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A State of Art for Smart Gateways Issues and Modification

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Authors' contributions

This work was carried out in collaboration among all authors. Authors LMA and SRMZ prepared the detailed review of previous works related to Smart Gateways Issues and Modification. Authors SFK and MAMS wrote the first draft of the manuscript. In addition, authors AAZ, BWS and KHS managed the analyses and discussion parts of the study. All authors read and approved the final manuscript.

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ABSTRACT

The Internet of Things (IoT) is a collection of objects such as sensors, actuators, and processors, which interconnected within a specific network to perform a task collaboratively. The IoT is one of the prevalent technologies, which has developed dramatically in recent years. Its reputation derives from its relevance and role in employing things in the best way, starting with smartphones that opened new horizons in control technologies and later developing new ideas regarding cloud-computing services. A smart gateway plays an essential role in the IoT applications that responsible for enabling communication between the network layer and the ubiquitous sensors network layer. IoT gateways are methods that operate with influential data centers as a point of communication between lower-end users. IoT gateways connect the heterogeneous devices in use and carry out many tasks to accomplish the computing mission. This work searches how IoT gateway's function and how they interact. In particular, it lists interface issues related to IoT

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gateways. In this paper, we research IoT and Smart Gateways and address Smart Gateways problems and computing techniques to promote IoT programs' stable transition to the Smart Gateway.

Keywords: Internet of Things (IoT); smart gateways; IoT gateways; software structure and communication protocols.

1. INTRODUCTION

The Internet of Things (IoT) can be used in a variety of applications, and it makes networking smarter and more advanced [1]. The IoT-based applications consist of physical objects, sensors, software, and electronic elements to collect and exchange data [2,3]. The IoT is a modern internet technology that uses internet resources to transform real-world physical objects into a managed virtual environment [4]. IoT can be employed by combining various related technologies and security techniques; most applications have made a range of criteria that IoT systems must fulfill at the applications design procedures [5,6]. It is the link between different things through the Internet [7]. Technology is developing rapidly, and devices are becoming smart daily due to the trend of the IoT. It has witnessed a relative rise in the world of innovative applications [8]. The IoT concept consists of combining a wide range of technologies, such as sensors, drivers, the Internet, and cloud computing, in addition to several communication infrastructures [9].

Clout Reference Architecture incorporates Cloud and IoT technologies: the consolidated and final version of this paper [10]. It begins with a description of several user pictures evaluated by Clout partners and provides the context of the application [11,12]. Analyzes of the chosen customer situations and the perspectives of the project participants, including four pilot towns: Genova (Italy), Santander (Spain), Fujisawa, and Mintaka (Japan), gathered a range of user/service and device specifications [13,14]. Cloud computing is based on computer and development technology, whereby dynamically, many things as a service are virtualized, scalable, and provided resources over the Internet [15,16]. Cloud computing will move all the data and programs to the cloud, including the information provided by the third part and computing such as storage and computation [17]. The providers will publish the services over the Internet and access all these services by the cloud's application layer through the web portal [18]. It can be defined as converting data besides procedures, where computation is also done how it is done. It is a transforming information technology and investigated in many fields [19,20]. An IT specialist's job environment is often updated progressively. Different problems are cracked for the conservative measurement of the highest treatment work while updating the program with additional calculation sequences [21,22]. The procedure of searching different kinds of clouds till now has no mechanism for discovery. The consumers of clouds generally have to search for the same services of cloud manually [23].

Nowadays, one can imagine that more devices are being added to connect to the Internet every day. The sensors have added additional good features in designing systems such as smart homes, smart cities, and smart cars. These devices may interact using their physical communication components [24]. There are billions of computers connected across the Internet that are capable of collecting data based on the concept of the IoT [25]. The IoT devices shape a graph rather than a Guided Acyclic Graph (DAG) to direct parcels [26]. The gate is the DAG source and responsible for gathering data and transferring it from IoT systems to the cloud and vice versa [27]. The number of IoT will shift over time if circumstances change in the network. When an IoT device is disconnected from the network through the IoT, DAG will grow significantly [14,28].

