Internet of Things (IOT): Research paper challenges and future application

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Abstract: As the Internet of Things (IoT) develops as the next stage in the evolution of the Internet, it becomes essential to recognize the different potential areas of IoT applications and the research challenges associated with these applications. From smart cities to healthcare, smart agriculture, logistics and retail, and even smart living and smart environments, IoT is expected to permeate every aspect of daily life. Although current IoT enabling technologies have improved significantly in recent years, there are still many issues that require attention. Since IoT concepts come from heterogeneous technologies, many research challenges can arise. The Internet of Things is so vast and touches almost every aspect of our lives, which makes it an important research topic for research in various related fields such as information technology and computing.The IoT thus opens the way to new dimensions of feasible research. This article presents the latest developments in IoT technologies and discusses future applications and research challenges.

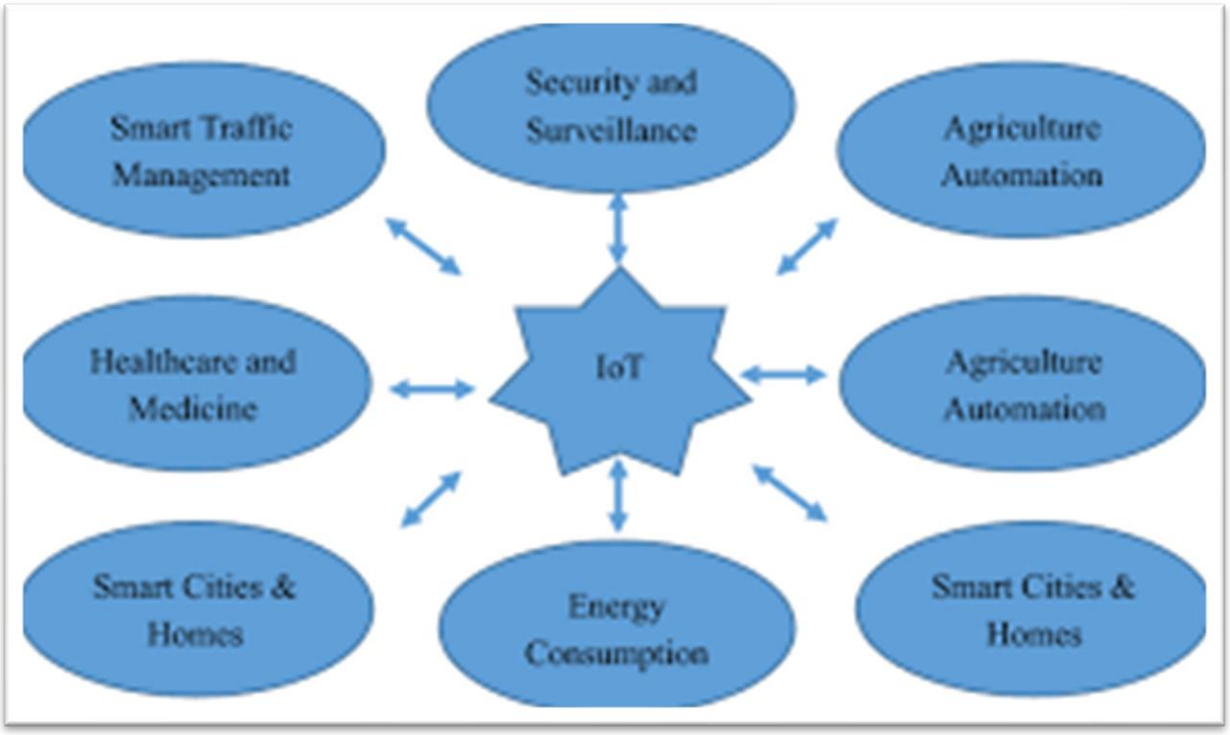
Keywords: Internet of things; IoT applications; IoT challenges; future technologies; smart cities; smart environment; smart living

