect data from entire product, analyze and transform them with the help of retail manager and improve experience for the next time.

(S. Chen, H. Xu, D. Liu, B. Hu, and H. Wang, 2014).

Figure 8: ***Smart Retail*** *(Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017)*

Applications of IoT In education

The applications of the Internet of Things (IoT) in educational settings have the potential to revolutionize teaching and learning processes.

1. Smart Classrooms

IoT devices can transform traditional classrooms into smart learning environments. Smart boards, interactive displays, and connected devices enable real-time collaboration, interactive learning experiences, and personalized instruction. Sensors in classrooms can monitor environmental factors like temperature, lighting, and air quality to create an optimal learning environment (Leyla Gamidullaeva, K. G, 2021).

2. Personalized Learning

IoT devices can collect vast amounts of data on individual students' learning preferences, behaviours, and progress. This data, when analysed using Big Data techniques, allows for personalized learning experiences tailored to each student's needs. Adaptive learning platforms and intelligent tutoring systems use IoT data to provide customized content, pacing, and feedback (Leyla Gamidullaeva, K. G, 2021).

3. Learning Analytics

Big Data analytics applied to educational data can provide valuable insights into student performance, learning patterns, and engagement. Learning analytics can help identify struggling students, predict their needs, and provide timely interventions. It can also enable educators to monitor the effectiveness of instructional strategies and curriculum design (Leyla Gamidullaeva, K. G, 2021).

4. Educational Research

IoT and Big Data offer new possibilities for educational research. Researchers can leverage data collected from IoT devices to study learning behaviour's, educational trends, and the effectiveness of interventions. It enables large-scale data analysis, uncovering patterns and insights that can inform evidence-based educational practices (Leyla Gamidullaeva, K. G, 2021).

Communication models of internet of things (iot)

Some communication models of IoT are following:

1. Device to Device communication

Device to device communication means there is no intermediate thing between two devices. It means two devices connected directly with each other. These devices use specific protocols to communicate and deliver messages with each other. These devices communicate with each other with corresponding small data condition. Domestic Light switches, bulbs, and security systems are examples of IoT devices that transfer little amounts of data to each other. (Karen Rose, Scott Eldridge, Lyman Chapin, 2015).

Figure 9: ***Device to device communication*** *(Karen Rose, Scott Eldridge, Lyman Chapin, 2015)*

2. Device to cloud communication

In device to cloud communication device directly use a cloud service to communicate. The advantage of device to cloud communication is that the wireless communication like WIFI create connection over the cloud services. Smart devices like smart TV, smart phones and many other devices use cloud database where data can be analysed home energy utilization (Karen Rose, Scott Eldridge, Lyman Chapin, 2015).

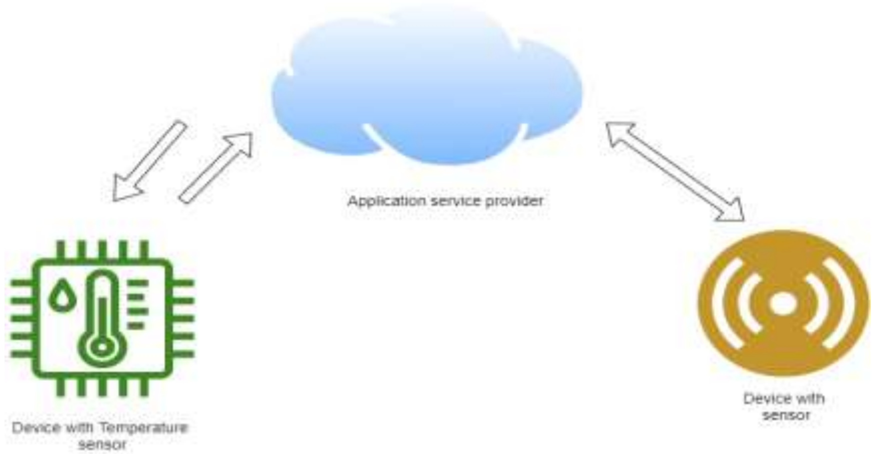

Figure* 10. *Device to cloud communication *(Karen Rose, Scott Eldridge, Lyman Chapin, 2015)*

3. Device to Gateway communication

In device to gateway or device-to-application layer gateway (ALG) communication connect IoT devices through ALG to connect with cloud services. In simple terms, there is an application with act as middle layer between cloud services and a gateway. In other words, there is a hub between the cloud services and gateway to communicate with each other. We can send information to the hub and hub can store it on the cloud service and reply back (Karen Rose, Scott Eldridge, Lyman Chapin, 2015).