The IoT gateway problem is partly because current portals integrate network connectivity, processing, and user interface functionality within the network. These devices need an application layer portal to connect to the Internet, translating data from the power-efficient connection to the Internet in general. However, these low-power connections do not currently provide an internet gateway but a limited link with a device-specific program that must be set up on a smartphone or a laptop. The new laptop website does not need a new application for the Wi-Fi router, but a new mobile app, a new laptop dongle, or a new base station computer is needed when a new IoT system is connected to it [29].

The paper structure: have the background theory in Section 2, Literature Review.

In Section 3, discussion in section 4, finally, the conclusion in section 5.

2. BACKGROUND THEORY

2.1 Generic Internet of Things Architecture

The concept of the IoT architectural design can be viewed as multilayers, which can generally be classed into four essential layers known as the layer of perception, network layer, middleware layer, and application layer [3,4,30].

Essentially the perception layer collects information and transforms it into a digital signal from the environments. While the network layer receives and transmits digital signals from the perception stage by the network and translates digital signals in different contexts for the application to the end-user [30,31].

The IoT architecture's middleware layer provides data processing capability. The advancement in IoT depends on technological progress and applies to different applications [30,31]. The IoT should be equipped to interconnect billions or trillions of heterogeneous things through the Web, so there is a basic requirement for adaptable layered engineering [31]. Another IoT layer named the business layer provides services to systems-based IoT concepts [32,33]. However, the major five-layer models of IoT technology are illustrated in Fig. 1.

2.2 Smart Gateways in IoT and Its Function

The gateway to the IoT is a similar Point of contact between Devices and apps that are smart. It could be a computer for the hardware or software. Both forms can be the gate: an elementary gateway (complex) or a smart gateway. The gate is only used as something that collects sensor input, incorporates it, and then transfers it to cloud processing. This form of the gateway is considered the main gateway or a tool that collects data from multiple sources [34]. When the compound could collect a large amount of data by smart devices, this data was compiled and transferred to the cloud, which takes many computing spaces and raises the communication load [35]. Fog computing was implemented as a cure for this in fog measurement at fog or edge a particular the amounts of pre-processing of a data is limited. Data is analyzed, simplified, and once again synthesize until it is sent to the cloud [36,37].

These processes are assigned via a smart gateway or an intelligent gateway amongst intelligent machines and Cloud servers, as shown in Fig. 2. The Smart Gate has different components, as presented below.

