THE IMPACT OF EMERGING AND DISRUPTIVE TECHNOLOGIES ON SOCIETY 5.0: INTERNET OF THINGS (IoT)

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Foreword: The topic of this scientific study was generated by the International Conference, organized in Sibiu, by the "Nicolae Bălcescu" Land Forces Academy together with the Military Sciences Section of the Romanian Scientists Academy, entitled "Emerging and Disruptive Technologies` Impact on Global Security", which took place on November 18, 2021.

Abstract: *In this scientific study, we have created a challenge on the research and knowledge of one of the five most emerging and disruptive technologies that pave the way for the world of tomorrow - the Internet of Things (IoT).*

Of the five technologies that are considered the most disruptive - Artificial Intelligence (AI), Blockchain, 3D Printing, Virtual / Augmented Reality (VR / AR) and the Internet of Things (IoT) - the last one mentioned here will be developed in this study.

This scientific study deals only with the most important aspects of the IoT field, where they are analyzed and presented: historic, evolutions, structure, operation, importance, benefits, implementation, advantages and disadvantages, evolution perspectives.

Using such systems, it is possible to improve the living standards of citizens, to provide users with a safer living environment and to benefit from the facilities offered by the implementation of the "smart city" concept.

Each of these systems brings in society many benefits and good results for people's lives, work and health of them, but also some unwanted use of the new malicious technologies.

Keywords: *Emerging technologies, disruptive technologies, digitization, the Internet of Things, artificial intelligence.*

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Introduction

Undoubtedly, technology has shaped the way we live our lives, bringing us into the information age. With an unlimited amount of information at hand and countless ways to connect and communicate instantly, we can't wonder: what's next?

This study investigates how we, as citizens of Society 5.0, borrow to us disruptive technologies such as Blockchain, IoT, cloud, and software-defined networks from Industry 4.0, with its automation and digitization of production verticals, to change the way we think and act, in cyberspace, in everyday life.

The 5.0 Society concept, introduced by Japan to address one of the biggest challenges facing the country (aging population), shows that through digitalization, many seemingly insurmountable issues can be found solutions.

Just as Industry 4.0 is the concept that defines the digital transformation of the manufacturing industry, 5.0 aims to address many challenges from the digitalization of the economy to the digitalization, at all levels, of Japanese society and the (digital) transformation of society itself.

Looking ahead - more than 20% of the global population is expected to be over 60 by 2050. It is essential to look at what Japan is doing and how this Society 5.0 works in reality, because we will have many lessons to learn from the perspective of an aging population. The solution is to develop emerging and disruptive technologies to help and / or replace humans. The evolution of technology has taken place in step with the numerical growth of the population of our planet.

As of 7/27/2021 7:00 PM, the world's population numbered 7,909,566,656 people and is continues to grow (this year increased by 73,648,565)[1], of which 5,168,780,607 Internet users and owners of 5,197,259 cell phones.

The distribution of Internet users on continents is based on population size and zonal technological development and is shown in Figure 1.

[1] https://www.worldometers.info/, accessed on. 27.11.2021.

