Survey on IoT using Big Data

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ABSTRACT

The Internet of Things (IoT) is rapidly transforming business strategies and disrupting markets. To collect and share data billions of physical devices around the worlds are connected to the internet. Integration of different technologies is the main factor in IOT. Without requiring human-to-human or human-to-system interaction they have the ability to send the information over a network interconnecting physical and virtual things. Internet of Things connected devices that include sensors, actuators, services and other internet connected objects to provide effective way of learning and interaction. In this paper explaining about IoT architecture, technologies, applications and challenges in future with the help of big data.

Keywords: Distributed Computing Internet of Things, Sensors, Data collection, Security, Privacy, Secure multi-party computation.

I. INTRODUCTION:

The IoT is a concept that depends on interconnected physical objects which creates a interconnect of devices that can able to generate information. Sensors are around us like in cars, buildings, and smart phones that can collect data about our environment [1]. IoT enables us to know things that need replacing, repairing or recalling [2]. These things can contact and interrelate with their neighbours to reach unified goals [3]. The evolution of the IoT relies on technical innovations in many fields, from wireless sensors to Nanotechnology. These innovations allow ideas to turns into specific products or applications. The evolution of the IoT relies on technical innovations in many fields, from wireless sensors to Nanotechnology. These innovations allow ideas to turns into specific products or applications. IoT generates numerous amount of data called as "Big data," provides advanced analytic techniques makes machine usage easier and efficient way. The Big data analysis is an advantage of its potential for high-level modelling and knowledge engineering. The Big data challenge is enable to understand the interaction between human and smart objects, but with the IoT the objects determine the content. Therefore, the impact on human life is an open issue which needs understanding how IoT plays an important role in a smart environment and smart world [5].

II. REVIEW OF RELATED WORK

Internet of Things and Its Work:

Big Data is quickly becoming the next big asset for many application areas. It would not be surprising for organizations to begin selling data of all types, including the metrics, knowledge, and insights received from the data accumulated and analyzed. Striving on this wave of Big

Data is Internet of Things (IoT). Technology, along with minimum storage costs, is making easy for organizations to process large amounts of data; as a result, a new trend is evolving known as "capture it all." Capture it all means collecting as much data about customers' product usage and behaviours as possible because the data collected may be useful for future purpose. At a time when organizations know the benefits of Big Data, IoT provides innovative ways of capturing data that can enhance these benefits.

Internet of Things is the concept of things (animals, people or objects) with a unique identifier can automatically transfer data over a network without human interaction. There are a number of devices that can be connected to the Internet to create a network of 'things' that interact with each other to make intelligent decisions. This is nothing new; the concept of Ubiquitous computing and sensor networks has been in use for a long time. Four technology trends are fuelling the IoT revolution and renewing interest, they include:

1. *Big Data*: Big Data's success is making people to realize the value of data, including the ways to identify valuable insights from data once considered junk. IoT deployments can produce huge amounts of data, as sensors are constantly sensing the data and triggering real-time events. It becomes relatively easy for the data to get accumulated over-time and the big data ecosystem or platform makes it easy to process these huge amounts of data.
2. *Cloud Computing*: With the introduction of Cloud computing, computing power and data storage has become cheaper and easier to store and process data in Cloud.
3. *Ubiquitous connectivity*: With the rapid increase in using of smart phones with data plans along with the demand for connectivity to the Internet over smart phones, the infrastructure has been upgraded. Many IoT architectures are piggy backing on connectivity of the smart phone.
4. *Low cost sensors*: The cost of Wi-Fi sensors and devices is in gradual fall. Standards like *Near Field Communication (NFC)*, and *iBeacon* are becoming mainstream and supported by smart phones. As a result, App Developers can use them creatively to build IoT use cases. These improvements in the Bluetooth technology, *Bluetooth low energy or BLE*, are also becoming a catalyst to the IoT revolution. In addition to the above, the ability of superior sensors to discreetly capture data is also a stimulus.