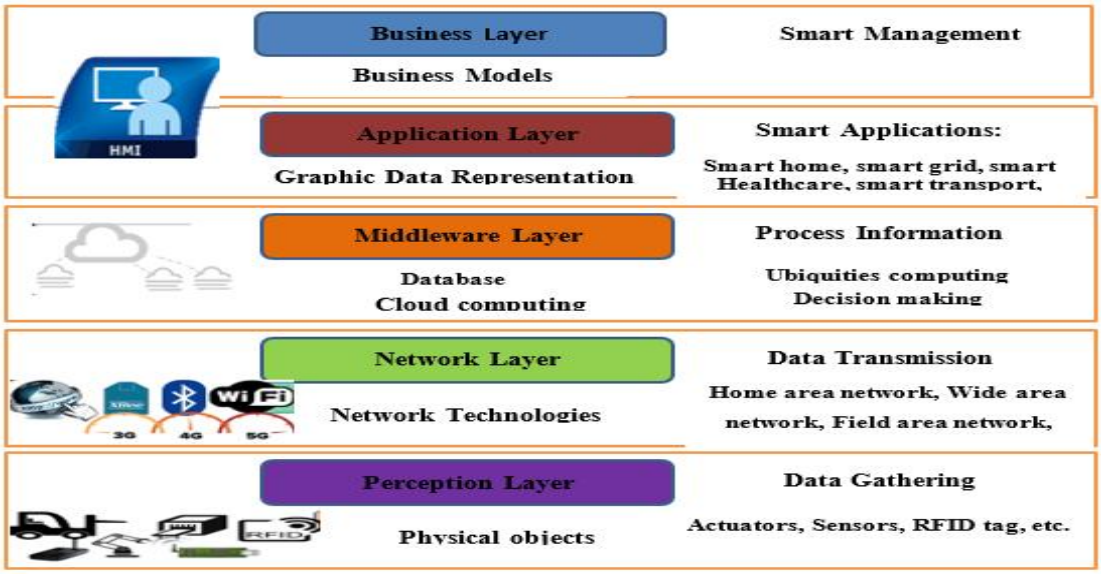

Fig. 1. The five layers of IoT technology

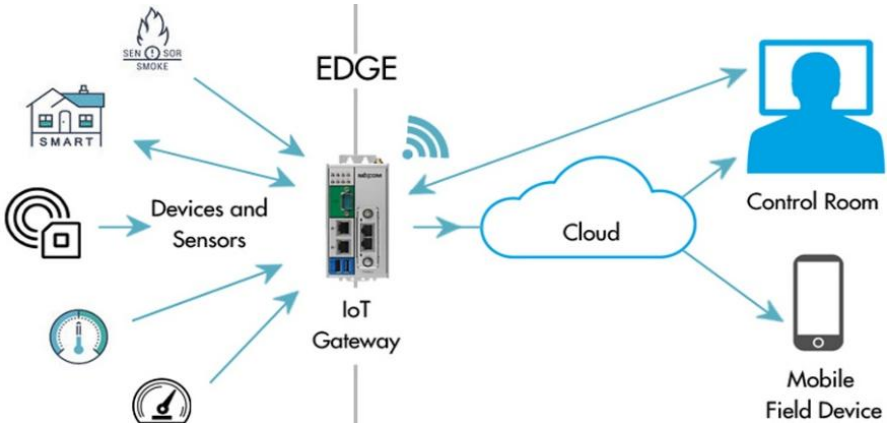

Fig. 2. Smart gateways in IoT

i) Data collection: The smart gateway receives data from the decade sensor.
ii) Useful data preprocessing and extraction: Sensor data are transmitted by separate preprocessing procedures stages such as data purification, convergence, scanning, sorting, and processing. This allows meaningful data to be derived from sensor data.
iii) Computing and saving data: The smart gateway offers a limited amount of interpretation and estimation on the preprocessed information that the intelligent products will store and use in the future.
iv) Data transmission to the cloud: The gateway uses the Internet's guidelines and protocols to transmit the related details to the system cloud server.
v) Monitoring and managing the system: The operations of smart things are tracked and handled by the smart gateway. Any task is achieved with a smart system. It also activates the smart system by activating the device as per the stimulation of the environment. The gateway always tracks and controls the electricity usage of smart things.
vi) Securing and communication of data: The smart gateway uses various Internet standard protocols for data and communication security.

2.3 Software Architecture for Smart Gateways

IoT gateways software package consists of numerous elements as follows (see Fig. 3) [38,39]:

i) Operating System Traditional gateways capabilities can be provided operating systems like macOS.
ii) Environment in Runtime Gateways: will run the program's code and can be modified dynamically.
iii) Connectivity and Collaboration: To facilitate communication through the gateway's widest range embraces all wireless technology and wired connections. Contact protocol for association with multiple devices, for instance, Zigbee, Wi-Fi, Z-Wave, Wireless. Gateways are to protect the consistency, safety, and privacy of telecommunications.
iv) Control and Messaging of Data: The gateways must obtain the sensor's data. Gateways try to solve the challenges along the path of those challenges, such as network transmitting data latency, IoT gateway, and accurate analytics. The gateways ought to analyse data and then forward analysed data to the data centre honestly.
v) Virtual management: This module enables networking, setup, start/stop gateways, or their applications to be shaped.
vi) Department of Security: Safe data storage, system management, and connectivity are supported by the protection manager.

2.4 IoT Gateways Contact Protocols

It allows communication between computers, sensors, engines, and cloud data smooth. Accessing both the gateway and the data in the cloud requires a fast connection pace [40,41]. Any gateway needs to manage various kinds of sensors and networks. Next, the most common