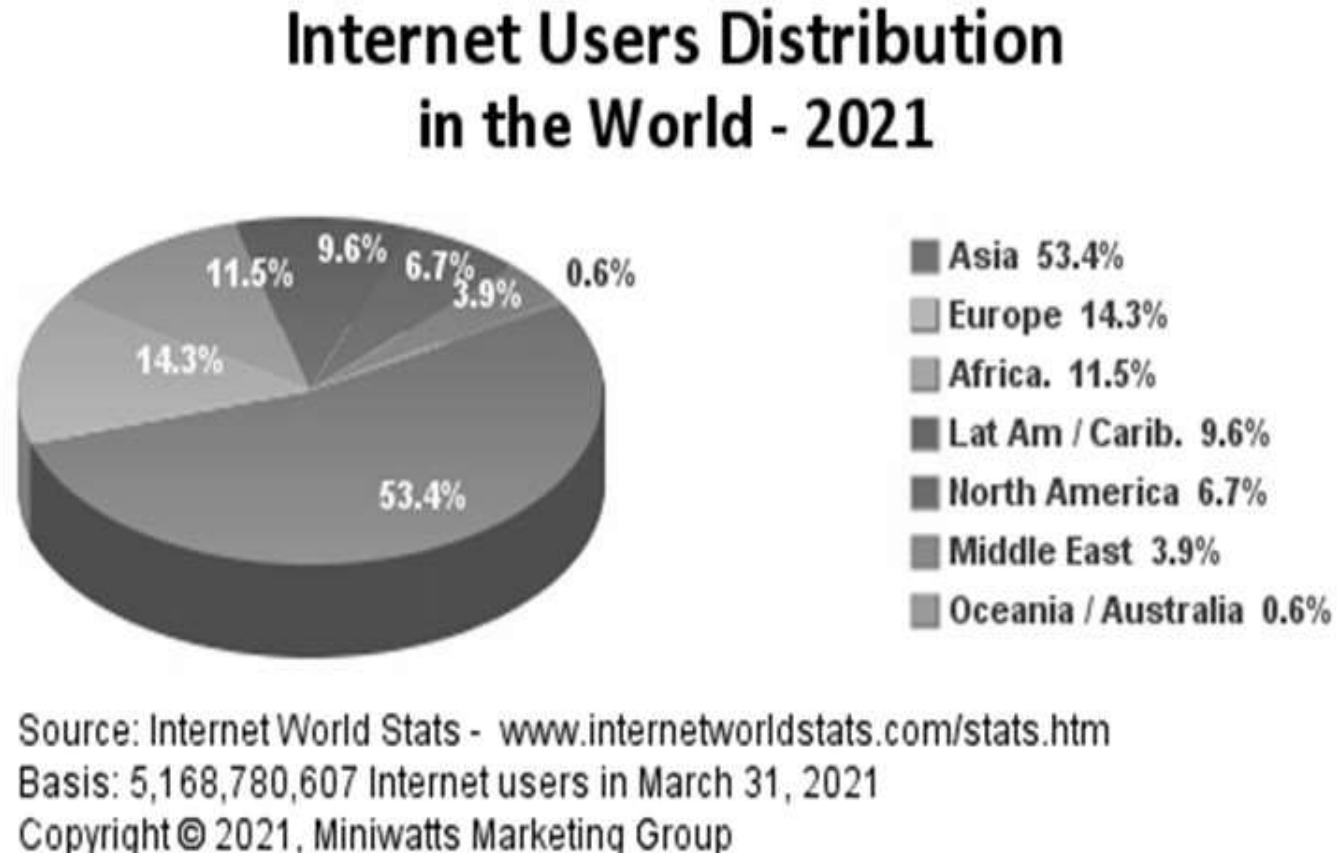

Figure 1 Distribution of Internet users[2]

Historic - "Internet of Things" (IoT) -

Today, the Internet is made up of billions of digital devices, people, services, and other physical objects with the potential to connect, interact, and exchange information about themselves and their environment.

Organizations are now using these digital devices and physical objects to produce and consume Internet-based services. This new Internet ecosystem is commonly referred to as the Internet of People, Things, and Services (IoPTS)[3]

[2] https://www.internetworldstats.com/stats.htm, accessed on 27.11.2021.

[3] Jessa Lingel, *An Internet For The People: The Politics And Promise Of Craigslist,* Series: Princeton Studies In Culture And Technology, Publisher: Princeton University Press, Year: 2020; Claire A. Simmers, Murugan Anandarajan, *The Internet of People, Things and Services: Workplace,* Series: Routledge Studies in Employment Relations, Publisher:

The expansion of information and communication technology (ICT) from desktops to laptops and ubiquitous smart objects, which perceive and communicate directly over the Internet - IoPTS, gives us the opportunity to review how the Internet is transforming our lives and jobs.

The Internet of Things (IoT) is a very popular word nowadays. The literature of recent years[4] confirms journalistic concerns in this field and demonstrates that it is a new scientific challenge on all continents of planet Earth.

Basically, it originates in the field of the Internet, ie networking, the field of sensor network research, and the field of cloud computing.

IoT is the combination of all three areas. In my opinion, in my research, some physical objects have been taken into account, such as the Internet of Things which consists of heterogeneous objects, somehow connected to each other and able to transmit some valuable information to each other and manage requests for action without human intervention. .

The Internet of Things (IoT) has brought a digital revolution to almost every aspect of our lives, such as meeting our daily needs, academic performance, product manufacturing, finance, commerce, and more. many comforts and facilities of our daily lives, if we do not take into account the issues related to the privacy and security of the IoT or the misuse of modern technologies, as major challenges for its further evolutions.