III. ARCHITECTURE OF IOT

The components that consist of IoT have been in existence for many years, with the possible exception of wearable's, and even wearable's have been around for ages if you count the digital watch. What is difference between the sheer number of devices with sensors that are now being connected, the ability of these devices to communicate in a manner that is much less proprietary and utilizing the existing networks to move data. The large number of sensor produce large amounts of data, but now with large-scale storage of data possible (big data) and the ease with which the data can be morphed into useful information and displayed on ubiquitous devices such as smart phones, this data becomes useful in many, many ways. The underlying thing that makes IoT is distinguishable; of sensors, network bandwidth, data storage, development tools and platforms, compute power … to be useful and ubiquitous IoT has to use very low-cost technology at different levels. The concept of automated control systems, Machine to Machine (M2M) and other like technologies have been around for decades, however in the last few years the commoditization of all what is needed to create IoT has come about. To understand IoT and this distinguishable feature has different core layers of technology that are needed in an IoT solution. Additional vertical layers of management and security are not shown, as they are not strictly necessary to understand how an IoT solutions works are framed, but rather are the ancillary but important layers needed as IoT matures.

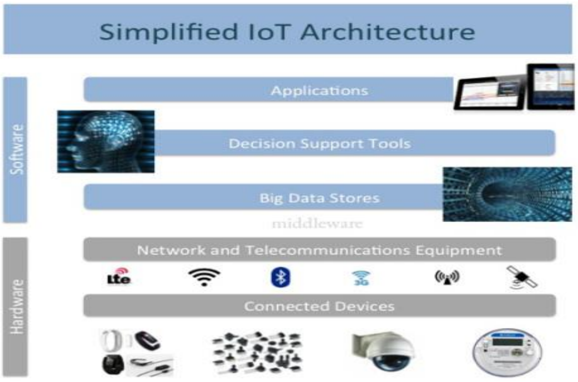

Fig. Example on IOT using Big Data

The foundation layer to IoT is the combination of **Connected Devices**. These devices include processors, memory and sensors that enable you to discover something about the device, it history, its current operating state or something about the environment it is located. When coupled together, the sensors enable the device to become smart, to not only report on its health, but also to accept commands to take action.

Consider a conference that is simultaneously transmitting information to audiences in three cities. When a presenter asks the audience a survey question, they can respond by raising their hands to indicate agreement to the proposition. As the vote is taking place, the total vote tallied across all three cities is displayed to the presenter and the audience in real time. Actually, that innovative set-up became reality recently at Free scale. We did that, in part, to illustrate the potential of the Internet of Things (IoT). Here is how it works. Each audience member is built-in with a wristband embedded with motion sensors. Sensor data from the wristband captures the movement of the audience member's wrist. To minimize communications bandwidth consumed by the devices to reduce the power consumption for wireless communications, contextually aware algorithms running on the wristband interpret sensor data and look for data patterns that suggest vertical displacements matching to a user raising his hand. When such a signature movement is present, the wristband transmits its data to a wireless access point situated at that conference location.

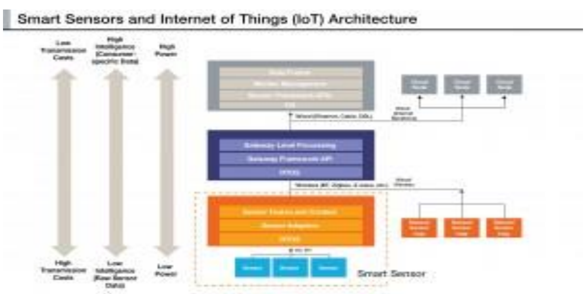

Figure 1. An example of IoT architecture Free scale used for the live vote tallying exercise

The wireless access points towards time-stamping of the data which receives from the wristbands and then forwards the information expeditiously to a cloud-based application which uses the results from the wristbands in all three conference locations to conclude when the presenter is taking a vote. Whereas the algorithms running in the wristband can recognize vertical motion, which is difficult to discern whether the sensor is moving vertically because a user is raising his hand, or simply a listener is fidgeting or standing up. The intelligence in the cloud, however, can notice the duration of a narrow window of time were sensors carried by a larger portion of the audience moving up simultaneously and deduce to a vote that it should tally.