IoT gateway communication protocols are listed [30,31]:

i) Application Layer: This layer consists of multiple protocols (e.g., HTTP, CoAP, Web sockets, MQTT, AMQP, XMPP).
ii) Transport Layer Security: Transport Control Protocol is used to coordinate correspondence between various programs. It is a link-driven protocol and hence has a high overhead for this purpose. It is notated that TCP is not ideal for low power constrained. UDP is much quicker than TCP since UDP is a connectionless protocol [31].
iii) Network layer: IPv4 uses 32-bit address fields and thus can store 232 addresses. The IoT depends on IPv6. In addition, there is another protocol used on a low-power wireless network named 6LoWPAN. IPv6 is an alternative variant intended for use with a few devices, including wireless Appliances. A gateway would facilitate the conversion of IPv4 and IPv6. 6LoWPAN networks will be linked to the Internet in the future with platforms that allow it. The Network Layer protocols often include routing, which low-power networks can use to direct IPv6.
iv) Physical Layer and Network Connectivity: Many networking systems, such as Bluetooth, Bluetooth Low Energy (BLE), and Wi-Fi, are used to connecting gateways to sensors. The low-power variant of Bluetooth and Wi-Fi- Wi-IoT can be found in low-power constrained networks. Various protocols like Zigbee, Z-Wave, Sub-GHz, and 802.15.4 dependent thread are used as a portal to be used in low-power intensive networks. For data storage gateway and managed connectivity networks, e.g., wireless, Wi-Fi, TV, microwave, etc., are applied [33].

2.5 Requirements for Design for Smart Gateways

Heterogeneous computers and networks must enable a gateway to execute its functions. For a developer, there are many challenges when erecting IoT gateways [42,43]:

2.5.1 Communications

The gateways have had to help the networking of nodes and backends. Low-power, reduced electricity links must be utilized by low-power nodes of the Internet. As a consequence of the growing number of (IoT) applications, the need for broad IP addresses has increased. Not all internet apps need to support IPv6, in any case. Gateway has to move the IP address to IPv4 and conversely [44].

2.5.2 Smartness

Smartness is a mechanism that increases the contact overhead, which excessively overloads the server with meaningless results [45]. Therefore, it requires the sensor information to be processed and studied. Computations should be carried out to minimize server overheads through gateways. If the gateway handles any of the decision-making and computations functions, it can be rendered more effective. The developer has to realize that the data obtained from the sensors need to be filtered before usage.

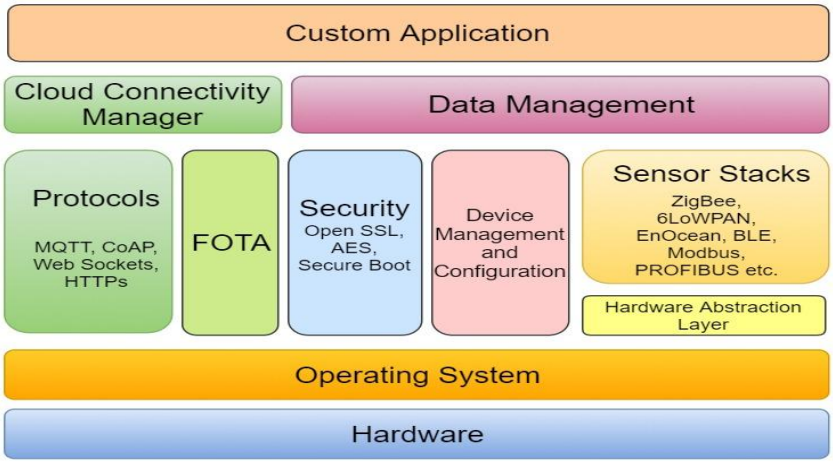

Fig. 3. Software architecture of IoT gateways

2.5.3 Storage

The gateway needs to store the relevant interpreted or calculated data. Gateways have to be designed in order to conserve small amounts of data for possible use.

2.5.4 Security protection

Another architecture issue for gateways is stability. The gateways must ensure that the information shared between the nodes and the servers is safe and reliable. It is also imperative to protect the data held within the gateway. For data protection, various encryption methods may be implemented. Gateways ought to have authentication standards for information security [46].

2.5.5 Supportable

The design and servicing of IoT devices maybe undertaken in a remote area. Another big issue in IoT gateway architecture is the protection function.

2.5.6 Scalable

Make sure you are developing a framework that can accommodate multiple gadgets. Overall, scalability maybe increased by the layering method. A device is to be initialized on a hierarchy of gateway servers.