By 2018, the concept of the Internet of Things has emerged from the embryonic stage and has gradually established itself as an integral

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Routledge, Year: 2018; Dustdar, Schahram; Nastić, Stefan; Šćekić, Ognjen, *Smart Cities : The Internet of Things, People and Systems,* Publisher: Springer International Publishing, Year: 2017; Dahir, Hazim; Dry, Bil; Pignataro, Carlos, *People, processes, services, and things: using services innovation to enable the Internet of everything,* Series: Service systems and innovations in business and society collection, Publisher: Business Expert Press 2015, Year: 2015.

[4] Haya Shajaiah, Ahmed Abdelhadi, Charles Clancy, *Performance and Security for the Internet of Things: Emerging Wireless Technologies*, Publisher: McGraw-Hill Education, Year: 2021; Monika Mangla (editor), Nonita Sharma (editor), Poonam Garg (editor), Vaishali Wadhwa (editor), Thirunavukkarasu K (editor), Shahnawaz Khan (editor), *Emerging Technologies for Healthcare: Internet of Things and Deep Learning,* Publisher: Wiley-Scrivener, Year: 2021; Errol S. van Engelen, *Emerging technologies: blockchain of Intelligent Things to boost revenues,* Series: Big data, business analytics, and smart technology collection, Publisher: Business Expert Press, Year: 2020.

component of future Internet technology. Given that IoT access management technologies depend on the centralized model, which introduces technical challenges in managing them on global platforms, Novo[5] has proposed a Blockchain-based control system with distributed access to different roles and multiple IoT permissions.

The Internet of Things was first included in a 1999 presentation by Kevin Ashton[6] at Procter & Gamble at the Massachusetts Institute of Technology (MIT). Although the idea of connected devices has been in use since 1970, Kevin Ashton wanted to draw P&G's attention to RFID[7] as he made his presentation on the Internet of Things.

A coke vending machine in the early 1980s was the first Internet device to update the status of the coke temperature in stock, as well as information on recent refills. It has evolved over the years, and now we have billions of devices connected to the Internet. At a very early stage of its development, the Internet was used to assign the connection between people and things.

In 2008, the number of connections between devices via the Internet was higher than the world's population; therefore, it led to the invention of the IoT.

Simply put, IoT deals with real-world objects or physical objects with which various detection and technological devices are used to obtain sensory data from the environment and to share information via the Internet.

The main physical object of IoT is based on RFID, which collects information in microchips and makes this data transferable to the user through the wireless communication channel.

The main goal of IoT is to optimize the state of things in an organized whole by connecting different physical objects and perform various functions such as data analysis, detection of information received from other objects, application of machine learning algorithms, to track the location of the sensor, as well as for identifying, monitoring, managing and

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[5] Novo, Oscar, *Blockchain meets IoT: An architecture for scalable access management in IoT*. IEEE Internet of Things Journal, *5* (2)/2018, 1184–1195.
[6] Kevin Ashtonera era co-fondatorul Auto-ID Laboratory de la MIT.
[7] RFID - **R**adio **F**requency **ID**entification.

deciding, in collaboration with an autonomous system distributed by sensors, information about other devices.

The Internet of Things (IoT) - evolution

IoT has received a lot of attention and recognition in recent years, when in fact scientists.

They focused on the idea of collecting small pieces of information, no matter how reasonable, from a machine or device, to be transferred from source to destination.

IoT concepts are studied and published by many publishers around the world, and even though researchers come from different countries and continents, there are many common or at least similar views.

"The Internet of Things (IoT) is a network of dedicated physical objects that involves embedded technology used to interact with internal or external environments. IoT is expected to provide connectivity and information exchange anytime, anywhere in a wide variety of physical objects, such as sensors, vehicles and mobile phones"[8].

In another acceptation, *"IoT is provided as a fully connected network paradigm, which is designed to bridge the gap between machine-type communications (MTCs) and wireless data networks"*[9].