Introduction: The term " Internet of Things" (IoT) was coined by Kevin Ashton in a 1999 presentation at Procter & Gamble. He is one of the founders of the Automatic Identification Laboratory at the Massachusetts Institute of Technology. He pioneered RFID technology (for barcode detectors) in supply chain management. He also founded Zensi, a company that produces energy sensing and monitoring technologies. The Internet of Things is an emerging topic of technological, social, and economic importance. Consumer goods, durable goods, cars and trucks, industrial components and facilities, sensors and other everyday objects combined with Internet connectivity and powerful data analytics promise to change the way we live and to work. With the widespread

implementation of Internet of Things devices and technologies, our daily lives have undergone significant changes. The Internet of Things is everywhere, even if we don't always see it or know that devices are part of it. For consumers, new IoT products such as internet-enabled devices, home automation components, and power management devices are driving us towards the "smart home", providing greater security and energy efficiency. Other IoT personal devices such as wearable fitness and health monitors that enable connected medical devices are changing the way healthcare services are delivered. The Internet of Things transform physical objects into a shared information ecosystem across wearable, wearable, and even implantable devices, enriching our technology and life data. 4044 Internet of Things technologies are expected to benefit people with disabilities and 4044 the elderly, improving quality levels of independent living at a reasonable cost. IoT systems such as connected vehicles, intelligent transportation systems, and sensors embedded in roads and bridges bring us closer to the idea of "smart cities" that help reduce congestion and energy consumption. IoT Technology has the potential to transform agriculture, industry and energy.

The definition of the Internet of Things (IoT) is not clearly defined . There is currently no definition, which means that there is no common definition of the majority of the global community of users, so the Internet or the Internet of Things matures and continues. Become the newest and most popular concept of information technology in the world. A "thing" in the IoT can be any device, any type of sensor that incorporates the 's ability to collect data and send it over the network without human intervention. The technology embedded in the object facilitates communication with internal conditions and the external environment, thus facilitating the decision-making process.

Application of IoT: The potential applications of IoT are not only numerous but diverse as they permeate nearly all aspects of the daily life of individuals, organizations and communities. IoT applications are said to cover many areas such as manufacturing or business, healthcare, agriculture, smart city, security and emergency.



A. Smart cities: IoT is said to play an important role in making cities smarter and improving infrastructure. Some of the IoT applications for building smart cities include: smart transportation, smart buildings, traffic congestion, waste management, lighting, smart parking and indoor maps. This may include different functions such as; monitor urban parking lots, monitor vibrations and equipment in bridges and buildings, install sound monitoring equipment in sensitive urban areas and monitor pedestrians and vehicles. Artificial Intelligence (AI)-enabled IoT can be used to monitor, control and reduce traffic congestion in smart cities. In addition, IoT enables the installation of smart and climate-controlled street lighting, as well as the detection of garbage and waste containers by tracking garbage collection times.Smart roads can provide alerts and important information, such as receiving weather changes or unexpected events such as traffic crashes and accidents.

B. **Healthcare:** Most health systems in many countries are inefficient, slow and error-prone. This is easy to change because the healthcare industry relies on many activities and materials that can be used and improved through technology. Other technologies that can make things easier, such as sharing information, storing information, and delivering medicine to many people and places, will go a long way in transforming the healthcare industry. The many

benefits of IoT applications in healthcare are mainly categorized as tracking patients, staff and products, identifying and validating the same people, gathering information and insights. It can improve the hospital's business when the patient is followed up.Also correct analysis and analysis, pay attention to the child's care and conflict, to reduce the problems that harm patients. Also, automated data collection and conversion is essential for process automation, reducing paperwork, automating program audits, and managing medical supplies. The sensor technology provides patient-centered functionality, particularly in diagnosis and using real-time information about patients' health indicators.