Sensors at the Source

The figure 1 illustrates the architecture challenges of IoT. At the source, IoT-connected device is often one or more sensors. A sensor converts signals from physical environments such as motion, magnetic field or ambient pressure into digital data. As sensors provide data continuously and autonomously, sensor data can quickly exceed human-generated data in volume. To assuage data congestion and associated transmission costs, smart sensors can make a real-time fortitude on the salience or relevance of the data and transmit them only when they are deemed potentially used by upstream applications. For example, an algorithm on a motion sensor can determine the sensor which may be inactive and can skip an update. A more sophisticated contextual algorithm can differentiate between the wearer raising his hand and other actions such as standing up. Introducing intelligence at the data source can reduce the bandwidth communications which may consume by sensor data and protract the battery lives of battery-powered wireless sensor nodes. However, computation capacity at the sensor node is more costly than cloud computing, and intelligent sensors designed for a specific application which may be a less effectively adapted to a different rationale.

Distress security is critical for the Intelligence at the data source. The aim is to require negotiation between cloud-based applications and data sources for permission to use their data, in part or as a whole based on different security and privacy protocols.

Figure2. Sensors are the root as a primary source of data for the Internet of Things, bringing layered intelligence to enrich human experiences

This is particularly aware in body-worn sensors which can record signals that may seem meaningless to the individual. When these signals are combined with other information in a data-mining algorithm, they cannot deliberately infringe consumer privacy. At the access level, the demands generated by sensor data can also be keen. Sensor data is real-time data, so gateways may be required to help synchronize different sets of sensor data and control data latency. Sometimes further contextual processing may occur at the gateway to reduce uplink bandwidth requirement. Within the cloud, to a large number of task workers from multiple servers and applications, are available with the set of sensor data .So the same wristband which is tracking the votes of a conference could be monitoring the wearer’s activity level, and helps to predict the daily traffic pattern. The wristband given in the example is the IoT-connected devices, which will dwarf all connectivity by 2020, including human-to-human, human-to-machine and machine-to-machine connections. Four factors:

- The decreasing cost of sensors and actuators, especially based on micro-electromechanical systems (MEMS) technology, make the vast deployment more feasible.
- The decreasing cost of Wi-Fi routers makes massive connectivity more feasible.
- The Internet Protocol Version 6 (IPv6) extends the number of unique Internet addresses to connect trillions of physical objects.
- Ubiquitous smart phones and tablets demonstrate the process and results of unprecedented connectivity.

IV. IOT TECHNOLOGIES

The IoT involves devices to obtain technology from the physical world and transform them into data. Technologies in IoT can be classified into data acquisition and network acquisition technologies.

- Data Acquisition Technologies Because of the rapid growth in computer hardware, software, the Internet, and sensors, the mobile communications have developed to enhance services. Additionally, they have extended into new application areas, with better enhancements, services and features with minor costs.

a) Two-dimensional code

It is a barcode that represent the data that the machine can read it. The one-dimensional code can read characters and numbers only and cannot read Chinese letters and images. The two-dimensional code was evolved to solve the one-dimensional code issues. The two-dimensional code handles black and white pixels that are represented on a 2D plane to save information. In the two-dimensional code, (0) expresses white, and (1) expresses black. The advantage of the two-dimensional code is the ability to express a variety of information as sounds, images, texts, and numbers. The Two-dimensional bar code was evolved by algorithms. The usual structure of images is monochrome BMP that result in the minimum volume in bytes [10].

b) RFID Technology

RFID technology can read remote source at a long distance. The identification code related to a tag so that, the resulting tag code can be sent to one or more readers. RFID involves of data communication between devices' readers and RFID tags, and it is a standard technology that can be used by many constructors. Therefore, accurate standards occur to confirm appropriate implementation. These standards are the EPC Global UHF v.1.2.0 and ISO 18000-6C. Many bank cards and roll tags are using passive tags [10],[11]. Communications can be created by active tags that have onboard battery provision. The main application of active tags is monitoring cargo in the part container. By comparing RFID with two- dimensional barcodes, the main advantage of RFID than two- dimensional barcodes is the ability of non-contact operation without user intervention [12].

c) Sensor

We can use sensors to describe objects or devices. There are varieties of sensor types as active pixel sensors, digital sensors, and biosensors.

