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Internet of Things in Africa

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Abstract:

The Internet of things (IoT) is the next great revolution in global industry, technology, and life. It is one technology that is penetrating the world so fast and is being adopted to create smart homes, smart environment, smart cities, connected automobile, wearables, and industrial Internet. Companies worldwide use IoT technology to improve efficiency and accessibility in their everyday operations. IoT is recently emerging for African enterprises that are innovating and establishing technological growth. The IoT is gaining momentum across Africa and has the potential to solve many problems on the continent. It is the real chance for Africa to be part of the global economy. The IoT market in Africa is expected to experience significant growth in the coming years. This paper examines the adoption of IoT in African nations.

Keywords: Africa, Internet of things, IoT, Internet of things for Africa.

INTRODUCTION

Africa is a continent that has 54 countries with an area of 30,370,000 square km and 1.4 billion individuals as of 2021, subdivided into five major regions, like Northern Africa (with countries like Libya, Egypt, North Sudan, Algeria, Morocco, and Tunisia as demonstrated) inhabiting the northerly region of Africa [1]. The continent is not just catching up with the world; it is propelling itself to the forefront of innovation. Africa is rising, and its tech scene is leading the way. Africa is closely watched as the next big growth market. It is the home to some of the youngest populations in the world. Africa is a booming continent with incredible growth potential, as the second-largest continent in the world and the world's largest free trade area, connecting 1.3 billion people (16.6% of the world population) across 55 nations.

Today, the Internet has become an indispensable part of life. When it comes to the Internet, the Internet of things (IoT) has taken center stage. The IoT is a giant network of connected things and people. The idea behind creating IoT was the amalgamation of the physical world into computer based systems. Some of the examples of IoT devices are cell phones, washing machines, laptops, etc. With IoT, anything that can be connected shall be connected. This is best illustrated in Figure 1 [2]. Internet of things is a tool for connecting physical objects to the virtual world using sensors and some Internet protocols to lessen human interventions.

The Internet of things refers to the billions of physical devices connected to the wireless Internet that allows exchanging data around the world. With IoT technology, we are fast moving towards a society where everything and everyone will be connected. IoT is transforming the education sector and making learning simpler and faster [3-5].

From financial services to agriculture, digital technology is being leveraged to deliver greater access and usher in the "future of everything" in Africa. Figure 2 shows smart Africa's vision statement [6]. The African continent has been slower in embracing the IoT concept compared to most developed nations, but Africa is now increasing it level of intake of IoT. The rise of IoT in Africa is driven by several elements such as a need to digitize industries such as manufacturing, transportation, agriculture, and retail. The African continent as a whole is also seeing an increasing adoption of IoT. Several African nations, such as South Africa, Kenya, and Nigeria, are investing in IoT to improve their infrastructure, increase efficiency, and reduce costs.

CONCEPT OF INTERNET OF THINGS

The term "Internet of things" was introduced by Kevin Ashton from the United Kingdom in 1999. Internet of Things (IoT) is a network of connecting devices embedded with sensors. It is a collection of identifiable things with the ability to communicate over wired or wireless networks. The devices or things can be connected to the Internet through three main technology components: physical devices and sensors (connected things), connection and infrastructure, and analytics and applications.

The IoT is a worldwide network that connects devices to the Internet and to each other using wireless technology. IoT is expanding rapidly and it has been estimated that 50 billion devices will be connected to the Internet by 2020. These include smart phones, tablets, desktop computers, autonomous vehicles, refrigerators, toasters, thermostats, cameras, pet monitors, alarm systems, home appliances, insulin pumps, industrial machines, intelligent wheelchairs, wireless sensors, mobile robots, etc. A typical IoT is shown in Figure 3 [7].

The Internet of things is much more than a simple technology. There are four main technologies that enable IoT [8]:

1) Radio-frequency identification (RFID) and near-field communication.
2) Optical tags and quick response codes: This is used for low cost tagging.
3) Bluetooth low energy (BLE).
4) Wireless sensor network: They are usually connected as wireless sensor networks to monitor physical properties in specific environments.

Other related technologies are cloud computing, machine learning, and big data.