Smart management: According to , the IoT has the capacity to strengthen and enhance the agriculture sector through examining soil moisture and in the case of vineyards, monitoring the trunk diameter. IoT would allow to control and preserve the quantity of vitamins found in agricultural products, and regulate microclimate conditions in order to make the most of the production of vegetables and fruits and their quality. Furthermore, studying weather conditions allows forecasting of ice information, drought, wind changes, rain or snow, thus controlling temperature and humidity levels to prevent fungus as well as other microbial contaminants

When it comes to cattle, IoT can assist in identifying animals that graze in open locations, detecting detrimental gases from animal excrements in farms, as well as controlling growth conditions in offspring to enhance chances of health and survival and so on. Moreover, through IoT application in agriculture, a lot of wastage and spoilage can be avoided through proper monitoring techniques and management of the entire agriculture field. It also leads to better electricity and water control.

Retail: Executing the IoT in Supply Chain or retail Management has many benefits. Some include; observing storage conditions throughout the supply chain, product tracking to enable trace ability purposes, payment processing depending on the location or activity period in public transport, theme parks, gyms, and others. Inside

the retail premises, IoT can be applied to various applications such as direction in the shop based on a preselected list, fast payment processes like automatically checking out with the aid of biometrics, detecting potential allergen products and controlling the rotation of products on shelves and warehouses in order to automate restocking procedures

The IoT elements mostly used in this setting include; wireless sensor networks and radio frequency identification. In retail, there is a current use of SAP (Systems Applications and Products), while in logistics numerous examples include quality consignment conditions, item location, detecting storage incompatibility issues, fleet tracking among others. In the industry domain, IoT helps in detecting levels of gas and leakages within the industry and its environs, keeping track of toxic gases as well as the oxygen levels within the confines of chemical plants to ensure the safety of goods and workers and observing levels of oil, gases and water in cisterns and storage tanks. Application of IoT also assists in maintenance and repair because systems can be put in place to predict equipment malfunctions and at the same automatically schedule periodic maintenance services before there is a failure in the equipment. This can be achieved through the installation of sensors inside equipment or machinery to monitor their functionality and occasionally send reports.

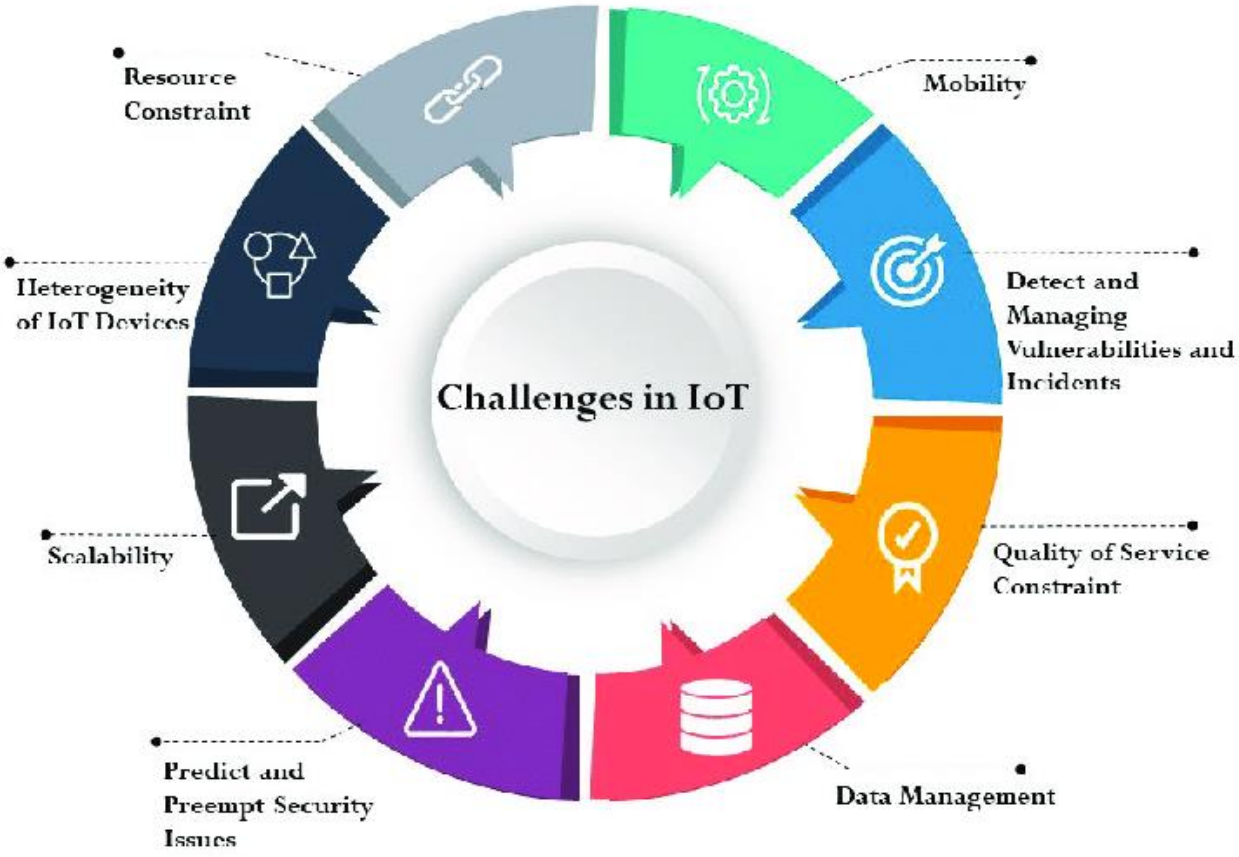
C. **Smart living:** In this domain, IoT can be applied in remote control devices whereby one can remotely switch appliances on and off hence preventing accidents as well as saving energy . Other smart home appliances include refrigerators fitted with LCD (Liquid Crystal Display) screens, enabling one to know what is available inside, what has over stayed and is almost expiring as well as what needs to be restocked. This information can also be linked to a smartphone application enabling one to access it when outside the house and therefore buy what is needed. Furthermore, washing machines can allow one to remotely monitor laundry. In addition, a wide range of kitchen devices can

