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Internet of Things-Based Energy Management, Challenges, and Solutions in Smart Cities

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***Abstract*— Smart cities have an attracted extensive and emerging interest from both science and industry with an increasing number of international examples emerging from all over the world. The promising and increasing trend in current computing, where it focuses on proper energy consumption leading to an increased life span of networks that uses interconnected devices that are technically referred to as the Internet of Things (IoT). These devices facilitate close resource availability on the edge of the network with resource pooling. This study presents a comprehensive survey on the proper Internet of Things-Based Energy Management in Smart Cities. The study shows that the IoTs have increased energy consumption, further the summarized table presented shows the state-of-the-art proposed methods in managing energy on different girds like smart home, smart building, and smart networks among others.**

Keywords—Smart Cities; Internet of Things; Energy Consumption

I. INTRODUCTION

Smart cities (SC) have an important role in dealing with recent urban challenges, realizing SC potential and for being a vendor hype. The authors firstly presented a review of diverse conceptualization, benchmarks, and evaluations of the smart city concept. They further depicted some eight different classes of smart city conceptualization models that have been discovered, which structure the unified conceptualization model and concern smart city facilities, services, governance, planning and management, architecture, data, and people. The study threw light over parameters that can be measured and controlled in an attempt to improve smart city potential [1].

More still, recent developments in SC initiatives across the world to motivate the opportunities and challenges that such initiatives pose where the author considered initiatives in over three categories that is to say data access and collection, end-user utility, and economic viability of different solution addressing some of these challenges that are nascent state and providing guidelines on how manufacturing and service operations management scholars contributing to the global smart city movements in detailed [2].

SC holds policies that have a positive impact on urban economic growth, Urban innovation impact of Smart City policies has been studied where archetypal SC programs showing the involvement not only of major multinational corporations of technological solutions to the local benefits. The study showed that the propensity score projected that cities may engage in SC policies above the smart world averages. This study provided effect absolutely for high-tech technologies that shrink for more narrowly defined technological classes. The results obtained depicted all the possible technological spillovers from technologies directly involved in SC policies [3].

The need to measure the power consumption of Physical Machines in SC has been further introduced to avail the uniqueness of SC, the operational challenges that SC environments are reducing the energy consumption and load balancing that have some similarities with cloud computing. The energy consumption of modern computing like fog resources depends on the requests that are allocated to the set of virtual machines.

Based on the presented three-layered architecture cloud, fog and consumer layer, the cloud and fog provide virtual machines to run the consumers' application quickly. The Nearby Data Center Optimize Response, Reconfigure Dynamically with Load is implemented to optimize the Response Time and Processing Time. These policies decide which requests are allocated to which Data Center The proposed Solutions are used to minimize the computational cost and also decrease the RT and PT of DCs as illustrated in [4].

The authors proposed a solution for Electric Vehicles energy management in SC where a deep learning approach was enhancing the energy consumption of electric vehicles by trajectory and delay predictions. Some other two recurrent Neural Networks were adapted and trained over 60 days of urban traffic settings.

The trained networks showed a precise prediction of trajectory and delay, even for long prediction intervals. An algorithm was designed and applied to well-known energy models for traction and air conditioning. Furthermore, the results showed how possible it is to prevent from battery exhaustion, energy models demonstrated the efficiency of the proposed solution in terms of route trajectory and delay prediction, enhancing the energy management well discussed in [5].

SC accounts for 35% of the international final energy demand. Efficiency enhancements and superior management techniques have a substantial impact on the reduction of energy prices and CO2 emissions. SC strength simulation is widely used to help planners, contractors, and building owners analyze diverse alternatives regarding the planning and administration of energy consumption in buildings. Two Control algorithms, such as deep reinforcement learning can tune themselves, are model-free, and low-priced to implement.

The authors introduce integrated simulation surroundings that combine CitySim, a fast building power simulator, and Tensor Flow, a platform for the environment-friendly implementation of advanced computer gaining knowledge of algorithms. This new environment will allow researchers to inspect novel mastering manage algorithms and show their robustness and attainable for numerous purposes in the built environment. Authors existing two case studies for power financial savings and demand response, respectively [6].

