International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 10
***Article Received:** 14 August 2023 **Revised:** 28 September 2023 **Accepted:** 18 October 2023*

Improvising Safety and Energy Efficiency of IoT based Networks Data Routing

Rakshitha Kiran P[1], Samitha Khaiyum[2], Chandrika M[3], Pavithra B[4]
[1]Assisant Professor, Dept. of MCA
Dayananda Sagar College of Engineering, Bangalore
Rakshitha-mcavtu@dayanandasagar.edu
[2]Professor, Dept. of MCA
Dayananda Sagar College of Engineering, Bangalore
Samitha-mcavtu@dayanandasagar.edu
[3]Assisant Professor, Dept. of MCA
Dayananda Sagar College of Engineering, Bangalore
Chandrika-mcavtu@dayanandasagar.edu
[4]Assisant Professor, Dept. of MCA
Dayananda Sagar College of Engineering, Bangalore
Pavithrab-mcavtu@dayanandasagar.edu

Abstract—The Internet of Things is also referred to as IoT, outlines the physical object networking which is comprised of sensors, software and other associated technologies and technical tools in order to connect and exchange data over the internet with other devices and systems. The IoT devices range from household to industrial tools. Over the years, one of the most emerging technologies of the 21st century is IoT as it plays a huge role in sophisticated industries to smart application such as cars, household appliances and many more. With the implementation of IoT, people can take an advantage of seamless communication between other people, processes as well as things. Without human intervention, data having key information can be gathered by different means such as computing, cloud, big data, and associated mobile technologies. This paper focuses on making an IOT based network's data routine safer and more energy efficient.

Keywords-IoT based network; IoT devices; IoT appliances; types of IoT networks, importance of IoT; types of IoT; Consumer IoT; Commercial IoT; Industrial IoT; Infrastructure of IoT; Software architecture model

I. INTRODUCTION

IoT is a type of system that helps to connect with other objects, and it is generally called smart devices, over the internet. Here object means devices such as a monitor, remote, or an automobile with embedded sensors. The objects have the potential to gather transferred data over IoT networks and the objects also have a specific IP address. Moreover, it also helps to enhance the interaction between the different connecting devices with the implication of advanced technology which results in strong decision-making. An IoT-based network's data routing refers to the process of transmitting data between IoT devices, sensors, and other components within the network. In an IoT system, various devices are interconnected to collect, exchange, and process data to enable intelligent decision-making and automation.

The data routing routine in an IoT network typically involves Data Generation, Data Aggregation, Data Transmission, Data Routing, Network Infrastructure, Data Processing and Analytics, Decision-Making and Actuation and Feedback Loop.

It's essential to note that the specific details of an IoT-based network's data routing routine can vary depending on the network architecture, device types, application requirements, and other factors. Ensuring the safety and energy efficiency of an IoT-based network's data routine is crucial for the optimal operation of the network and the devices within it.

II. BACKGROUND

In this session safety and energy efficiency of an IoT-based network's data routine which is important factor for the optimal operation of the network and the devices is discussed [1]. There are various reasons for the demand for IoT network in many growing and developing organization and industries such as the cost-effectiveness of computer chips. Furthermore, millions of people and objects across the globe are interconnected with each other with the help of the implication of the IoT network [2]. Moreover, the technological tools that are used in daily routines have the potential to make advantage of different sensors and interpret cohesively. Additionally, it helps to enhance connectivity by increasing the efficiency of the users [3]. In order to implement the IoT network, it is required to increase the scalability and security, as it plays a crucial role in both interpersonal and organizational growth and development. Here are some considerations to address safety and energy efficiency of an IoT-based network's data routine is:

Data Encryption and Authentication: To ensure data security, encryption techniques can be employed to protect sensitive information during transmission. Implementing authentication mechanisms, such as digital certificates or secure access controls, helps verify the identity of devices and prevent unauthorized access.