be interfaced through a smartphone, hence making it possible to adjust temperature, like in the case of an oven. Some ovens which have a self-cleaning feature can be easily monitored as well. In terms of safety in the home, IoT can be applied through alarm systems and cameras can be installed to monitor and detect window or door openings hence preventing intruders .

D. **Smart environment:** The environment has a vital role within all aspects of life, from people, to animals, birds and also plants, are all affected by an unhealthy environment in one way or another. There have been numerous efforts to create a healthy environment in terms of eliminating pollution and reducing wastage of resources, but the existence of industries, as well as transportations wastes coupled with reckless and harmful human actions are common place elements which consistently damage the environment. Consequently, the environment requires smart and innovative ways to help in monitoring and managing waste, which provide a significant amount of data that forces governments to put in place systems that will protect the environment. Smart environment strategies integration with IoT technology should be created for sensing, tracking and assessment of objects of the environment that offer potential benefits in achieving a sustainable life and a green world. The IoT technology allows observing and managing of air quality through data collection from remote sensors across cities and providing round the clock geographic coverage to accomplish better ways of managing traffic jams in major cities . IoT sensor networks can control radiation through constant monitoring of its levels, particularly around nuclear plant premises for detecting leakage and propagating deterrence.

Research challenges: For all the above potential applications of IoT, there has to be proper feasibility into the different domains to ascertain the success of some applications and their functionality. As with any other form of technology or innovation, IoT has its challenges and implications that must be sorted out to enable mass adoption. Even though the current IoT enabling technologies have greatly improved in the recent years, there are still numerous problems that require

attention, hence paving the way for new dimensions of research to be carried out. Since the IoT concept ensues from heterogeneous technologies that are used in sensing, collecting, action, processing, inferring, transmitting, notifying, managing, and storing of data, a lot of research challenges are bound to arise. These research challenges that require attention have consequently spanned different research areas



A. Privacy and Security: Owing to the fact that IoT has become a vital element as regards the future of the internet with its increased usage, it necessitates a need to adequately address security and trust functions. Researchers are aware of the weaknesses which presently exist in many IoT devices. Furthermore, the foundation of IoT is laid on the existing wireless sensor networks (WSN), IoT thus architecturally inherits the same privacy and security issues WSN possesses . Various attacks and weaknesses on IoT systems prove that there is indeed a need for wide ranging security designs which will protect data and systems from end to end. Many attacks generally exploit weaknesses in specific

devices thereby gaining access into their systems and consequently making secure devices vulnerable . This security gap further motivates comprehensive security solutions that consist of research that is efficient in applied cryptography for data and system security, non-cryptographic security techniques as well as frameworks that assist developers to come up with safe systems on devices that are heterogeneous.