Figure 11. *Device to Gateway communication model* *(Karen Rose, Scott Eldridge, Lyman Chapin, 2015)*

IOT TECHNOLOGIES

IoT has following technologies:

1. Privacy and security

Security is an important factor in all over the aspects that can face almost in every field of life. We must ensure the Internet-of-Things (IoT) safety and privacy. IoT is the largest field in the computer science, so we can manage the privacy and security challenges of IoT (Aly, Elmogy, & Barakat, 2015).

2. Network Communication

In network communication the communication between one device to another device. There are communication models that use for the communication. The communication models are

a) Device to device communication
b) Device to cloud communication
c) Device to Gateway communication

3. Cloud Computing

In cloud computing directly communicate with cloud service. The advantage of cloud communication is that the wireless communication like WIFI create connection over the cloud services. Smart devices like smart TV, smart phones and many other devices use cloud database where data can be analysed home energy utilization (Karen Rose, Scott Eldridge, Lyman Chapin, 2015).

4. Software Applications

Many software applications used in IoT such as sensor, smart grid and many more. These applications used IoT. Many hardware's also used in IoT. They make our life easier (Karen Rose, Scott Eldridge, Lyman Chapin, 2015).

5. Internet

Internet is most widely used all around the world. We can use internet for many reasons for example, if we search anything we can google it, if we want to connect with over beloved once we can use internet etc. Hence internet can make our life easier (Karen Rose, Scott Eldridge, Lyman Chapin, 2015).

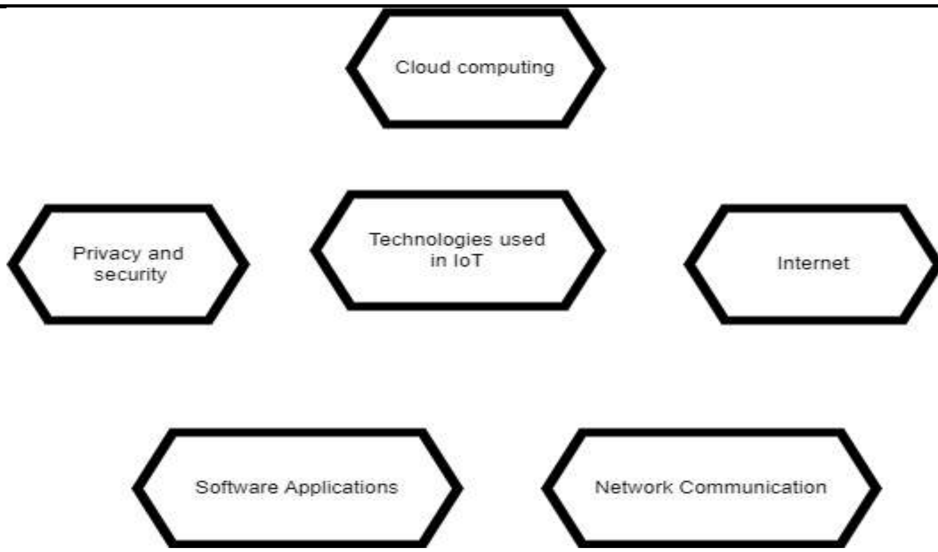

Figure 12: ***Technologies used in IoT*** *(Karen Rose, Scott Eldridge, Lyman Chapin, 2015)*

FUTURE OF IOT

There may be future of IoT which are following:

I. IoT and sensor

Most sensors don't utilise their output data effectively. The functionality of the technology may be enhanced by developing analytics features, according to 62% of the firms that participated in the poll. More training on analytics tools was also regarded by 45% of respondents as a possible solution. The manufacturers also noted aspects including increased mobility, computer power, and data storage capacity (Falguni Jindal, Rishabh Jamar, & Prathamesh Churi, 2018).

II. IoT and mobile data

The creation of data via IoT sensors is not very effective. Smartphones, which are essential to the Internet of Things, are typically used to gather the data. Smartphones serve as the user interface for IoT applications. They are a bad choice, though. The majority of network traffic nowadays is routed over Wi-Fi access points in the absence of IoT administrations. What transpires if the knowledge is multiplied by "n" times? Similar to this, mobile networks and communication devices have severe drawbacks in some areas, including high costs, unreliability, and power consumption (Banafa, 2014).