Secure Communication Protocols: Using secure communication protocols, such as Transport Layer Security (TLS) or Datagram Transport Layer Security (DTLS), add an extra layer of protection to the data being transmitted within the network. These protocols encrypt the communication channels, safeguarding the data against eavesdropping and tampering.

Network Segmentation: Segmenting the IoT network into separate subnets or virtual local area networks (VLANs) enhances security by limiting the impact of a potential breach or compromise. Each segment can have different access controls, reducing the risk of unauthorized access to critical components or sensitive data.

Device Firmware and Software Updates: Regularly updating the firmware and software of IoT devices is essential to patch vulnerabilities and address security flaws. Timely updates ensure that devices are protected against emerging threats, reducing the risk of data breaches or unauthorized access.

Energy-efficient Protocols and Techniques: IoT devices are often powered by batteries or have limited power sources. Implementing energy-efficient protocols and techniques, such as low-power communication protocols (e.g., Zigbee, Bluetooth Low Energy) and optimized data aggregation algorithms, can help extend the battery life of devices, reducing energy consumption and the need for frequent battery replacements.

Sleep Modes and Power Management: IoT devices can be programmed to enter sleep modes when not actively transmitting or receiving data. These modes reduce power consumption during idle periods, optimizing energy usage. Additionally, power management techniques, such as dynamic power scaling or duty cycling, can be implemented to control the power usage of devices based on their workload or specific requirements.

Edge Computing and Data Filtering: Leveraging edge computing capabilities allows data processing and filtering to be performed closer to the source, reducing the amount of data transmitted over the network. By filtering out unnecessary or redundant data at the edge, bandwidth usage is optimized, leading to improved energy efficiency and reduced network congestion.

Environmental Monitoring and Control: Monitoring the environmental conditions within the IoT network, such as temperature, humidity, or power fluctuations, helps identify potential issues that could impact both safety and energy efficiency. Implementing automated control systems based on these monitoring results enables proactive measures to maintain optimal conditions, prevent failures, and minimize energy waste.

III. IOT-BASED NETWORK ARCHITECTURE

The Internet of Things also symbolizes IoT is an advanced technology that helps to allow everything may it be people of things, to interconnect and communicate among themselves across the internet with the help of different devices without the intervention of humans or computers [4]. One of the main and most important terms that are often referred to as smart devices is automation, which helps to improve efficiency by reducing human interference, therefore, resulting in enhancing the machine intelligence, and the automation processes, and all these effective processes can be improved only by the implication of IoT networks [5].

All the devices like sensors, advanced gadgets, and software, collectively called IoT networks assist to improve the communication and exchange of key data to other devices without the intervention of humans and interference. IoT network assists much big and renowned business organizations, as well as ordinary houses; it is regarded as one of the innovative technology that has helped humans in every possible way as it is safe and energy efficient. The network is not only restricted to things and humans, however, but it also helps to build a strong interconnection between other living things such as plants and animals. Furthermore, the devices allow the collection and exchange of key important data with the help of the IoT network [7]. Developing a methodology for the data routine in an IoT-based network involves several steps to ensure effective data collection, transmission, storage, and analysis.

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 10
***Article Received:** 14 August 2023 **Revised:** 28 September 2023 **Accepted:** 18 October 2023*

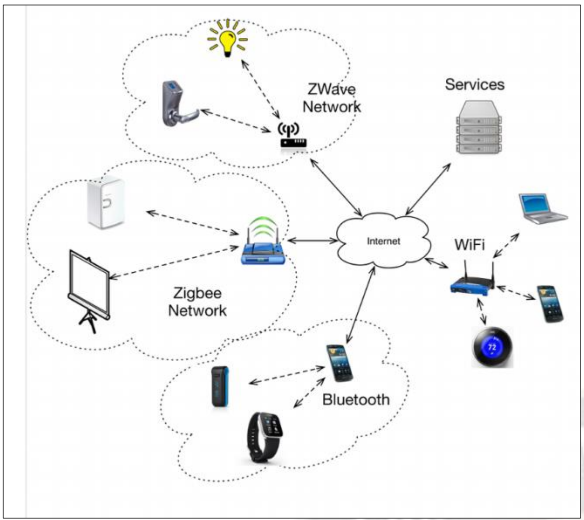

Figure 1: IoT Network Architecture

The methodology for IoT-based network data routing involves several key steps. Firstly, a network architecture is designed, considering factors such as device density, coverage area, and scalability. Next, the appropriate connectivity and communication technologies are selected, determining the wireless protocols and mechanisms for device-to-device and device-to-gateway communication.