Two other authors in the field consider that *"IoT is a system that includes things, communication, data analysis and applications. It involves a massive number of objects connected to the Internet. These objects*

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[8] Q. F. Hassan, *A Tutorial Introduction to IoT Design and Prototyping with Examples,* IEEE, 2018, pp. 153-190; M. Mohammadi, A. Al-Fuqaha, S. Sorour, and M. Guizani, *Deep learning for IoT big data and streaming analytics: A survey*, IEEE Communications Surveys & Tutorials, vol. 20, Fourth Quarter, 2018, pp. 2923-2960; N. Nikaein, M. Laner, K. Zhou, P. Svoboda, D. Drajic, M. Popovic, and S. Krco, *Simple traffic modeling framework for machine type communication*, IEEE ISWCS, August, 2013, pp. 1-5; J. Zheng, D. Simplot-Ryl, C. Bisdikian, and H. T. Mouftah, *The internet of things,* IEEE Communications Magazine, vol. 49, November, 2011, pp. 30-31, *apud* Haya Shajaiah, Ahmed Abdelhadi, Charles Clancy, *Performance and Security for the Internet of Things: Emerging Wireless Technologies,* Publisher: McGraw-Hill Education, Year: 2021, p.14.

[9] S. Vural, P. Navaratnam, N. Wang, C. Wang, L. Dong, and R. Tafazolli, *In-network caching of internet-of-things data,* in IEEE International Conference on Communications (ICC), June, 2014, pp. 3185-3190, *apud* Haya Shajaiah, Ahmed Abdelhadi, Charles Clancy, *Performance and Security for the Internet of Things: Emerging Wireless Technologies,* Publisher: McGraw-Hill Education, Year: 2021, p.14.

communicate with each other while there are heterogeneous architectures, which cause the ability to secure IoT communications"[10].

It is believed that- *"In IoT, wireless sensor networks are used to detect objects and send data through communication channels, which can lead to security issues*[11]*"*.

In the area of ensuring the security of communications required for IoT, which may be a vulnerability of this new technology, it is considered that *"Security challenges in IoT communications must be taken into account when designing IoT architectures and protocols*[12]*"*.

Assortment and sharing of information by IoT devices are blockchain-supported technologies and standards[13], such as wireless communication and frequency identification (RFID) standards.

However, because many IoT devices provide information to an input, leading the information to the Blockchain network that runs on distributed registry technology, Blockchain, and IoT, as discrete advances,

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[10] F. Al-Turjman, E. Ever, and H. Zahmatkesh, *Small cells in the forthcoming 5G/IoT: Traffic modelling and deployment overview*, IEEE Communications Surveys & Tutorials, vol. 21, First Quarter, 2019, pp. 28-65; S. Pattar, R. Buyya, K. R. Venugopal, S. S. Iyengar, and L. M. Patnaik, *Searching for the IoT resources: Fundamentals, requirements, comprehensive review, and future directions*, IEEE Communications Surveys & Tutorials, vol. 20, Third Quarter, 2018, pp. 2101-2132, *apud* Haya Shajaiah, Ahmed Abdelhadi, Charles Clancy, *Performance and Security for the Internet of Things: Emerging Wireless Technologies,* Publisher: McGraw-Hill Education, Year: 2021, p.14.

[11] N. Neshenko, E. Bou-Harb, J. Crichigno, G. Kaddoum, and N. Ghani, *Demystifying IoT security: An exhaustive survey on IoT vulnerabilities and a first empirical look on internet-scale IoT exploitations*, IEEE Communications Surveys & Tutorials, vol. 21, Third Quarter, 2019, pp. 2702-2733; I. Makhdoom, M. Abolhasan, J. Lipman, R. P. Liu, and W. Ni, *Anatomy of threats to the internet of things*, IEEE Communications Surveys & Tutorials, vol. 21, Second Quarter, 2019, pp. 1636-1675.

[12] F. Meneghello, M. Calore, D. Zucchetto, M. Polese, and A. Zanella, *IoT: Internet of threats? A survey of practical security vulnerabilities in real IoT devices*, IEEE Internet of Things Journal, vol. 6, pp. 8182-8201, October 2019;
M. Yi, X. Xu, and L. Xu, *An intelligent communication warning vulnerability detection algorithm based on IoT technology,* IEEE Access, vol. 7, pp. 164803-164814, 2019.

[13] Errol S. van Engelen, *Emerging technologies: blockchain of Intelligent Things to boost revenues,* Series: Big data, business analytics, and smart technology collection, Publisher: Business Expert Press, Year: 2020.

are still limited in their applications in many areas. However, Blockchain with IoT is a concept that is becoming popular in almost every field and it would not be wrong to say that in the future, almost everything will use features of Blockchain integration with IoT.

IoT, also known as the *Internet (web) of Everything (IoE*) or *economic web,* is another innovation that could be seen as a global organization of machines and gadgets equipped to manage human activity while they function in everyday life.