III. IoT and volume of data

IoT applications produce a lot of data. It is a reality that: Since a large portion of the data created via IoT applications is worthless noise from devices whose states are unchanged, it is not necessary to keep the whole quantity of data generated via IoT applications on the cloud. To avoid a storage problem in the future when using IoT devices, the most important difficulty is selective storage of information on a cloud in this context. Additionally, it states that users would receive only accurate and pertinent information, and that remaining (junk) data generated by IoT devices will be properly removed (Falguni Jindal, Rishabh Jamar, & Prathamesh Churi, 2018).

IV. IoT and data centers

Applications for the Internet of Things produce plenty of data. It is a fact that not all of the data generated by IoT applications has to be stored in the cloud since a significant percentage of it is useless noise from devices whose statuses have not changed. The most significant challenge is selective cloud storage of data in this instance in order to prevent a storage issue in the future when employing IoT devices. Additionally, it adds that IoT device-generated data would be correctly erased and that consumers will only receive accurate and pertinent information (arjani, M., Nasaruddin, F., Gani, A., Karim, A., & , Hashem, I. A. T., Siddiqa, A., & Yaqoob, I., 2017).

V. IoT as a future technology

IoT is a global development of several disciplines. Some of the fundamental IoT building elements are currently in general usage and include microcontrollers, microprocessors, sensors, and networking devices. Much if they are becoming smaller and more accessible to produce, they have shown to be even more effective nowadays (Falguni Jindal, Rishabh Jamar, & Prathamesh Churi, 2018).

BIG DATA

The phrase "big data" describes a collection of enormous datasets where conventional techniques cannot be continued. It consists of a data sets or collection of data sets whose time complicity, velocity, growth of rate is difficult to catch, control and examine like conventional database. Data is created from different source and appear on system at numerous places. Size of data is from tera byte to petabyte and moving fast toward exabyte (Umar Ahsan, Abdul Bais, 2016).

Big data have four dimensions also called “4 V” which are following:

1. Velocity

Velocity means speed of the data. When data comes from other device it should be high speed and when data download from other device it also should be high speed

(R. Khan, S. Khan, R. Zaheer & S. Khan, 2012).

2. Volume

Volume means amount of data. IoT stores lot of data, records, information on devices. This is the challenge of the data that it stores large amount of dat. Many organizations use big data to store their data (Umar Ahsan, Abdul Bais, 2016).

3. Variety

Data can be arrived from different source for example mp3, mp4, radio signals and so on. These data can be stored in right context is the biggest challenge. Another challenge is that with the data, manage the storage and format of the data. Otherwise change the quality of the data. For example, the quality of the data can be changed (Shivanjali Khare & Michael Totaro, 2020).

4. Veracity

Veracity means "Truthness" of the data. IoT face many challenges like hardware failure that cause data loses. The Truthness of the data should be maintained. It is mandatory to difference between dependable and independent data (Shivanjali Khare & Michael Totaro, 2020).

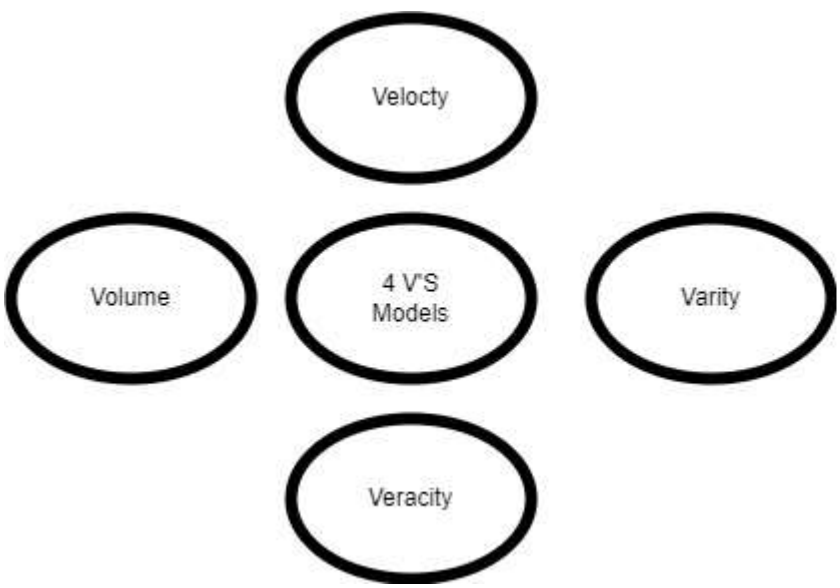

Figure 13: ***4 V's model*** *(Shivanjali Khare & Michael Totaro, 2020)*

BIG DATA ANALYTIC PLATFORM

Different analytic platform of big data is following:

1. Hadoop

Hadoop is a free and open-source software system for storing and analysing multiple information. The Hadoop Distributed File System is the most significant component of the Hadoop architecture. It was created in 2005 as a companion to the Nutch search engine project. Hadoop is a java-based system for storing and processing large amounts of data. (Hafiz Burhan Ul Haq, Haroon Ur Rashid Kayani, Saba Khalil Toor, Sadia Zafar, & Imran Khalid, 2020).

2. Apache Spark

It's also open-source, like Apache Hadoop, but it's used to reduce Map-constraints, Reduces such as fault tolerance and linear scalability. It has a fast response time and is simple to use (Gulia & Chahal, 2020).

3. Dryad

It may be used to create a data flowchart for both parallel and distributed data sets. Without learning concurrent programming, a user can utilise numerous computers at the same time. It is effective at handling cluster failures, graph creation, allocating work to available free computers, and visualising jobs to free machines (Isard, M., Budiu, M., Yu, Y., Birrell, A., & Fetterly, D. Dryad, 2007).

4. Apache Drill

It's part of a distributed system that analyses Big IoT data. It works with a variety of query languages. It has the ability to handle web servers at once. HDFS is used for storage, while Map-Reduce is used for analysis (Kelly, J., 2013).

5. Storm

It's used to handle a large amount of data. It makes use of real-time information that must be shared and fault tolerant. It generates a data cluster in the same way as Hadoop clusters do. It is a supervisor and a slave node at the same time. (Gulia & Chahal, 2020).

6. Splunk

It's a hybrid of big data and cloud computing. The user may examine, search, and evaluate the data via a web interface. It aids in the indexing of machine-generated structured and unstructured data. As a result, it is appropriate for IoT Big Data sets. It's a smart assistant for real-time and business-focused data discovery (C.L.P., Chen, C.Y. Zhang, 2014).

7. Jasper soft

It is a free and open-source programme for actual data analysis. It visualises data from a variation of sources, including MongoDB, Cassandra, and Redis. It has the ability to generate strong HTML (Gulia & Chahal, 2020).

8. Apache Mahout

It's open-source big data software that doesn't require a licence. It is employed in the field of automated learning. It's used to apply various machine learning techniques. It is used by large corporations such as Google, Yahoo, Amazon, IBM, Twitter, and Facebook to create scalable machine learning algorithms (Gulia & Chahal, 2020).

9. 1*010data*

It is made up of database columns. It can operate with semi-structured data. It can sustain infrastructure on a massive scale. It is deemed insufficient for extracting, manipulating, and loading data. It also offers complex analytic services such as statistical analysis and optimization (V. Morabito, 2015).

10. Sap-Hana

It's utilized for massive IoT data analytics in-memory addressing operations. It provides answers to a variety of large unformed IoT data problems. SAP-Hana includes libraries for visuospatial skills, text analysis, and R language support (F. Farber, S. K. Cha, J. Primsch, C. Bornh¨ovd, & S. Sigg, and W. Lehner, 2012).

11. HP-HAVEn

Hadoop Autonomy Vertica Enterprise was introduced by HP (HAVEn). This platform is used by HP that has a large number of solutions for Big IoT data analytics. It is used for large amounts of data that are examined using a columnar database. It is capable of parallel processing (S. Burke, 2013).

12. Hortonworks

Hortonworks is a platform built on Hadoop. It's used to analyse Big IoT data. It is an enhanced version of Hive that is open-source software. It is unable to decrease the number of vertices in a group (Hortonworks., 2019).

13. Pivotal Big Data

On a public cloud, it is deployed, tested, and implemented. It comes with a single licence. Massive parallel processing is made easier using Pivotal. IoT data may be used for predictive analytics, but it should be stored in HDFS. (Y. Zhuang, Y.Wang, J. Shao, L. Chen, W. Lu, J. Sun & B.Wei, and J. Wu, 2016).