2.6 Security Issues for IoT Gateways and Solutions

Smart gateways could connect with the IoT and examine and archive the details of sensors. Ensuring stable connectivity is one of the key features of the gateway. There is a risk of internet protection weakness in the open and accessible gateway. Many scientists have researched this phenomenon (Security issues in IoT). There are three main protection tools for smart gateways as described below [47]:

2.6.1 Requirements for computer protection

Gateways are imperative for data from various sources to be transmitted and preserved in an IoT environment. Before hitting the destination, the details from the source cannot be updated. Data consistency is recognized as this necessity [48]. When transmitting data to sensor nodes or data centers, the gateway can maintain data confidentiality and vice versa. Data security is another big issue [49]. It is important to maintain the data sent from the gateway strictly. A gateway supervises many sensor nodes. As the number of smart devices in the gateway grows, data protection threats have several possibilities to occur. The work published by King et al. presented providing symmetric data protection encryption mechanisms with gateway support [50].

2.6.2 Requirements for access level protection

The identification of the smart devices connected with the system must be checked through gateways. Attackers may use an identification mistake to send malicious details to gateways. Authentication protocols should be reliable enough to allow the gateway to identify unsafe nodes [51].

2.6.3 Functional protection attributes

Protection resources for web platforms are categorized into reliability and availability, and versatility [52].

3. LITERATURE REVIEW

A smart using gateway plays an important role in the IoT systems that connect the network layer and the ubiquitous sensor network layer.

Zhang et al. [53] presented a basic communication protocol using SIP as a gateway. The SIP intermediate software is designed to resolve the data exchange problem between standard SIP connection and portal equipment service, which checks data connections for text data, control letters, and media flow. This design provides a reference solution for integrating smart home portals and intermediate software technologies.

YAN et al. [54] suggested a smart home portal based on ZigBee wireless sensor network technology. Analyzes the current state and development of smart grid furniture, a smart gate system designed to furnish the house based on ZigBee technology. ZigBee wireless networking technologies and Internet technology were built into the scheme.

Wan et al. [55] the researcher proposed a framework by including extra software in the smart gateway for data collection, data analysis, and reporting. Evaluation and experiments using

collected smart home data show that the proposed platform and the different MDA systems can efficiently collect and provide accurate data.

Jianqi et al. [56] presented a steering gate design based on the smart home's wireless networks. The experiment results show the following: The routing gateway via the web interface can monitor and query information on home computers, provide users with internet connectivity requirements, and accomplish the design's purpose.

Hoque et al. [57] predicted IGaaS service enhances service efficiency with drones and phones and decreases portal numbers in static and wireless scenarios by offering a gate-on-demand service. The experiments on the Contiki framework and the simulation of Cooja illustrate the feasibility of the proposed method.

Davoli et al. [58] suggested a technique that utilizes available information about the current network status (SNR values periodically measured for satellite links and GW buffer occupancy) to transmit traffic flows between gates in the event of congestion or disruption. The prediction algorithm is also used to forecast failure occurrences and allow the network to connect in advance to minimize satellite bandwidth waste at the same time. A performance evaluation was carried out using a simulation tool to align the proposed strategy with other literature strategies to achieve natural efficiency.

Souifi et al. [59] used LoRa to implement a smart home application. An important part of the proposed design has also been dedicated to developing a local server (LoRa-server) for the smart home system. Besides, the Lora WAN portal has been utilized to manage the connection between the LoRa-server and sensors. In the end, voice assistants like Mycroft have been incorporated via voice commands to monitor our devices. The final design provides the user with full and secure control over connected devices.

Sarma et al. [60] suggested the conclusion has been drawn that it is not appropriate for the smart gateway to repeat the data and continue with it in advance at any time; instead, it should act as a smart load balancer. Pre-processing data reveals the value of work, which positively influences efficacy without pre-processing every file/data needing to be submitted with its original size.

Patil et al. [61] introduced a suitable mode for IoT gateways, and specific gateways became necessary in the IoT. IoT gateways play an important role in spreading data from various sensor networks that support different technology to the internet cloud. The requirement for many gateways to avoid congestion is essential as the IoT network needs to place more gates to reduce its use.

Ivanović et al. [62] suggested implementing a cloud unit responsible for performing administrative training tasks on several home automation portals. However, it is possible to extend the solution to support multiple additional task types by adding more sub-services. The functions of the executed unit are tested on 250 real portals. Future research will focus on testing system limits regarding the number of gates to perform the tasks.