• Active pixel sensor (APS) is an image sensor involving of an integrated circuit including a collection of pixel sensors; each pixel has a photo indicator and an operating amplifier. An essential benefit of CMOS APS architecture is its high efficiency [13].

• Digital sensors a digital sensor that is an automated or electrochemical sensor, wherever conversion and transmission of data are completed digitally. The specification required for digital measurement and wireless transmission manage remote PC-based sensor diagnostics, tracking, and analysis. Applying the massive operating capacity, result in hard analogy electronics requirements enhancement [14].

• The biosensor is an analytical device used for determining analytic that include biological components and physicochemical detector. Biosensors depend on screen printed, so it is used for a large extent construction. Despite the biosensors composed from bio-components, many challenges face biosensors as long response time, short constancy, and poor generation [15].

- Network Acquisition Technologies

WSN is a principle network that permits things to form communication with each other. Wireless radio interfaces have small varieties, and hence intermediate nodes are used for the spread of data. One, several or all nodes in the sensor network can behave as gateways to the Internet. The key benefit of WSN is that the probability of peer-to-peer communications among the nodes exists. The variability of short scope access networks is merged with a wide range network like the Internet to design an enormous intelligence network. Therefore, the things are connected to each other in their small network, and the small network can be connected to large networks to complete the IoT [10], [11].

a) Zigbee

Zigbee is a wireless network technology constructed for little sensor degree. This protocol includes the network layer, the infrastructure layer, and the application layer. These layers are defined in its concepts [10].

b) Z-Wave Z-Wave is a wireless interconnection technology that authorizes spread from a management entity to one or more entities in the network. It consists in its architecture of the network, infrastructure, and application layers [10].

c) 6LoWPAN

Low-power Wireless Personal Area Networks (Lo WPANs) are a wireless network that consists of a vast quantity of low-cost devices. They are measured with similar wireless networks. Lo WPAN includes challenges as small packet sizes, low bandwidth, and low power, large volumes of devices, battery groove, and unreliability from radio connectivity challenges. When they are merged with the Internet Protocol (IP), the constraints of Lo WPAN are suited. So, there is 6LoWPAN [10].

V. APPLICATIONS OF IOT

The IOT is not a similar in temperament theory. The value of IOT comes from many applications which is useful to human life. Applying solutions will be the primary principle invention engine for these applications. There exist some successful applications already developed in different fields like transportation, smart environments domain, health care domain, food sustainability, and futuristic applications [4], [6].

A. Transportation

1. Smart parking

The smart parking offers solutions for managing parking which helps drivers to save time energy and fuel. By providing accurate information about vehicles parking spaces, it will be useful for making traffic flow better and reduce traffic jam [6].

2. 3D Assisted driving

Vehicles like cars, buses and trains that are integrated with sensors can give useful information to the driver to save better navigation and safety. By using 3D assisted driving, the drivers can find out the correct path based on prior knowledge about traffic jam and accidents [6].

B. Smart environments domain

1. Smart water supply

In smart cities, water supply should be track to assurance that the water amount is sufficient for human needs. The smart cities can be able to detect water loss problem before it occurs, and so it can save on the budget significantly. It helps the smart cities to detect the water disclose sites and identify reform priority to prevent much amount of water from loss [6].

2. Smart homes and offices

Sensors, actuators, and controllers can be added to several home and office devices as a fan, for home based appliances like fridge, washing machine, air conditioner, and microwave. For example in Turkey, they apply an application for a home that is, a solution for many problems. This application can monitor home remotely, detect fires, protect home from thefts, and control devices as a heater and air conditioners from remote devices as a tablet, computer or phone [6], [13].