In confirming this statement, I quote Haler and his collaborators who present the world in which we live: *"A world in which physical objects are perfectly integrated into the information network and in which physical objects can become active participants in business processes. The services are available to interact with these smart objects via the Internet, querying their status and any information associated with them, taking into account security and privacy issues*[14]*".*

IoT is estimated to reach twenty-six billion units by 2020, up from 0.9 billion in 2009. IoT has a wide range of uses, such as transportation, agriculture, health care, electricity generation and distribution, security, defense, etc.

The IoT structure is composed of the following layers:

1. Perception layer: Responsible for detecting the environment and sending the collected data to the network layer, there are different types of sensors used in this layer to collect data.

2. Network layer: Intended to connect to other similar types of sensors, this layer is also responsible for collecting and transmitting sensor data.

3. Application layer: Used to provide application-specific services to the end user, this layer has been used to develop user-centric services such as smart home, smart health, and smart city.

The structure of IoT is shown graphically in Figure 2.

[14] Haller, S., Karnouskos, S., & Schroth, C. (2008, September). *The internet of things in an enterprise context,* [Symposium]- Future Internet, Springer, Berlin, Heidelberg, pp. 14–28.

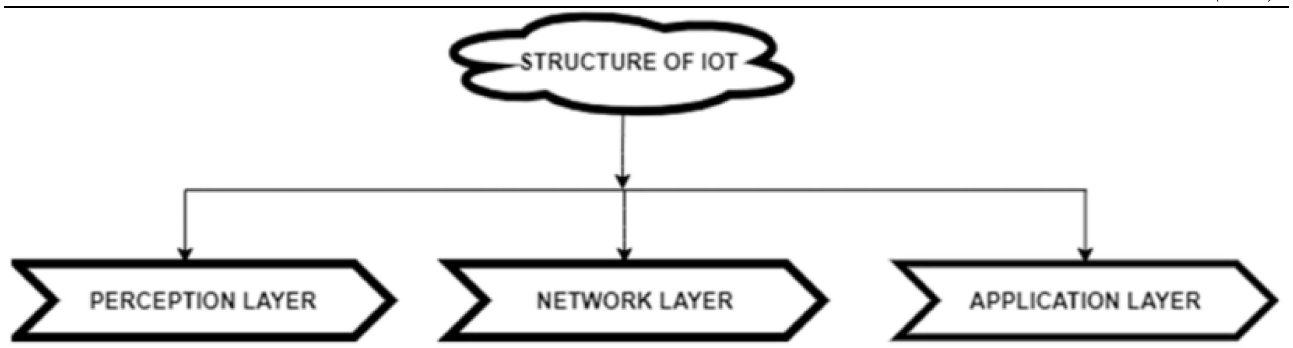

Figure 2. IoT structure[15]

The IoT functioning

The IoT system consists of intelligent objects that have built-in processors, sensors, and connection components to detect a change in state or measure a quantity of the object, analyze and transmit the information it collects from its environment as an input signal for a computer via an IoT gateway.

Such objects can also transfer data to other devices and process the information they share with each other.

These devices are able to cope with their status change without human intervention, although users may interact with these devices, perhaps to configure them or provide instructions or obtain data.

The protocols used with these devices depend mainly on the IoT applications that are being implemented.

Artificial intelligence and machine learning can further help make the data collection process easier and more dynamic.

The importance of IoT

IoT networks help people make smart their lives and gain better control over their lives with the help of devices /smart homes / smart cities.

IoT has also become essential for business. IoT helps companies get a real-time picture of how their setup will actually work, provide insights

[15] Vikram Bali (editor), Vishal Bhatnagar (editor), Sapna Sinha (editor), Prashant Johri (editor) *Disruptive Technologies for Society 5.0: Exploration of New Ideas, Techniques, and Tools*, Publisher: CRC Press, Year: 2021, p.18.

into their performance, and connect with supply chains and logistics operations, all in a connected, business-enabled setup into the Internet.

IoT helps companies not only automate processes and reduce labor costs, but also enable connectivity to a level where data sets and isolated processes are replaced by connected machines and higher systems, all connected to a core system to monitor and take action when needed.

Moreover, it helps to reduce waste and streamline the provision of services, for example, by reducing the time lag between inventory demand and replenishment, so that the cost of delivering services decreases, which also brings transparency in customer transaction management.