The Internet of things (IoT) technology enables people and objects to interact with each other. It is employed in many areas such as smart transportation, smart cities, smart energy, emergency services, healthcare, data security, industrial control, logistics, retails, government, traffic

congestion, manufacturing, industry, security, agriculture, environment, and waste management. Figure 4 shows the most widely used application areas of IoT [9].

IoT supports many input-output devices such as camera, microphone, keyboard, speaker, displays, microcontrollers, and transceivers. It is the most promising trend in the healthcare industry. This rapidly proliferating collection of Internet-connected devices, including wearables, implants, skin sensors, smart scales, smart bandages, and home monitoring tools has the potential to connect patients and their providers in a unique way.

Today, smartphone acts as the main driver of IoT. The smartphone is provided with healthcare applications.

The narrowband version of IoT is known as narrowband IoT (NBIoT). This is an attractive technology for many sectors including healthcare because it has been standardized [10]. The main feature of NBIoT is that it can be easily deployed within the current cellular infrastructure with a software upgrade.

The Internet of things (IoT) is essentially the connection of devices to the Internet.

IoT network connects various types of devices like tablets, smartphones, personal computers, laptops, and wearable devices.

USE OF INTERNET OF THINGS IN AFRICA

The Internet of Things (IoT) has revolutionized the way we connect with and interact with our environment. IoT technology significantly impacts the lives of those across Africa. It is already making its presence felt on the African continent by addressing a host of issues around security, water control, energy, health monitoring, mining, agriculture, manufacturing, government, and traffic congestion. Here we consider IoT is some selected industries.

- Healthcare: Integrating IoT-based solutions in healthcare transforms healthcare delivery in Africa. IoT is being used for healthcare solutions that provide better diagnosis and remote treatment options for patients. IoT-based solutions facilitate telemedicine consultations, connecting patients in remote or underserved areas with healthcare professionals. Remote monitoring of patients in rural or underserved areas is now possible, connecting them to medical professionals miles away. RFID tags track medical equipment and supplies in the healthcare sector. Hospitals and clinics can better manage resources, reduce waste, and improve patient care.
- Automotive Industry: The automotive industry is using sensors and beacons embedded in the road working together with car-based sensors to be used for hands-free driving, traffic optimization, and accident avoidance. Automotive IoT covers IoT use cases in mobility and transportation settings. Among the various segments within the IoT market, the automotive IoT sector is expected to dominate with a projected market volume of US$9.17bn in 2024. This indicates the increasing integration of IoT technology within the automotive industry [11]. An IoT environment delivers more intelligence on the assembly line or in the manufacturing process.
- Agriculture: Agriculture is a key player in nearly all African nations and it occupies a pivotal role in the improvement of the continent's economy. Digital agriculture is an ever-expanding field focused on the enhancement of farming through improved information and communication processes. An IoT sensing platform can make digital farming accessible to small-scale farmers in rural Africa. It helps in enhancing agriculture productivity by manifolds. The platform provides information on the state of the soil and surrounding environment coupled with computer vision to classify the type of soil. It has been tested and deployed in real work

environment in Uganda and South Africa [12]. Farmers can attach RFID tags to animals, and this helps in disease control, breeding management, and tracking livestock movements. For example, agricultural land in Nigeria was found to be 77.7% in 2016 as well as employment in agriculture to be 36.55 % in 2017. This makes agriculture an important sector in Nigeria.