VI. CHALLENGES AND FUTURE DIRECTIONS OF IOT

In many application fields, the IoT offers several new prospects to the industry and end user. The IoT needs theory, technology, architecture, and standards that join the virtual world and the real physical world in a merged outline. Some key challenges are listed in the following subsections.

1) ***Architecture Challenge:*** IoT covers an extensive variety of technologies. IoT includes a cumulative number of smart interconnected devices and sensors such as cameras, biometric, physical, and chemical sensors. They are often nonintrusive, visible, and hidden. The devices are connected in a wireless or ad hoc manner as the communication may occur at any time and the facilities turn into mobile dependent and more complex. In IoT, data collected from different resources so it will be difficult to integrate these heterogeneous data. The solution is to collect data from various sources and determine the common characteristics between them to explain data and find the associations to support decision-making. The existence of heterogeneous reference architectures in IoT is important. IoT architecture must be reliable and elastic to suit all cases as RFID, Tags, intelligent devices, and smart hardware and software solutions [19].

2) ***Environment Innovation Challenge:*** IoT is a complicated network that may be achieved by some sponsors, where services can be openly produced. Therefore, new services or applications should be supported without resulting loads for the market accesses or other operation blocks. So, the cross-domain systems supporting innovation is still deficient [4].

3) ***Technical Challenge:*** There are several technical challenges as varied architecture in the network technologies and applications. IoT contains different types of networks that are not easy to integrate them. The cost of communication technology should be small and connections must be reliable. Defining the form of suitable security and privacy solution is a complicated process. Activation of automated services stills a challenge [4], [19]. It should be able to provide adequate device to store information, network, and compute capacity to continue with the inflow of new data [22], many data processing challenges are listed in the following subsections:

a) Heterogeneous Data Processing:

In IoT applications, the enormous data are gathered from heterogeneous sensors such as cameras, vehicles, drivers, passengers, and medical sensors. It results in heterogeneous sensing data like text, video, and voice. Heterogeneous data processing as fusion, classification gets exclusive challenges and also provides many advantages and new opportunities for system enhancement [23]. An IoT system may include various types of sensors whose data have heterogeneous data structures. For example, IoT system may contain many forms of sensors were each category can be separated into different forms of sensors, such as traffic sensors, hydrological sensors, geological sensors, meteorological sensors, and biomedical sensors.. The sampling data from different sensors may have a disparate semantics and data structure that critically raises the troubles in data processing [23].

b) Noisy Data Noisy data is irrelevant data:

The term was often used as a replacement for abnormal data, but its significance has extended to hold data from the unstructured text that cannot be understood by machines such that it cannot be recognized and translated correctly by machines. Slightly data that has been collected, stored, or altered or used by the program that originally made it can be identified as noisy. Statistical analysis can used in collected the information from old data to clear noisy data and simplify data mining [5]. Anomaly detection is the recognition of irregular events or patterns which is not considered as expected events or patterns.

c) Massive -Intensive Data:

Massive data signifies its volume which may be terabytes or pet bytes in size and indicated to a Big data. All the data processing methods which are appropriate to be applied at a data canter. The data to be handled in IoT are massive data. In an IoT system, there could be a considerable amount of connected sensors, and these sensors incessantly send sampling data to the data centre. The data canter needs to save the latest forms of the sampling data and also needs to save past forms of the data for some period say one week to offer query processing, state monitoring, and data analyzing. The size of data can be visualized to be massive and processing them effectively is a significant challenge [22].

VII. CONCLUSION

The IoT denotes to spreading the Internet of physical objects such as a room, table, or another human sensing objects as collections of features. They can be detected, determined, and accessed by devices like actuators, sensors or other smart devices. As the vast increasing of existing devices, sensors, actuators and network communications, a massive amount of data has been generated. There are many problems result in the increasing of data volume as massive, heterogeneous, noisy data, privacy, and security. Applications of IoT have been presented. Technologies have been surveyed from the perspective of data acquisition and network based. Finally, challenges have been discussed.

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