Rossi et al. [63] presented that SG technologies' architectural improvement is provided and an introduction to nutrition link diversity schemes and disruption probability modelling. The optimization process follows a practical approach for the satellite operator, trying to determine the best SG configurations to reach the target system's performance in light of some possible GWs sites. In particular, two different algorithms were presented with two objectives: maximizing system productivity and feeding link C /N0 maximizing.

Eridani et al. [64] demonstrated that based on studies carried out on the smart gateway network structure, it could be inferred that the device is capable of serving 1 to 5 customers. The device will register and automatically request data. The scheme is capable of operating as well. For further study, it is best to add a link mechanism in the gates or add a major network to assemble several portals so that the network has a wider range to communicate LoRa with the information system used as a user interface. To facilitate encryption, it can also be added to the crypto format and decryption. Constructing is easier, too. A device that uses a real sensor and measures the LoRa parameter in rapid mode.

Andi Adriansyah et al. [65] created a small system for smart homes by integrating microcontroller panel technology with a WLAN connection. The proposed system includes monitoring and controlling the home environment based on the values of the environment data that are read by the sensors installed inside the house, such as automatically turning on or off

household lights. Microcontroller kits include a C-based IDE operating system running on an ATMega 328 board and other related sensors.

El-Basioni et al. [66] proposed a range of amenities and controls. These devices also monitor home appliances' behavior according to the sensor signals received over a wireless network. The reporting form is used to determine the response according to the signal sent, whether event-driven, time-driven, or ordered.

Souvee Gunputh et al. [67] describe the controlled system's essence using the Arduino Mega 2560 microcontroller board connected to a Wi-Fi network. Researchers have designed a system that integrates home appliances, lighting systems, gas leakage and smoke detection system, automatic windows and blinds, a retractable bed, and a self-regulated ventilation system. The home environment can be controlled automatically by a voice recognition system. Also, commands can be given to the lighting system via a smartphone or tablet through a web-server.

4. DISCUSSION

The optimization of IoT interoperability is challenging. The systems need to interact in various ways to build and develop logical solutions to these problems using IoT technology, so many of those systems have not been used in smart systems architecture as necessary. Interoperability between system devices is needed to achieve this goal, and IoT portals suggest one potential solution. The portals function as part of the hub and data transmission model as an IoT infrastructure. In the hub model, devices at the endpoint communicate to a certain degree using a gateway or central hub that carries information to and from the Internet more than the devices at the end that connect directly to the Internet. This introduction to using the portal in designing the IoT provides a host of benefits. Through this questionnaire, the main difference between smart portals and IoT is observed. In addition to the techniques of sending and receiving the necessary data and understanding this data to provide organizational information through the portals. However, the IoT gateway's problem persists because today's portals include network management, data processing, user interface functions, and network connectivity. Table 1 illustrates the IoT getaway tool used as listed in the literature review section.

It is evident from the table that some researchers depending on the optimization of the Smart Gateways (SG), ZigBee technology, LoRa-server, IGaaS: A Gateway as a Service. Rather than middleware Network (Wi-Fi) has been placed between the system software and hardware Arduino microcontroller. to reach the Significant Satisfied Aims.

Table 1. Summary of literature review related to smart gateways

Author	Author's objectives	Results
Zhang et al. [53]	Using SIP as a gateway and the SIP intermediate software is designed to resolve the data exchange problem between standard SIP connection and portal equipment service, which checks data connections for text data, control letters, and media flow.	This design provides a reference solution for integrating smart home portals and intermediate software technologies.
Wan, Chen et al. [55]	An additional data collection and recognition system based on the intelligent gateway was used. Data collection, awareness, and reporting can be achieved by including additional software in the smart portal.	Evaluation and experience using actual smart home data show that the proposed platform and the different MDA systems can collect data efficiently and provide accurate data awareness. The performance evaluation shows that the port plug-in is economical in computing power.
YAN et al. [54]	An intelligent gate system to provide the building with the technology ZigBee.	The intelligent home portal for a wireless network sensor solution from ZigBee. Explore the actual state of the clever grid furniture and its creation. ZigBee wireless networking technologies and Internet technology were built into the scheme.