- Mobile Applications: In Africa, mobile numbers are people's unique identifiers for digital services. IoT mobile applications play a significant role in connecting people and data by enabling devices to communicate with each other and users through smartphones or tablets. They empower individuals to harness the potential of IoT technology to improve efficiency, convenience, and security. They can analyze data from connected devices to provide insights and trends, helping users make informed decisions. IoT mobile apps enable users to access and control their IoT devices from anywhere with an Internet connection, increasing convenience and accessibility [13].
- Business: African businesses are grappling with the new reality of the digital age. At its core, digital transformation fundamentally changes everything for businesses. With the massive number of interconnected things, businesses all over the world are positioning themselves to tap into the huge potential that IoT brings. Businesses in countries all over Africa are now using IoT applications to improve their business environment as well as the lives of the citizens.
- Government: IoT technology is being used by government agencies and commercial companies to make vital services such as utilities more efficient and accessible. Reforming governments have started to appear across the length and breadth of Africa.
- Entertainment: Africans have embraced digital entertainment in recent years, most notably in Nigeria and South Africa, two of the continent's most sophisticated markets. Internet-based video content has truly taken off in Africa, competing with broadcast TV for consumer attention. The growing popularity of digital entertainment among African consumers can be attributed to better network coverage and the wider availability of affordable smartphones. African consumers increasingly want to create their own viewing/listening mix when it comes to digital entertainment. Figure 5 shows a group of ladies enjoying digital entertainment [14].
- Tourism: Tourism is a social, cultural, and economic phenomenon which entails the movement of people to places outside their usual environment. Although information and communication technologies (ICT) have been adopted in some aspects of the tourism industry, there is further room to enhance the performance of this industry through the adoption of IoT technologies. For example, the mission of the South African Department of Tourism is to create a conducive environment for growing and developing tourism through innovation, strategic partnerships, provision of information, and knowledge management services. South Africa is endowed with archaeological sites, arts and culture sites, botanical gardens, caves, historical sites, museums, natural wonders, waterfalls, world heritage sites, blue flag beaches, etc. for tourism. IoT has a place in the monitoring and tracking of wild animals. The adoption of IoT for the South African tourism industry enhances the efficiency of the industry, and impacts on the South African economy [15].

ADAPTING INTERNET OF THINGS IN AFRICAN NATIONS

In Africa, we are seeing an increased adoption of IoT technology, which is specifically being used to transform the lives of individuals on the continent. African countries such as Ghana, Nigeria, Rwanda, and South Africa have seen a steady rise in successful IoT implementation meant to improve key areas of sustainable development—water monitoring being one of the most popular sectors. Figure 6 displays an official checking Internet-based water monitoring device at a borehole in Burkina Faso [16]. We examine how IoT technology is being used in some selected African nations [17,18]:

- South Africa: This country is taking the lead in terms of adopting the IoT. It is one of the fastest-growing IoT markets in the continent. The IoT boom in South Africa presents an array of opportunities across various sectors. The IoT technology promises smarter cities, streamlined logistics, enhanced healthcare, and improved energy management. One of the key examples of how IoT is used in South Africa is electronic tolling systems, which are an innovative technology that uses sensors and digital connections. The systems connect everything from traffic status and the number of vehicles passing through toll gates to electricity grids and traffic controls. The E-toll system collects tolls electronically without human intervention since there are no physical booths on the highway. This tolling system utilized IoT technology to make toll payments more efficient and cost-effective via an IoT-based electronic tag. Figure 7 shows the toll system on the highway [18]. Headquartered in South Africa, Africa Wildlife Tracking (AWT) is using ORBCOMM's state-of-the-art satellite modems to provide secure, near real-time GPS tracking and monitoring of large animals such as elephants in some of the world's most remote regions and densest forests. The ORBCOMM modem's small size and low-power consumption transceivers have resulted in improved longevity and performance in the battery-powered elephant collars [19,20].
- Nigeria: This country is the biggest mobile market and most populous African country. It has enormous prospects in IoT, which if effectively implemented is likely to bring about increased productivity across all economic sectors and an improved standard of living for Nigerians. In Nigeria, IoT is being used for monitoring and controlling energy consumption in buildings, and for tracking and managing medical equipment. The National Agency for Food and Drug Administration and Control (NAFDAC) in 2010 resorted to the IoT-based product verification initiative to curb drug counterfeiting by using radio frequency identification (RFID). The IoT solution used tags equipped with RFID to secure the integrity of the drugs throughout the supply chain. Figure 8 shows how RFID tags are used to present counterfeit drugs [18]. One of the most important applications of IoT in Nigeria was the use of RFID cards and readers in the 2015 general elections. The technology was used to check the authenticity of voters in the elections and greatly improved the credibility of the process by its ability to detect fake and cloned Permanent Voter Cards (PVCs), thus curbing massive thumb printing. Another important application of IoT technology in Nigeria is the use of Unmanned Aerial Vehicles (UAVs) in the fight against terrorism [21]. IoT Africa is the Sigfox operator for Nigeria. Sigfox in Nigeria will build the low power wide area network and allow connectivity of Sigfox compliant devices to connect on the network. With IoT Africa as a Sigfox, the Nigerian economy should expect a substantial boost. IoT Africa is aiming to offer a wide range of high-quality connected products such as utility meters, gas sensors, health watches, smart ID, smoke detectors, container trackers and street lighting solutions [22].
- Kenya: In Kenya, IoT is being used for smart city initiatives, including traffic management and waste management. Nairobi County in Kenya have been struggling with waste management challenges for a long time. In Kenya, an IoT-based application is being used to manage waste in an efficient and cost-effective way. It is also meant to create a digital map of the Nairobi streets. Some companies have developed sensor-based systems that can detect the amount of waste present in bins across the country. The system has been proven to reduce costs by up to 40%, making it an efficient and environmentally friendly way of dealing with waste in Kenya.
- Tanzania: In Tanzania, IoT technology is being used to stop oil pilferage within fleets via RFID technology. An IoT-enabled application using RFID was implemented to track each truck within the fleet in real-time. The application involved attaching an IoT-enabled gateway device to the truck's cabin area and RFID-enabled tags to the hatch. Usangu Logistics is a heavy transport company with a fleet of over 100 trucks and tankers dedicated to serving thousands of