A routing protocol is chosen based on network size, scalability, energy efficiency, and reliability. Network segmentation and addressing schemes are implemented to divide the network into logical subnets and assign unique identifiers to devices. Routing algorithm parameters are configured, optimizing settings such as network metrics and table size.

Qualities of Service (QoS) management mechanisms are established to prioritize critical data and control congestion. Security measures are implemented to protect data privacy and integrity. Monitoring and optimization techniques are employed to continuously assess network performance, identify bottlenecks, and optimize routing paths. Scalability and future-proofing considerations are taken into account, and the methodology is regularly evaluated and enhanced based on feedback and advancements in IoT networks.

IV. PRACTICES FOR IMPROVING SAFETY AND ENERGY EFFICIENCY

There are numerous administrative ways that can assist to design effective IoT networks. To make an IoT-based network's data routine safer and more energy-efficient, you can consider implementing the following practices[8]:

Security Measures:

a. Implement strong data encryption and authentication mechanisms to ensure the confidentiality and integrity of data during transmission.

b. Apply secure communication protocols, such as TLS or DTLS, to protect data exchanged between devices and the network.

c. Regularly update device firmware and software to address security vulnerabilities and protect against potential threats.

d. Employ access controls and role-based authentication to prevent unauthorized access to devices and data.

e. Use network segmentation and isolation techniques to restrict access to critical components and limit the impact of potential breaches.

Energy Optimization:

a. Employ energy-efficient communication protocols such as Zigbee, Bluetooth Low Energy (BLE), or LoRaWAN, which are designed to reduce power consumption.

b. Utilize optimized data aggregation techniques to ease the quantity of data transmitted and minimize network bandwidth usage.

c. Implement sleep modes and power management strategies to ease power usage during idle periods for IoT devices.

d. Employ edge computing and fog computing techniques to process data closer to the source, reducing the need for data transmission to centralized servers.

e. Use energy harvesting technologies, such as solar or kinetic energy, to power IoT devices and reduce reliance on batteries or external power sources.

Data Lifecycle Management:

a. Apply data compression and deduplication techniques to minimize storage requirements and optimize data transmission.

b. Implement data retention policies to manage the storage duration of IoT data and prevent unnecessary accumulation of data.

c. Regularly backup data to ensure data availability and reliability in case of failures or system disruptions.

d. Use data anonymization and privacy-preserving techniques to protect sensitive information and comply with data protection regulations.

e. Dispose of data securely and permanently when it is no longer needed to prevent unauthorized access or potential data leaks.

Monitoring and Optimization:

a. Implement real-time monitoring of network traffic, device performance, and energy consumption to detect anomalies or potential security threats.

b. Utilize data analytics and machine learning algorithms to identify patterns and optimize network performance, energy usage, and resource allocation.

c. Uninterruptedly monitor and optimize network infrastructure, including routers, gateways, and servers, to ensure efficient data routing and minimize energy consumption.

d. Regularly assess the network architecture and configuration to identify areas for improvement, security enhancements, and energy-saving opportunities.

V. IOT NETWORK APPLICATIONS

IoT is an advance technology which is capable of generating a connectivity network with the help of innovative devices into communicating platforms and it help to improve the interconnectivity between things to thing, human to things, human to humans etc and helps to meet the physical world to digital world [9]. IoT helps to upgrade, improve and simplify by building strong automation processing. Iot has the capability to improve the working efficiency and enhance the performance levels, as the sensors are combined with strong connectivity and artificial intelligence by making it a cost effective approach. There are several significant factors in the emergence of the IoT network systems, and the major reason is considered to be the development of advance technology, cost effectiveness, energy efficient, as the sensors and RFID tags are super abundant in contemporary world [10].