B. **Processing, Analysis and Management of Data:** The procedure for processing, analysis and data management is tremendously challenging because of the heterogeneous nature of IoT, and the large scale of data collected, particularly in this era of Big Data . Currently, most systems utilize centralized systems in offloading data and carrying out computationally intensive tasks on an international cloud platform. Nevertheless, there is a constant concern about conventional cloud architectures not being effective in terms of transferring the massive volumes of data that are produced and consumed by IoT enabled devices and to be able further support the accompanying computational load and simultaneously meet timing constraints . Most systems are therefore relying on current solutions such as mobile cloud computing and fog computing which are both based on edge processing, to mitigate this challenge. C. Monitoring and Sensing Even if technologies concerned with monitoring and sensing have made tremendous progress, they are constantly evolving particularly focusing on the energy efficiency and form aspect. Sensors and tags are normally expected to be active constantly in order to obtain instantaneous data, this aspect makes it essential for energy efficiency especially in lifetime extension. Simultaneously, new advances in nanotechnology/biotechnology and miniaturization have allowed the development of actuators and sensors at the Nanoscale.

C. Scalability: Internet of Things has a big concept than the conventional Internet of computers, because of things are cooperated within an open environment. Basic functionality such as communication and service discovery therefore need to function equally efficiently in both small scale and large scale environments. The IoT requires a new functions and methods in order to gain an efficient operation for scalability.

D. Self-Organizing: Smart things should not be managed as computers that require their users to configure and adapt them to particular situations. Mobile things, which are often only sporadically used, need to establish connections spontaneously, and able to be organize and configure themselves to suit their particular environment. Data volumes: Some application scenarios of the internet of things will involve to infrequent communication, and gathering information's form sensor networks, or form logistics and large scale networks, will collect a huge volumes of data on central network nodes or servers. The term represent this phenomena is big data which is requires many operational mechanism in addition to new technologies for storing, processing and management.

E. Data interpretation: To support the users of smart things, there is a need to interpret the local context determined by sensors as accurately as possible. For service providers to profit from the disparate data that will be generated, needs to be able to draw some generalizable conclusions from the interpreted sensor data.

F. Interoperability: Each type of smart objects in Internet of Things have different information, processing and communication capabilities. Different

smart objects would also be subjected to different conditions such as the energy availability and the communications bandwidth requirements. To facilitate communication and cooperation of these objects, common standards are required.

G. Power supply: Things typically move around and are not connected to a power supply, so their smartness needs to be powered from a self-sufficient energy source. Although passive RFID transponders do not need their own energy source, their functionality and communications range are very limited. Hopes are pinned on future low power processors and communications units for embedded systems that can function with significantly less energy. Energy saving is a factor not only in hardware and system architecture, but also in software, for example the implementation of protocol stacks, where every single transmission byte will have to justify its existence.

H. IoT understanding: The issue is how to increase number of people who they able to understand the changes and the implications more clearly. “The pace of change has exceeded the rate of human capability to absorb, the cup is already full” said Jeff Kavanaugh VP and Senior partner in High Tech and Manufacturing for Infosys. IoT is going beyond of calling it by early stage as connected devices to be smart, immersive, and converting the data it collected to valuable data about object, operation, or individual person. The fast expedition and IoT learning will lead to down sensor costs, enabling more business cases that was very expensive in the past. Other factors need to be mentioned here related to social, legal, and ethical issues keys mentions: The key social, legal, and ethical issues facing the IoT, as discussed by the Oxford Internet Institute are: Global misinformation systems, big data problems, public attitudes, opinions, and behaviour, tightly coupled systems, Quality of

service issues, new forms of risk, and linking the IoT to work on responsible innovation.