customers in Tanzania with oil, lubricants, and other bulky products. An IoT-enabled gateway device is attached to the truck's cabin area, and the seals are tagged with RFID-enabled tags. The implementation of this IoT-enabled solution resulted to a very severe drop in cases of pilfering of the oil that the trucks and tankers were carrying.

- Egypt: In Egypt, IoT technology is being used to control household appliances and improve the energy efficiency of homes. Integreight developed an IoT chip that can be integrated with modern appliances like refrigerators, cameras, TVs, washing machines, etc., allowing users to control their appliances remotely via their smartphones.
- Namibia: This small African nation is not to be left behind in the field of IoT. In order to improve the effectiveness of antiretroviral drugs, Namibia implemented an IoT-based electronic dispensing tool. Pharmacists use this tool to dispense the correct medicine in correct amounts to patients.

BENEFITS

The IoT is a distributed network of smart devices that offers an ecosystem of business and application areas as transportation, education, security, utilities, service, health, and quality delivery. The opportunities presented by IoT in Africa are huge. The benefits of IoT across a wide variety of sectors include improved access to essential resources, asset tracking, security solutions, enhanced healthcare, energy optimization, fleet management, waste management, and EV charge point infrastructure. Other benefits of IoT in Africa include the following [17]:

- *Connectivity:* In the digital world, connectivity defines convenience and efficiency. Due to the expansion of trade and transport networks, companies are working more internationally. Goods and services need to be monitored and secured while travelling vast distances. Devices require international connectivity, roaming, and in-built resilience.
- *Growth:* There are several areas that are seeing high growth due to IoT. The technology is being used to help many African countries drive rapid economic growth. Creating new jobs and helping businesses become more competitive in the global marketplace. As the IoT market continues to expand and evolve, Africa holds immense potential for growth and innovation.

CHALLENGES

The adoption of IoT Africa has been slow due to challenges such as cost, accessibility, shortage of experienced talent, infrastructure deficiencies, high levels of poverty, underdeveloped economies, and poor insights. Other challenges include the following [23-25]:

- Connectivity: In order for IoT to work effectively, it relies on high speed Internet connections. One of the main challenges in certain regions of Africa is the lack of adequate Internet connectivity. Some regions have limited mobile connectivity with few operators. Rural communities are unable to benefit from the advantages that IoT can offer. The challenge then becomes providing reliable, mobile connectivity across diverse and sometimes remote areas.
- Borderless Continent: One of the most significant challenges in Africa is creating a "borderless continent" in the sense of connectivity. The sheer size of the continent coupled with a disparate technology ecosystem creates challenges for connecting devices. Multiple Mobile Network Operators (MNOs) exist in Africa, but not a single MNO covers an entire country. Working with multiple MNOs creates operational complexity.