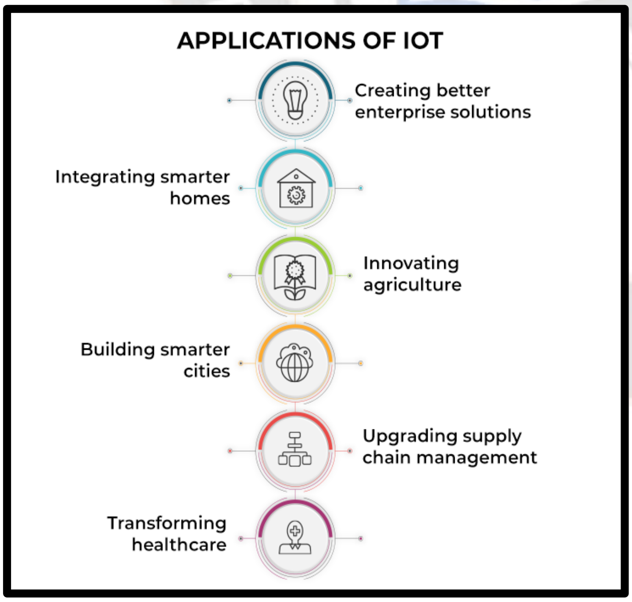

Figure 2: IOT applications[10]

VI. ADVANTAGES OF IOT-BASED NETWORK

There are basic components of an IoT network system, which include IoT sensors, IoT connectivity, IoT processing, and IoT interface [11]. The interconnectivity that is provided by the IoT network is defined as an advanced innovative technology that assists in generating new connecting platforms as well as infrastructure networks with the help of the involvement of different IoT devices [12]. Moreover, there are various kinds of communicating technologies that help to connect IoT devices. The communicating technologies include LPWAN, cellular, satellite, Wi-Fi, and other associated technologies, all the technologies assist to build strong communication connectivity. Moreover, the implementation of IoT networks helps to reduce human intervention and enhances the efficiency of the workflow [13].

VII. ADVANTAGES OF IOT-BASED NETWORK

Monitoring and optimization techniques are crucial for ensuring the efficient operation and performance of IoT-based network routines. These techniques involve real-time monitoring of network components, data flows, and system metrics, as well as implementing optimizations to improve resource utilization, responsiveness, and overall network efficiency. Here are some common monitoring and optimization techniques used in IoT-based network routines:

Network Monitoring:

Real-time monitoring of network traffic, bandwidth usage, and latency to identify bottlenecks, congestion, or performance issues: Monitoring network connectivity and device status to ensure devices are operational and properly connected. Analyzing network metrics, such as packet loss, latency, and throughput, to assess network health and identify areas for improvement.

Data Monitoring and Analytics:

- Collecting and analyzing data about data (metadata) to gain insights into data usage patterns, data quality, or data access patterns.
- Analyzing data transmission patterns, data volume, or data frequency to identify anomalies, trends, or potential optimizations.
- Implementing data analytics techniques like real-time analytics to derive actionable insights from the collected data.

Resource Optimization:

- Optimizing network resources, such as bandwidth, processing power, or storage capacity, to meet the demands of IoT devices and applications.
- Implementing traffic shaping and prioritization techniques to allocate network resources effectively based on device or application requirements.
- Employing edge computing or fog computing techniques to offload processing and storage tasks

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 10
***Article Received:** 14 August 2023 **Revised:** 28 September 2023 **Accepted:** 18 October 2023*

closer to the data source, reducing latency and bandwidth requirements.

Energy Optimization:

- Monitoring and optimizing energy consumption of IoT devices, sensors, and network infrastructure to improve energy efficiency.
- Utilizing energy-efficient communication protocols, such as Zigbee or Bluetooth Low Energy (BLE), to minimize power consumption during data transmission.