IoT has thus assumed its importance as a technology for everyday use and we will see it gain more spotlight once other companies start using it to be more competitive.

IoT applications are found in many fields, such as - medicine (for example-monitoring patients' heart rate to keep track of data and send it to the doctor); industrial areas (for example, product quality control; smart cities, for example, monitoring bus routes); fitness equipment (for example, tracking calories to be burned); home automation (for example, controlling the temperature and air quality of the house or rooms).

Other challenges include reducing energy consumption and minimizing resource use.

Benefits of IoT for Organizations

IoT is useful in many ways for organizations, both industry-specific, and multi-industry. Some of the common benefits of IoT for organizations include: monitoring business processes and implementing improvements where needed; improving the customer experience by streamlining the service delivery process; providing cost-effective and timely solutions to organizations and their customers, reducing waste, time pressure, and time required to complete service delivery; increasing employee productivity by implementing machines for repetitive work and leaving workflows essential for human intervention; integrating new business models that infuse new ideas into outdated ways of working; making timely decisions to coordinate with changing workflow and thus help generate new revenue.

IoT helps companies review possible ways of doing business, provides insights into isolated processes, and helps improvise business

approaches and strategies using a variety of tools. It is frequently used in production and logistics organizations, which use various sensors and IoT devices, being used in agriculture, infrastructure, and home automation.

For example, in agriculture, IoT helps farmers by collecting data on the weather (rain, temperature, humidity, etc.) and also soil content, especially soil containing water, nutrients, plant and animal waste, and more. related features that help automate farming methods and connect sensors to a central server monitored by people, reducing the work and time required to respond to critical events.

Similarly, the infrastructure industry uses IoT to monitor production-to-storage operations, not only saving time and costs - but also keeping paper-free workflow, improving workflow quality, while sensors monitor changes in building structures, bridges, etc., and reporting anomalies. The latest use of IoT is in the home automation industry, which, by monitoring and manipulating mechanical and electrical systems in buildings, helps keep homes safe and inhabitable, so smartly.

Such smart homes/cities can help reduce waste and energy consumption. Therefore, several modern companies/industries in most sectors (health, finance, manufacturing, or retail) are trying to take advantage of the benefits of IoT as well as security and defense (drones, unmanned aerial vehicles-UAVs (Unmanned Aerial Vehicle), research satellites, surveillance cameras, target lighting systems, smart helmets, guidance systems, facial recognition).

Implementation issues

Experts focus on the performance and security challenges that affect different types of IoT communications. Various mathematical approaches are proposed to improve the performance of IoT communications and to develop security to countermeasures for different types of IoT security threats.

A very important role in the performance of IoT communications is played by the allocation of the necessary radio spectrum, a fact confirmed by the researchers who approach this field. Thus, ..., *"Due to the recent rapid growth of wireless services, commercial spectrum bands are now overcrowded, while other pre-allocated spectrum bands are underused.*

Spectrum sharing allows wireless systems to select underused areas of the spectrum, which would greatly increase the efficiency of spectrum use"[16].

The Introduce a resource allocation based on a carrier aggregation approach (CA-Carrier aggregation) to allocate permanent network spectrum resources as well as underutilized spectrum resources under the CA agreement. The proposed approach has improved the performance and quality of the end-user experience. It states: *"In addition, in order to address the limitation of spectrum use, spectrum auctions have been suggested and have proven to be a promising solution for releasing underutilized spectrum to potential secondary users. Spectrum auctions are vulnerable to security threats and the transactions behind them caused by possible bid manipulations"*[17].

Security issues in spectrum auctions need to be given enough attention in the concerns of those in the right to do so.

The importance of ensuring a sufficient frequency band for IoT is also in the attention of researchers in this field. Thus, it is stated that: *"Providing a higher spectrum can provide a significant gain in mobile broadband capacity only if those resources can be efficiently aggregated with the existing resources of the commercial mobile system".*[18]

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[16] M. Ghorbonzadeh, A. Abdelhadi, and T. C. Clancy, *Cellular Communications Systems in Congested Environments: Resource Allocation and End-to-End Quality of Service Solutions with MATLAB,* Springer International Publishing, 2017; A. Khawar, A. Abdelhadi, and T. C. Clancy, *On the impact of timevarying interference-channel on the spatial approach of spectrum sharing between s-band radar and communication system,* in Military Communications Conference (MILCOM), 2014; A. Khawar, A. Abdel-Hadi, and T. C. Clancy, *Spectrum sharing between s-band radar and LTE cellular system: A spatial approach,* in 2014 IEEE International Symposium on Dynamic Spectrum Access Networks: SSPARC Workshop (IEEE DySPAN 2014 - SSPARC Workshop) (McLean, USA), April 2014.