14. MapR

MapR provides large data and analytics, additionally incorporating various Hadoop modules to boost speed. MapR offers its own way to system recovery. In comparison to Hadoop, however, MapR is more complex (Ejaz Ahmeda,, et al., 2013).

APPLICATIONS OF BIG DATA

Different applications of big data are following

1. Retail

With the help of IoT, we can use smart retail. Smart retail means now we can use many apps and sensor that can detect the information about the product like its price, number etc. It can help shopkeeper about the product. Foer example one Product is about to finish. With the help of sensor or application shopkeeper detect this information about the product (J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, 2013).

Figure 13: ***Smart Retail*** *(Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017)*

2. Health

IoT has numerous applications in healthcare. We can join sessions of doctor's and physicians by seating in our homes. In covid when there is ban outside than we can connect to doctors by seating in or house. These are all done with the help of IoT (Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017).

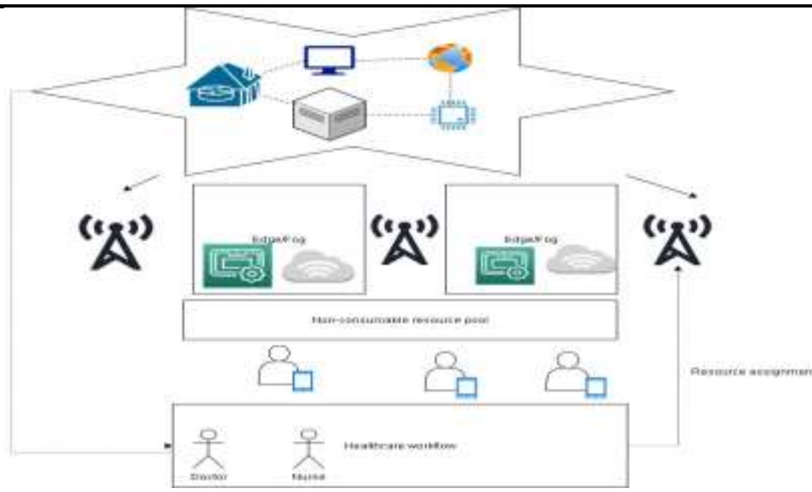

Figure 14: ***Health care in IoT*** *(Mirza Abdur Razzaq and Muhammad Ali Qureshi, 2017).*

3. Marketing

Marketing analytics assists businesses in evaluating their marketing success, analysing customer behaviour and purchasing patterns, and analysing marketing trends to aid in the modification of marketing techniques such as ad placement on a website, dynamic pricing, and tailored goods (Abhay Kumar Bhadani & Dhanya Jothimani, 2016).

4. Banking

Big data can also be used in banking. Customers' investment worthiness may be assessed using demographic information, behavioural data, and financial employment (Abhay Kumar Bhadani & Dhanya Jothimani, 2016).

5. Education

Big data can be used in education sectors. We can computerize course module and give feedback according to teaching patterns. It also assists teachers in evaluating their teaching technique and making adjustments depending on student performance and needs (Khadija Ahaidous,Mohamed Tabaa. Hanaa Hachimi, 2023).

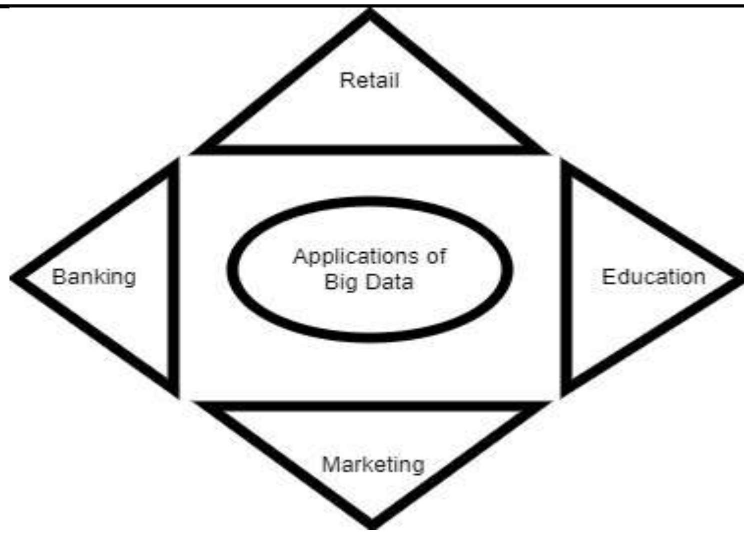

Figure 15: ***Applications of Big data*** *(Abhay Kumar Bhadani & Dhanya Jothimani, 2016).*

INTERNET OF THINGS AND ITS IMPACT ON BIG DATA

The internet of things impacts on people, processes, things and data which are following:

I. People

As more items are watched and controlled, individual capacities increase as a result (Alansari, Z., Anuar,, , Kamsin, A.,, Soomro, S., Belgaum, & M. R., 2017).