Dynamic Network Optimization:

- Implementing dynamic routing algorithms to optimize data routing paths and reduce network congestion. Employing adaptive transmission power control to optimize communication range and minimize power consumption.
- Utilizing load balancing techniques to distribute data traffic evenly across the network, improving overall network performance.

Predictive Maintenance:

- Using predictive analytics and machine learning algorithms to monitor device health, predict failures, and schedule maintenance proactively.
- Collecting and analyzing sensor data to identify patterns or anomalies that may indicate potential device or network failures.

Quality of Service (QoS) Optimization:

- Prioritizing critical data or high-priority applications to ensure quality of service requirements are met.
- Implementing QoS mechanisms, such as traffic classification, bandwidth reservation, or traffic shaping, to guarantee desired performance levels for specific data streams or applications.

Continuous Improvement:

- Regularly evaluating network performance, analyzing monitoring data, and identifying areas for optimization.
- Incorporating user feedback and requirements to refine network routines and enhance user experience. Staying updated with emerging technologies, protocols, and best practices to implement new optimization techniques and improvements.

VIII.TYPES OF IOT

Monitoring and optimization techniques are crucial for ensuring the efficient operation and performance of IoT-based network routines. These techniques involve real-time monitoring The Internet of things is of five types that are explained in this research which have changed the working capacity of the world and extended it further more forward in terms of efficiency, productivity and services.

1. Consumer IoT

This category of technology of IoT is used for communication in short-range distances. The Consumer IoT can be used or deployed for home and office purposes. Wi-Fi, Bluetooth, and more are one of the best examples of such technology based on IoT technology that provides connectivity for a short distance range. Few common examples of the products of CIoT are smart assistants, home appliances, wearable, and others.

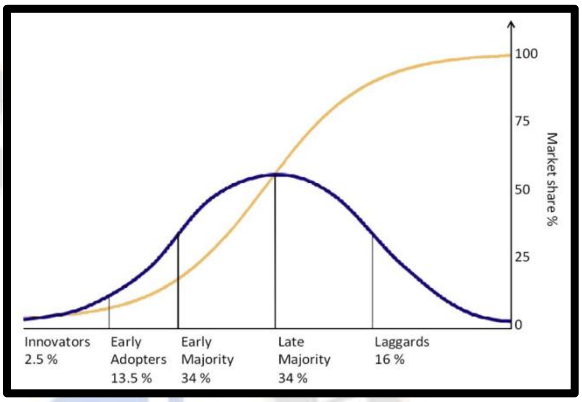

Figure 3: Consumer IoT Adoption graph [14]

2. Commercial IOT

Commercial IoT has the ability to deliver benefits to larger units or venues as compared to Consumer Iot which can serve only smaller venues like homes and small offices. Commercial IoT is the most used type of technology used to provide its services to supermarkets, healthcare facilities, hotels, and much more. Commercial IoT is nowadays used for the betterment of business and enhancing customer experience. Accession to any sort of corporate facility has become extremely easy with the use of Commercial IoT[20].

Table 1: Commercial IOT use in healthcare in ECG machine and signals[15]

Feature	Description
RMSSD	Root mean square of the Inter-beat (RR) Intervals (the time intervals between consecutive heart beats)
meanNN	Mean RR interval
sdNN	Standard deviation RR interval
cvNN	Coefficient of Variation (CV), i.e. the ratio of sdNN divided by meanNN
CVSD	Coefficient of variation of successive differences, i.e. the RMSSD divided by meanNN
medianNN	Median of the absolute values of the successive differences between the RR intervals
madNN	Median Absolute Deviation (MAD) of the RR intervals
mcvNN	Median-based Coefficient of Variation (MCV), i.e. the ratio of madNN divided by medianNN
pNN20	The number of interval differences of successive RR intervals greater than 20 ms divided by the total number of RR intervals
pNN50	The number of interval differences of successive RR intervals greater than 50 ms divided by the total number of RR intervals

3. Industrial IoT

The industries after the industrial revolution have become more efficient with the evolution of the Internet of things, especially in the industrial field.