[17] Haya Shajaiah, Ahmed Abdelhadi, Charles Clancy, *Performance and Security for the Internet of Things: Emerging Wireless Technologies,* Publisher: McGraw-Hill Education, Year: 2021, p.15.

[18] H. Shajaiah, A. Khawar, A. Abdel-Hadi, and T. Clancy, *Resource allocation with carrier aggregation in LTE advanced cellular system sharing spectrum with s-band radar*, in Dynamic Spectrum Access Networks (DYSPAN), 2014 IEEE International Symposium, April 2014, pp. 34-37; M. Ghorbanzadeh, A. Abdelhadi, and C. Clancy, *Quality of service in communication systems,* in Cellular Communications Systems in Congested Environments, Springer, 2017, pp. 1-20

The authors of the work on the security and performance of IoT[19] technology have developed a research project in which they proposed a secure spectrum auction and developed a spectrum sharing system that provides efficient use of spectrum resources, an essential level of security, confidentiality, and intelligibility, to enable the most efficient and reliable use of shared spectrum at a low cost.

The security challenges of smart grids and the proposed security and privacy methods for smart grid communications have also been studied.

A secure programming mechanism for smart grid energy resources has been developed through a bidding process.

Security of communications for IoT applications is very important, given their wide range of commercial, industrial, and government applications.

Physical security methods are considered attractive solutions for IoT. However, not all existing physical security techniques are suitable for IoT applications.

The secret of uplink[20] in IoT is very essential- because uplink communications contain data on the reports of potentially classified sensors. IoT security challenges and their potential solutions have been extensively studied in various other specialized papers.

However, these studies did not focus on the security of IoT uplink communication. The same researchers say they have considered the uplink communications of low-latency IoT industrial networks that communicate critical sensor data. An attack-resistant system framework has been proposed for reporting uplink sensor data. Under attacks from an interceptor capable of intercepting uplink transmissions, countermeasures are provided for such attacks and the cost of security in terms of latency (delays) and backhaul rate (regression) is studied.

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[19] Haya Shajaiah, Ahmed Abdelhadi, Charles Clancy, *Performance and Security for the Internet of Things: Emerging Wireless Technologies,* Publisher: McGraw-Hill Education, Year: 2021, pp.15-16.

[20] Uplink- A transmission path for data or other signals from a terrestrial station to a communications satellite

"On the other hand, we have taken into account the cyber vulnerabilities of the computer system for Machine-to-Machine (M2M) networks being connected to the Internet in general. Because perfect cyber security and robustness is an idealistic construction, it is worth designing an IDS[21] to quickly detect and mitigate the harmful consequences of cyberattacks. A new anomalyction and classification framework has been proposed for a general M2M uplink system to detect distributed denial-of-service (DDoS) attacks, emergency scenarios, and terminal device failures"[22].

Spectrum Marketing Architecture[23]

We consider a spectrum trading scenario in which the owner of the spectrum is a federal regulatory agency that leases its underutilized spectrum from the long-term 3.5 GHz onboard radar to a broker who manages the spectrum's assets and plays. the role of an intermediary for the owner of the underutilized spectrum (Owner), for example, the federal government and the WSPs[24].

The architecture of these spectrum assignments is represented by a spectrum pyramid, as shown in Figure 3. At the top of this pyramid is the owner of the spectrum who rents the underused frequency bands to a spectrum broker under certain rules[25].

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[21] IDS-**I**ntrusion **D**etection **S**cheme.

[22] Haya Shajaiah, Ahmed Abdelhadi, Charles Clancy, *Performance and Security for the Internet of Things: Emerging Wireless Technologies,* Publisher: McGraw-Hill Education, Year: 2021, p.16.