Voice-Controlled Devices: The question here is touching things left and right is the best idea? Nowadays we can confirm that not the best idea due to ongoing COVID pandemic. Not only for this reason but also for the general convenience we can shift towards the interfaces. Starting from ATMs non touchable to the voice control panels in our industrial fields, for sure voice technology is already changing the way of our interaction with some of objects around us. But as usual there is hazard here, voice-controlled devices raise privacy and security challenges. Some of the main concerns here is related to the voice payments or any financial transactions will use this facility. This point will take us back to the one of the major IoT trends, which is the enhanced IoT security. IoT systems will be more secure in the near future to give us the right time to explore new possibilities.

Internet of Medical Things: From this headline Internet of Medical Things, we can come up with slogan "The power to save lives". The development of medicine is going with cooperation with the technological progress at the same time. IoT and its future may bring more positive changes to the healthcare field. The whole world had already need to re-evaluate the importance of remote healthcare specially with the ongoing COVID pandemic. Security and safety are essential requirements in the clinical environment, but with present of IoT it can helps by improving the monitoring and processing patient data. Shortly patients and doctors will not even be required to be meet face to face, which will be the most useful during the lockdown, in such it happens again. We can confirm that shortly, IoT trends will get more great influence in the healthcare field, with all the smart medical devices becoming more popular.

We can say that the functions of e-Health devices can include the following:

• Monitoring: which it gives the ability to the devices to be able to monitor your heart rate, blood pressure, and other health markers.

• Emergency response: With this option for the devices will be able to send you an alarm as well as recommendations in case of a health emergency and/or call you an assistance.

• Fitness assistance: with this option for the devices will be able to offer some general assistance as well as advice during the physical training.

• Reporting: with this option for the devices will be able to collect data about your condition and send it to your doctor. All the above was only just the tip of the mountain in showing how the new technology will change the way we are dealing with health. Hopefully in the current or coming decades we can see how the nanotech devices can collect data about our conditions, report the same to doctors, as well as assistance in healing us as we go. We can assuming that the future of the Internet of Things and we need to be ready for it.

5G and IoT: 5th Generation 5G technology will be main component of the next network society. 5G will help a lot of connected devices to meet the expected real time, reliability communication needs for application performance. 5G will also provide wireless connection for so many applications and use cases, including smart cities, smart homes. It will also accelerate the development cycle of the internet of things. 5G will be leader of the global IoT. Main features of the new 5G technology are reviewed and presented in.

Massive IoT: Massive IoT means the services typically expanding relaying on a huge number of devices, sensors, and actuators. Sensors are low cost and very low energy consuming. But in fact, generated data by each sensor will be small, and very low latency. While actuators are also low cost, they will have varying energy footprints ranging from very low to moderate energy consumption. Here we will show Vertical markets for Massive IoT tech, figure 4 shows the massive IoT applications.

Critical IoT: Critical IoT means applications like traffic safety/control, control of infrastructure and wireless connectivity for industrial processes. These applications require high reliability and availability when we talk about wireless connectivity, as well as low latency. On the other hand, Devices low cost and energy consumption but not important as it for Massive IoT applications. Also, the amount of data transported from and to devices not large, wide instantaneous bandwidths are useful in order to meet capacity and latency requirements.

CONCLUSION: The IoT can best be described as a CAS (Complex Adaptive System) that will continue to evolve hence requiring new and innovative forms of software engineering, systems engineering, project management, as well as numerous other disciplines to develop it further and manage it the coming years. The application areas of IoT are quite diverse to enable it to serve different users, who in turn have different needs. The technology serves three categories of users, individuals, the society or communities and institutions. As discussed in the application section of this research paper, the IoT has without a doubt a massive

capability to be a tremendously transformative force, which will, and to some extent does already, positively impact millions of lives worldwide. According to, this has become even more evident, as different governments around the world have shown an interest in the IoT concept by providing more funding in the field that is meant to facilitate further research. A good example is the Chinese Government.

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