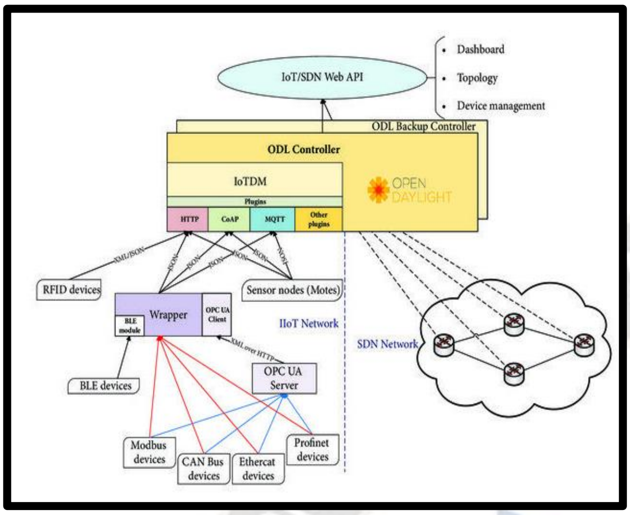

Figure 4: Industrial IOT Software architecture model[17]

The practical use of this category of Iot can be seen in large manufacturing industries and large-scale plants. The development of IoT and its use in the industrial field has increased the productivity and efficiency of factories, saving extra expenses and ensuring data security. There are basically five types of IoT still industrial IoT is well-known among the other four types[19].

IX. CHALLENGES OF IOT-BASED NETWORK

The IoT is also symbolizes as (IoT) which helps to describe the physical objects networking which is consists of sensors, software, and other associated technologies and tools to build strong connectivity and exchange data across the internet [14]. The technology is becoming the need of the population, as it helps to analyze and interpret the way of living of humans and their surrounding objects. As there is no exception, IoT networks also deals with many challenges and provocations such as in security, deployment and the designing. The challenges include, lack of encryption, lack of testing and analysis of the collected data. Moreover other issues include hacker attacks, low batter life, data collection, lack of connectivity, dependency on technology and many more [15]. It can be energy efficient option; however when there is the establishment of high levels of IoT setup, then it requires huge amount of energy consumption and hence degrade the connectivity.

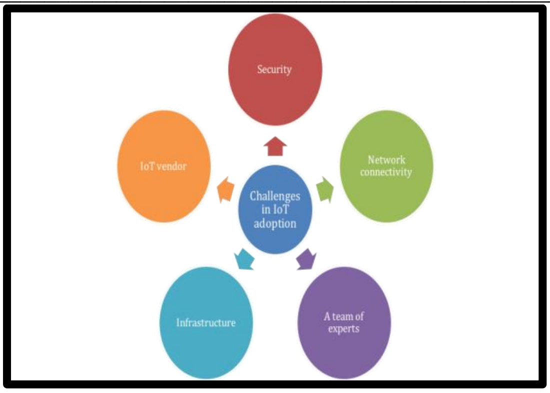

Figure 6: Challenges of IoT-based network[7]

From the determination and interpretation of IoT networking systems and the data obtained from authentic sources, it has been observed that the role of IoT networks and associated technological devices play a significantly important role in the development and growth of organizations and industries. The implementation of IoT networks deals with various challenges and provocations such as encryption and security risks for both the devices and the users [16]. Lack of visibility and limited security resources are regarded as the major problem that needs to be focused on by the management of organizations and industries [17]. Along with these, lack of testing and lack of interpretation of gathered data from the devices can be other problems [18].

X. CONCLUSION

Ensuring the safety and energy efficiency of IoT-based network data routing is of paramount importance for the successful operation of IoT systems. By implementing robust security measures and optimizing energy consumption, organizations can maximize the benefits of IoT while minimizing risks. Furthermore, through the implementation of IoT technologies in different field of the hyper-connected world, digital tools, and the advanced system has the potential to record, monitor and analyze the interaction among connected thing. Therefore, it can improve the cooperation between the physical world and the digital world for high efficiency and productivity.