The wider use of (IoT) enables SC to be built. The authors studied identify key IoT challenges and understand the relationship between these challenges to support SC growth [7]. The (IoT) is a rising science that proffers to join big smart devices collectively and to the Internet. An IoT-based SC can offer quite some clever offerings to citizens and administrators, for this reason improving the utilization of public resources regarding transportation, healthcare, environment, entertainment, and energy.

The integration of transmitting, computing, and caching is having a profound effect on the improvement of bendy and efficient IoT in SC. a scalable and sustainable IoT framework that integrates UDN-based hierarchical a couple of access and computation offloading between MEC and cloud to support the clever metropolis vision. The proposed built-in framework can considerably decrease the end-to-end lengthen and energy consumption of computing facts from big IoT gadgets [8].

Given the exponentially developing range of IoT devices and the large wide variety of SC services as well as their unique QoS requirements, it has been a massive assignment for servers to optimally allocate limited resources to all hosted applications for exceptional performance. Note that by pushing the computing and storage assets to the proximity of quit IoT devices, and deploying functions in distributed edge servers, facet computing technology seems to be a promising solution for this challenge. The authors present how to allocate edge assets for average service response time minimization [9].

Transmission is the soul-concept in the smart world, but due to the resource-constrained nature of these tiny devices and voluminous amounts of the data, it is very challenging to brazenly talk about the sustainable and Green SC platform. Thus, to treatment, these issues two Hybrid Adaptive Bandwidth and Power Algorithm (HABPA), and Delay-tolerant Streaming Algorithm (DSA) are proposed with the aid of adopting stored video move titled, StarWarsIV.

Experimental effects are acquired and analyzed in phrases of overall performance metrics i.e., power drain, battery lifetime, delay, general deviation and packet loss ratio (PLR) in association to the buffer size. It is concluded that the HABPA two extensively optimizes power drain, battery lifetime, fashionable deviation, PLR of the IoT-enabled units with much less prolong respectively at some point of media transmission in SC [10].

This paper is structured as follows, in section 2 we provided related work for the energy management, section 3 illuminate's internet of Things architecture in general, section 4 explicates the software model. Lastly, section five has the identified challenges and state-of-art solution with conclusion the paper and indistinctly depict our future work.

II. Related Work

In this section, we present some of the related works mainly on IoT based energy management in smart cities.

A. Multi-Energy Networks

Improvement of smart grid technologies, is growing activity in and the manageable of dispensed multi-energy systems, for instance from districts or communities, to furnish demand response. The authors introduce a novel and powerful 'transitive energy' modeling and evaluation framework for distributed multi-energy systems.

The framework includes a DMES stochastic optimization model; a modular and extensible cost mapping methodology for identifying transitive energy rate alerts and cash flows for different electricity machine actors; earnings sharing model; and an economic assessment mannequin primarily based on necessary cost-benefit analysis. The framework is illustrated through the analysis of DR business instances in a real area [11].

The authors propose total optimization of energy networks in a smart city by using multi-population global-best modified Genius storm optimization (MP-GMBSO). The efficient utilization of electricity is fundamental for a discount of CO2 emission, and smart city demonstration initiatives have been performed around the world to reduce whole energies and the amount of CO2 emission. Multi-population primarily based on evolutionary computation strategies has been demonstrated to improve answer exceptional and the approach has an opportunity for enhancing answer quality.

The proposed MS-GMBSO makes use of solely migration for multi-population models, which is the first-class individual amongst all of the sub-populations so far, It is tested that the proposed MP-GMBSO based technique with ring topology, the W-B policy, and 320 folks is the most high-quality amongst all of the multi-population parameters [12].

The energy network is an integrated device that is capable of transporting, transforming, and storing quite a few types of energy. Some hubs can be combined as a network and achieve higher efficiency via changing data and electricity with every other. A decision-making framework for greatest integration of unbiased small-scale disbursed strength structures and normal large-scale mixed heating and power plant life is presented, an overall performance simulation mannequin of this energy network is proposed based totally on electricity hub thought and power glide between its elements. The outcomes subsequently end with improving energy utilization effectivity and reducing machine running costs, even beneath a machine contingency circumstance [13].