II. Processes

More devices and users will be able to communicate with one another in true moment. As a result, Even the most difficult activities may be finished with a higher proportion of involvement and involvement in a task are significantly more important (Alansari, Z., Anuar,, , Kamsin, A.,, Soomro, S., Belgaum, & M. R., 2017).

III. Data

The availability of the capacity to gather data more often and with more dependability, which can result in wise decision-making (Alansari, Z., Anuar,, , Kamsin, A.,, Soomro, S., Belgaum, & M. R., 2017).

IV. Objects

The capacity for more precise control over things. Consequently, the worth of items like mobile devices will increase and they might assist in much more than the present circumstance (Alansari, Z., Anuar,, , Kamsin, A.,, Soomro, S., Belgaum, & M. R., 2017).

RESEARCH OBJECTIVES

The goal of research on the Internet of Things (IoT) and big data in the fields of science and education is to discover novel applications of these technologies to improve learning, decision-making, resource utilization, and scientific research in a safe and ethical manner. To improve student engagement and academic results, researchers are looking at how IoT devices and sensors can develop smart, interactive learning environments that provide personalized learning experiences, adaptive assessments, and real-time feedback. In addition, they want to use big data analytics to guide decision-making in fields including curriculum development, resource allocation, and student support systems.

RESEARCH METHODOLOGY

IoT and big data applications in science and education are being studied using a varied research technique. In the beginning, quantitative techniques are used to collect and analyse vast amounts of data from various sources. This entails gathering information using sensors and IoT devices placed in educational settings, research labs, and other pertinent areas. Metrics of student performance, sensor readings, experimental findings, and diverse contextual data are examples of the types of data that may be gathered. Then, to glean relevant insights, spot patterns, and establish connections between variables, statistical analysis methods including regression analysis, data mining, and machine learning algorithms are applied.

DISCUSSION

In this paper we discuss the IoT applications, challenges, communication models, layers of IoT, features of IoT, Big data V's models, big data platforms and implementation of big data. In the contexts of education and science. We discuss that big data and IoT is an important factor in our lives. It has a significant impact on all fields of science. Every field like computer science, medical, education, entertainments industry etc. Even we communicate over the internet with our beloved once by the help of IoT communication models. Hence, in this paper we discuss IoT and big data in contexts of education and science in detail. Big data analytics may also help with curriculum development, resource allocation, and educational policy-making, resulting in policies that are supported by data and that improve educational systems. IoT devices linked with scientific equipment in the area of science may record data in real-time, automate experiments, and enable remote monitoring, enabling researchers to gather and analyze massive volumes of data. These databases may be used to derive valuable insights using big data analytics approaches, aiding scientific research, multidisciplinary partnerships, and evidence-based decision-making.

RECOMMENDATIONS

Here are some suggestions for how to deploy the Internet of Things (IoT) and big data effectively based on the possible advantages and difficulties related to these technologies in the context of science and education:

First and foremost, it is crucial to make investments in a solid infrastructure and the incorporation of technology in educational institutions and scientific research centres. This entails guaranteeing dependable connection, carefully placing IoT devices and sensors, and setting up secure data management and storage systems. To use IoT and big data tools successfully, educators, researchers, and administrators need also receive enough training and assistance.

The standardisation and interoperability of data should also be emphasised. The establishment of common data standards and protocols would enable smooth data integration and interchange across many platforms and devices, and is something that educational institutions and scientific communities should aim towards. Effective data analysis, comparison, and cooperation will be made possible by this interoperability, improving insights and research results.

Throughout the implementation phase, privacy and security should come first. To ensure compliance with applicable laws, educational institutions and research organisations should create strict data privacy policies. Sensitive data should be protected via encryption, access restrictions, and anonymization methods, while simultaneously encouraging openness and consent in data collection and usage procedures.

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