REFERENCES

[1] Ahmed, S., Chowdhury, M.Z. and Jang, Y.M., 2020. Energy-efficient UAV-to-user scheduling to maximize throughput in wireless networks. *IEEE Access*, *8*, pp.21215-21225

[2] Albreem, M.A., Sheikh, A.M., Alsharif, M.H., Jusoh, M. and Yasin, M.N.M., 2021. Green Internet of Things (GIoT): applications, practices, awareness, and challenges. *IEEE Access*, *9*, pp.38833-38858.

[3] Alrehan, A.M. and Alhaidari, F.A., 2019, May. Machine learning techniques to detect DDoS attacks on VANET system: a survey. In *2019 2nd International Conference on Computer Applications & Information Security (ICCAIS)* (pp. 1-6). IEEE.

[4] Aslam, S., Michaelides, M.P. and Herodotou, H., 2020. Internet of ships: A survey on architectures, emerging applications, and challenges. *IEEE Internet of Things journal*, *7*(10), pp.9714-9727.

[5] Chithaluru, P., Kumar, S., Singh, A., Benslimane, A. and Jangir, S.K., 2021. An energy-efficient routing scheduling based on fuzzy ranking scheme for internet of things. *IEEE Internet of Things Journal*, *9*(10), pp.7251-7260.

[6] Du, J., Jiang, C., Wang, J., Ren, Y. and Debbah, M., 2020. Machine learning for 6G wireless networks: Carrying forward enhanced bandwidth, massive access, and ultrareliable/low-latency service. *IEEE Vehicular Technology Magazine*, *15*(4), pp.122-134.

[7] Haghi, M., Neubert, S., Geissler, A., Fleischer, H., Stoll, N., Stoll, R. and Thurow, K., 2020. A flexible and pervasive IoT-based healthcare platform for physiological and environmental parameters monitoring. *IEEE Internet of Things Journal*, *7*(6), pp.5628-5647.

[8] Hu, H., Xiong, K., Qu, G., Ni, Q., Fan, P. and Letaief, K.B., 2020. AoI-minimal trajectory planning and data collection in UAV-assisted wireless powered IoT networks. *IEEE Internet of Things Journal*, *8*(2), pp.1211-1223.

[9] Liu, Y., Ma, X., Shu, L., Yang, Q., Zhang, Y., Huo, Z. and Zhou, Z., 2020. Internet of things for noise mapping in smart cities: state of the art and future directions. *IEEE Network*, *34*(4), pp.112-118.

[10] Pang, J., Huang, Y., Xie, Z., Han, Q. and Cai, Z., 2020. Realizing the heterogeneity: A self-organized federated learning framework for IoT. *IEEE Internet of Things Journal*, *8*(5), pp.3088-3098.

[11] Shakoor, S., Kaleem, Z., Baig, M.I., Chughtai, O., Duong, T.Q. and Nguyen, L.D., 2019. Role of UAVs in public safety communications: Energy efficiency perspective. *IEEE Access*, *7*, pp.140665-140679.

[12] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[13] I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[14] K. Elissa, “Title of paper if known,” unpublished.

[15] R. Nicole, “Title of paper with only first word capitalized,” J. Name Stand. Abbrev., in press.

[16] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[17] M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.

[18] Electronic Publication: Digital Object Identifiers (DOIs):
Article in a journal:

[19] D. Kornack and P. Rakic, “Cell Proliferation without Neurogenesis in Adult Primate Neocortex,” Science, vol. 294, Dec. 2001, pp. 2127-2130, doi:10.1126/science.1065467.
Article in a conference proceedings:

[20] H. Goto, Y. Hasegawa, and M. Tanaka, “Efficient Scheduling Focusing on the Duality of MPL Representatives,” Proc. IEEE Symp. Computational Intelligence in Scheduling (SCIS 07), IEEE Press, Dec. 2007, pp. 57-64, doi:10.1109/SCIS.2007.357670.