Author	Author's objectives	Results
Jianqi et al. [56]	Presented a steering gate design based on the wireless networks of the smart home.	The trial results show the following: The routing portal, via the web interface, can monitor and query information on home computers, provide users with internet connectivity requirements, and accomplish the purpose of the concept.
Souifi et al. [59]	LoRa was used in this study to implement a smart home solution.	The Lora WAN portal is designed to manage and create this connection between LoRaserver and sensors.
Davoli et al. [58]	suggested a delivery solution that exploits available information about the status of the current network (SNR values periodically measured for satellite links and GW buffer occupancy) to transmit traffic flows between gates in the event of congestion or disruption	The results were obtained to assess the improvement of the proposed solution's performance and strength in different network conditions.
Rossi et al. [63]	optimization of the Smart Gateways (SG)	The optimization process follows a practical approach to the satellite operator, trying to determine the best SG configurations to reach the target system's performance in light of possible GWs sites.
Eridani et al. [64], 2019	demonstrated that based on studies carried out on the structure of the smart gateway network.	To make encryption easier, it can also be added to the crypto format and decryption. Constructing is easier, too. A device that uses a real sensor and measures the LoRa parameter in rapid mode.
Patil et al. [61]	IoT gateway(s) placement is needed for communication between the sensor network and IoT cloud, supporting all IoT network technologies.	The IoT consists of many portals for the IoT (IGW) that can lead to a costly method. Set gates can be optimized to improve network efficiency, which lowers publication costs and improves productivity.
Ivanović et al. [62]	Use of administrative configuration tasks implemented on several home automation Gateways.	By adding more sub-services, the solution can be extended to accommodate multiple additional job types.
Sarma et al. [60]	Intelligent load balancing system dependent on the switch with fog and cloud.	Preprocessing data explains the value of work, which positively influences efficacy without preprocessing every file/data needing to be submitted with its original size.
Hoque et al. [57]	IGaaS: A Gateway as a Service	This increases service level by delivering a door on demand by drone or smartphones and reducing both static and wireless portals.
Andi et al. [65]	Employed a WLAN gateway for transmuting system instructions to hardware control unite.	Suggest monitoring and controlling the home environment effectively based on received home sensor data.
El-Basioni et al. [66]	Using wireless network gateway in the proposed system design.	The behavior of home appliances is visualized and managed via the adapted system network.
Souvee et al. [67]	A middleware Network (Wi-Fi) has been placed between the system software and hardware (Arduino microcontroller).	The home environment can be controlled automatically by a voice recognition system. Also, commands can be given to the lighting system via a smartphone or tablet through a web-server.

Using this methodology and techniques, both researchers have strong structures, frames, and functions, such as providing a reference solution for integrating smart home portals and intermediate software technologies, an intelligent home portal for a wireless network sensor

solution from ZigBee. Pre-processing data explains the value of work, which positively influences efficacy without pre-processing every file/data needing to be submitted with its original size. Home appliances' behaviour is visualized and managed via the adapted system network, and the home environment can be controlled automatically by a voice recognition system.

5. CONCLUSION

In conclusion, we can observe that effective methods have been created, with many of these works derived from the problem-solving style. Using the IoT, most of the physical tasks may be transferred to electronic tasks based on the information collected, data analysis, and connections to the Internet. However, The IoT gateway has various security issues and challenges. The IoT gateway problem is partly because current portals integrate network connectivity, processing, and user interface functionality within the network. Therefore, the disentanglement of these functions is suggested to improve the connectivity of IoT devices. This article shows how to manage IoT gateways accessibility effectively. Besides, design and networking protocols of the IoT gateway. Thus, gateways require several frameworks for handling heterogeneous communications. It also looked at some technology challenges at IoT gateways, such as reliability, availability, storage, and safety. The IoT experiments gateways are also in a state of large growth. Certainly, further improvements will be made to the creative IoT reflections of portals hence expanding IoT applications.

We have discussed in this article the A State of Art for Smart Gateways Issues and Modification. The topic also centered on numerous technologies for IoT that would be expanded across the smart getaway. Challenges of smart getaway IoT deployment and transparent problems are also discussed. In general, this paper's purpose was to include an overview to summarize up-to-date research contributions on smart getaway and its applications in our environment and illustrate potential research directions and genuine concerns regarding the integration with the IoT of smart getaway.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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