- Power: The unreliability, unavailability, and unaffordability of connectivity and power grid infrastructure hinder the implementation of a multi-layered IoT architecture for rural societal services.
- Regulation: Africa lacks a uniform data governance framework. A lack of comprehensive IoT-specific regulations affects data security and privacy. An African enterprise solution must factor in the variety of regulatory and legal requirements across the continent. A comprehensive IoT-specific regulations is needed to foster market confidence.
- Skills Gap: There is a lack of skilled personnel and a shortage of IoT-specific training programs. African universities should teach about Internet of things so that we create a critical mass of people who can meaningfully contribute in the evolution of the sector.
- Architecture: IoT includes a range of complex integrated smart technologies that are mobile, transparent, decentralize, and invisible. This creates complexity in IoT data integrations of a large data-set through heterogeneous environments. These necessitate heterogeneous architectures and hardware that are flexible and open standard in IoT.
- Security: Security is one of the critical issues among the various IoT technologies within the network communication such as 2G, 3G, 4G, Optic networks, or WSNs. The IoT is facing security issues increasing susceptibility to vulnerabilities, attacks, and threats to infrastructure applications and services via the Internet. The increase in security vulnerabilities, threats and attacks have raised eyebrows in Africa in both private and public firms. The major issues experienced in big data and IoT is security as a result of computing and storing large amounts of the dataset within the cloud storage.
- Compatibility: This is due to heterogeneous technologies required to connect to suitable devices. This necessitates additional software and hardware due to incompatibilities and complexity.

To address these challenges, collaborative partnerships between government, industry stakeholders, and research institutions are crucial.

CONCLUSION

The Internet of things is a system of interconnected computing devices, machines, objects, animals or people that are provided with the ability to transfer data over a network without requiring human interaction. The network of devices is capable of collecting data, sharing data over the Internet, and sourcing information for users with ease. The IoT technology has the potential to offer new jobs and provide new solutions to issues such as water and power shortages. IoT is transforming the way we live and work [26]. Every area of life stands to benefit from the innovations and efficiencies possible in a fully connected world. If explored quickly, harnessed, and implemented, IoT could be the great breakthrough for African industry and could put Africa at the forefront of this revolution.

The IoT is a reality that cannot be ignored. Although Africa is still behind the rest of the world in terms of Internet penetration, the gap is quickly closing. In spite of many obstacles to overcome, the future of IoT in Africa is bright and promising, with significant potential to transform various sectors such healthcare and agriculture. For more information about Internet of things in Africa, one should consult the following related journals:

- IEEE Internet of Things Journal,
- Internet of Things; Engineering Cyber Physical Human Systems