[23] A. Khawar, A. Abdelhadi, and C. Clancy, *Target detection performance of spectrum sharing mimo radars*, Sensors Journal, IEEE, September 2015, vol. 15, pp. 4928-4940; C. Sturm and W. Wiesbeck, *Waveform design and signal processing aspects for fusion of wireless communications and radar sensing*, Proceedings of the IEEE, July 2011, vol. 99, pp. 1236-1259; C. Shahriar, A. Abdelhadi, and T. C. Clancy, *Overlapped-mimo radar waveform design for coexistence with communication systems,* CoRR, 2015, vol. abs/1502.04117; X. Chen, X. Wang, S. Xu, and J. Zhang, *A novel radar waveform compatible with communication,* in International Conference on Computational Problem-Solving (ICCP), 2011, pp. 177-181.

[24] WSPs-**W**ireless **S**ystem **P**rovider**s.**

[25] Federal Communications Commission, *Mobile Broadband: The Benefits of Additional Spectrum,* 2010.

The broker is a secondary market that bids these frequency bands to the WSP. At the bottom of the pyramid are end-user devices (UE-User Equipment) to which the spectrum is assigned by WSP BSs[26]. In this section, specialists focus on designing a secure spectrum auction between the broker (i.e., the bidding broker) and the WSP BSs, allocating the underused frequency bands.

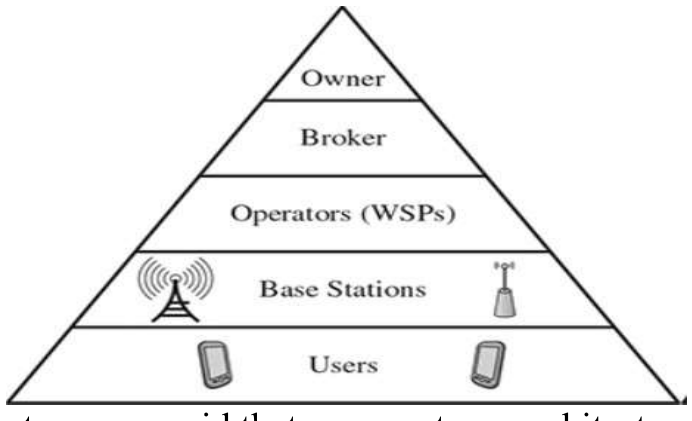

FIGURE 3. A spectrum pyramid that represents an architecture for underutilized spectrum assignments[27]

Advantages and disadvantages of IoT

• IoT helps us access information anywhere, on any device, and in real-time.

• Improves communication between different interconnected objects.

• Save time and money by transferring data over the Internet in real-time.

• Automates jobs, thus improving the quality of service with the fewest human errors until the elimination of human intervention.

• Security issues arise as devices grow and a lot of information is shared on the network, increasing the risk of hacking/information theft.

[26] BS- **B**ase **S**tation.

[27] Haya Shajaiah, Ahmed Abdelhadi, Charles Clancy, *Performance and Security for the Internet of Things: Emerging Wireless Technologies,* Publisher: McGraw-Hill Education, Year: 2021, p.36.

• As systems get bigger - with perhaps millions of devices involved - managing data from such a large number of devices can become a challenge in itself.

• A system error can damage every device that is connected to the IoT network.

• Due to the lack of any international standards for IoT devices, it can become difficult for devices to communicate with each other when purchased from different vendors.

Evolution perspectives

An extension of this area may be the implementation of the text-to-speech module for visually impaired users to interact with such systems.

Implementation requires the installation of (cheap) facial recognition cameras to increase user security and privacy.

This activity can also be implemented for different platforms, for example, iOS[28] and Android.

Conclusions

Studies in this area of research focus on home automation, a system that uses the wireless sensor network in the cloud. Research has defined the procedure for working and managing various types of electrical and electronic equipment using remote controlled systems.

This way of working and managing these devices is called the automation system, which serves to complete the daily routines.

The proposed system is easy to use, is based on the IoT platform, is connected to wireless sensor networks and requires cloud computing.

The results-based system is very economical, 100% efficient and consumes little energy. In order for the system to work throughout, its database is stored in the cloud, where all files or records are updated and synchronized daily and are available for access only by authorized users.

By using such systems, we tend to improve living standards, provide a safe environment for users, and make operation devices very fast, and get rid of handling accidents.

[28] iOS (**i**Phone **O**perating **S**ystem) - designates the operating system from the American company Apple Inc. for the following computers and smart devices.

In order to integrate more IoT features, such as tracking users 'sleep patterns, health conditions, or improving users' model lifestyles, artificial intelligence capabilities and machine learning algorithms can be implemented.

All this will be better the more developed the wireless communication channels such as 5G and/or 6G networks and more.

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