REFERENCES

1. W. Shafik, “Chapter 7 navigating emerging challenges in robotics and artificial intelligence in Africa,” https://www.irma-international.org/viewtitle/339985/?isxn=9781668499627
2. “New technology trends for 2022,” December 2021, Unknown Source.
3. S. Bassendowski, “Technology in education column,” *Canadian Journal of Nursing Informatics,* vol. 13, no. 1, March 2018.
4. M. M. Asad et al., “Investigating the impact of IoT-Based smart laboratories on students’ academic performance in higher education,” *Universal Access in the Information Society*, 2022.
5. M. N. O. Sadiku, U. C. Chukwu, and J. O. Sadiku, “Internet of things in education: A brief overview,” *International Journal on Integrated Education,* vol. 6, no. 5, May 2023, pp. 304-312.
6. “Tata Communications transformation services and smart Africa alliance come together to bridge skills gap in Africa,” July 15, 2019, Unknown Source.
7. A. Ghosh, “Internet of things : Basics,” March 2014, https://thecustomizewindows.com/2014/03/internet-things-basics/
8. M. N. O. Sadiku, S. M. Musa, and S. R. Nelatury, “Internet of things: An introduction,” *International Journal of Engineering Research and Advanced Technology*, vol. 2, no.3, March 2016, pp. 39-43.
9. A. M. Rahmani et al., “E-Learning development based on internet of things and blockchain technology during COVID-19 pandemic,” *Mathematics,* vol. 9, 2021.
10. S. Anand and S. K. Routray, “Issues and challenges in healthcare narrowband IoT,” *International Conference on Inventive Communication and Computational Technologies,* 2017, pp. 486-489.
11. “Internet of things – Africa,” https://www.statista.com/outlook/tmo/internet-of-things/africa
12. A. Oliveira-Jr et al., “IoT sensing platform as a driver for digital farming in rural Africa,” *Sensors* (Basel), vol. 20, no.12, June 2020.
13. D. Hattingh, “Top 5 IoT innovations transforming lives in Africa,” October 2023, https://telecoms.adaptit.tech/blog/top-5-iot-innovations-transforming-lives-in-africa/
14. “Africa & the Internet,” https://news.africa-business.com/post/africa--the-internet-
15. O. Gcaba and N. Dlodlo, “The Internet of things for South African tourism,” https://web.archive.org/web/20160910064504id_/http://researchspace.csir.co.za:80/dspace/bitstream/10204/8674/1/Gcaba_2016.pdf
16. I. Atanga, “The Internet of everything water,” May-July 2017, https://www.un.org/africarenewal/magazine/may-july-2017/internet-everything-water
17. “IoT in Africa: 4 Key use cases,” https://caburntelecom.com/iot-in-africa/
18. “6 IoT applications that improved people’s lives in Africa – A story of 6 countries,” https://www.vizocom.com/ict/6-iot-applications-that-improved-peoples-lives-in-africa-a-story-of-6-countries/

19. G. Jack, "The IoT boom in South Africa: Opportunities and challenges," December 2023, https://www.linkedin.com/pulse/iot-boom-south-africa-opportunities-challenges-jack-geldenhuys-kausc#:~:text=The%20IoT%20boom%20in%20South%20Africa%2C%20projected%20to%20reach%20a,healthcare%2C%20and%20improved%20energy%20management.
20. "ORBCOMM's IoT technology and Africa wildlife tracking track conservation efforts around the world," October 2020, https://news.satnews.com/2020/10/08/orbcomms-satellite-iot-technology-and-africa-wildlife-tracking-support-conservation-efforts-around-the-world/
21. M. Ndubuaku and D. Okereafor, "State of Internet of things deployment in Africa and its future: The Nigerian scenario," *The African Journal of Information and Communication*, vol. 15, no. 15, December 2015.
22. "IoT Africa, Sigfox seal partnership deal," https://www.iotafricanetworks.com/post/iot-africa-sigfox-seal-partnership-deal
23. R. Cohen, "The business case for IoT in Africa: Opportunities and challenges," https://flolive.net/blog/the-business-case-for-iot-in-africa-opportunities-and-challenges/
24. E. Umeh, "Digital transformation in Africa requires homegrown solutions," December 2021, https://hbr.org/2021/12/digital-transformation-in-africa-requires-homegrown-solutions?utm_medium=paidsearch&utm_source=google&utm_campaign=domcontent&utm_term=Non-Brand&tpcc=paidsearch.google.dsacontent&gad_source=1&gclid=EAIaIQobChMIo-2ymcWShgMVi4JaBR3AOgyPEAAYASAAEgKrSvD_BwE
25. J. K. Machh et al., "Towards a strategic application of IoT and big data for African societal solutions," *IST-Africa 2020 Conference Proceedings Miriam Cunningham and Paul Cunningham (Eds) IST-Africa Institute and IIMC*, 2020.
26. J. Stewart, "Challenges surrounding IoT deployment in Africa," December 2019, https://www.comparethecloud.net/articles/challenges-surrounding-iot-deployment-in-africa/

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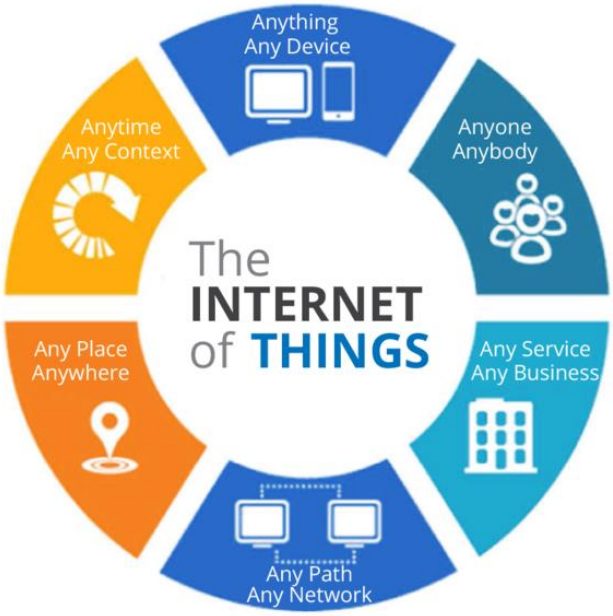

Figure 1 anything that can be connected is connected to IoT [2].

Figure 2 Smart Africa's vision statement [6].

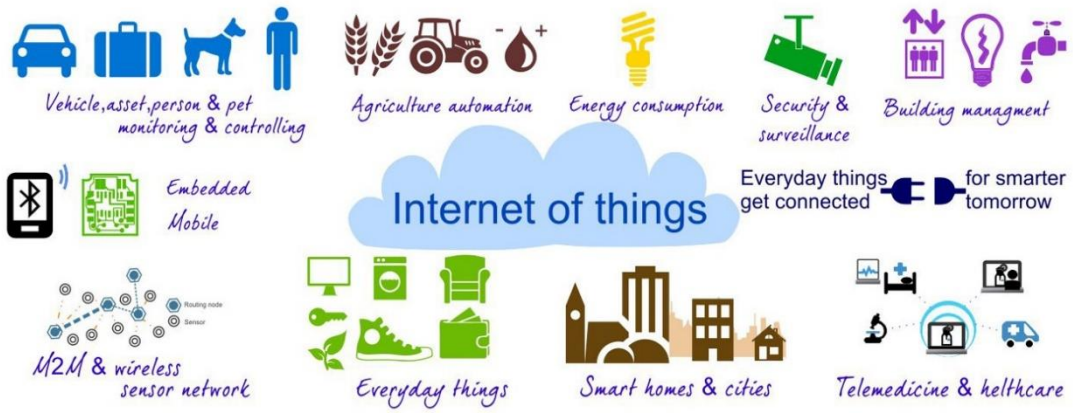

Figure 3 a typical IoT [7].

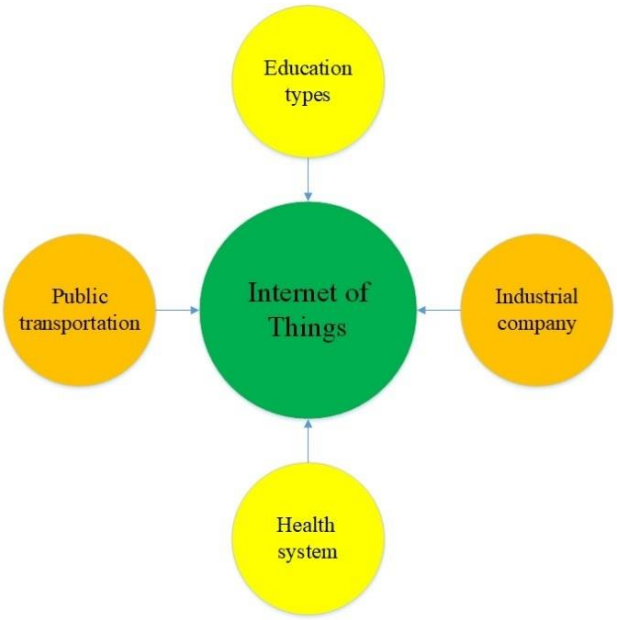

Figure 4 The most widely used IoT application areas [9].

Figure 5 A group of ladies enjoying digital entertainment [14].

Figure 6 an official checking Internet-based water monitoring device [16].

Figure 7 the toll system on the highway in South Africa [18].

Figure 8 RFID tags are used to present counterfeit drugs [18].