B. *Smart Building*

Future buildings will offer new convenience, comfort, and efficiency possibilities to their residents to supply a systemic review of how SB impact in managing most suitable energy saving, thermal comfort, visual comfort, and indoor air satisfactory in the constructed environment. The finest administration of electricity saving and occupant remedy performs a crucial position in the constructed environment. To do this, there has to be a purposeful sensing gadget that connects the surroundings variables (e.g., temperature) with building environmental manage structures such as the heating, ventilation, and air-conditioning system. The authors explore the application of SB in the built environment and analyze this in phrases of power-saving, thermal comfort, visible comfort, and indoor air quality. Following this, the statistical analysis is discussed in terms of data, information, and know-how accrued from the SB [14].

For designing and implementation of an SB prototype. SB utilizes (IoT) solutions to collect, analyze, and manipulate information from SB in an SC environment. The developed SB prototype is successful in real-time interactions with the residents. The most important goal is to adapt the construction settings to the residents' desires and supply the maximum comfort degree with minimum operational costs.

For this purpose, building parameters are amassed by using a set of sensors and transferred to a database in real-time, which can be accessed, analyzed and visualized. Environment houses such as temperature, light, humidity, audio, video, surveillance, and get entry to popularity are managed through a model-based controller [15].

The future expectation of SB consists of making the residents' journey as convenient and blissful as possible. The large streaming records generated and captured via SB home equipment and units contain valuable records that wish to be mined to facilitate well-timed actions and better decision making. Machine learning and massive information analytics will most likely play an essential function to enable the transport of such smart services. The authors survey the location of smart building with a special center of attention on the function of techniques from Machine learning and big data analytics [16].

C. *Smart Power Grid*

To enhance the first-rate of lifestyles and meet the desires of citizens, corporations and institutions. Nowadays we hear extra and greater about the (IoT). Cities grow to be smart, but at the same time, it is now not regarded as the quality of data that these devices send over the internet. The authors, focus on energy efficiency, and in particular how energy measurements are carried out and sent. The authors suggest a low value smart electric powered meter for the size of electrical parameters. The meter is capable of adapting to the variability of the grid keeping a high stage of dimension accuracy [17].

A smart grid poses technical challenges to the power distribution network due to the fact of the growing data traffic ensuing from numerous data applications. Traffic scheduling algorithms manage these heterogeneous functions by applying exclusive priorities to every visitor's kind primarily based on (QoS). The authors propose a context-aware traffic scheduling (CATSchA) algorithm to schedule the traffic such that it ought to adapt to varying power network conditions. The CATSchA algorithm is carried out in a packet-switched network the usage of the NS-3 simulator, and the traffic demand is fulfilled based totally on the algorithm's context-awareness. The proposed algorithm lowers the delay while retaining the throughput and link efficiency [18].

IoT aims to deliver a smarter electric power grid. This work discusses the contemporary challenges and opportunities of IoT-enabled smart electricity systems from a wide variety of aspects. Existing techniques and latest solutions with appreciate to home demand response, IoT cyber protection, and modeling, and simulation challenges confronted by using present-day smart grid are provided thru combining hardware (analog and digital) and software to address some of the challenges in building a smarter and more related smart grid [19].

III. INTERNET OF THINGS ARCHITECTURE

In this section, we present the IoT architecture mainly based the IoT based energy management in SC.

A. Energy cloud server

Energy affectivity is imperative trouble due to the truth that numerous tasks are jogging on Energy devices with restrained resources. Cloud computing can offload computation-intensive tasks from energy devices onto effective cloud servers, which can significantly minimize the energy consumption of energy devices and as a result decorate their capabilities. Cloud computing, energy devices transmit data via the wireless channel.

However, when you consider that the state of the channel is dynamic, offloading at a low transmission charge will result in a serious waste of time and energy, which similarly degrades the (QoS). To tackle this problem, the author proposes an energy-efficient and deadline-aware task offloading approach primarily based on the channel constraint, intending to minimize the energy consumption of energy devices whilst enjoyable the closing dates constraints of cloud workflows. this method, task offloading approach can outperform energy consumption of energy devices, the execution time of cloud workflows, and the strolling time of algorithms [20].

In the latest years, Energy affectivity has emerged as a key indicator for data centers. To optimize energy efficiency, Management personnel in cloud data centers have to recognize the relationship between the workload patterns and the energy consumption of the infrastructure. Authors reason an energy prediction model to estimate the energy consumption of servers in cloud data centers based totally on overall performance counters of their processors. Finally, through inspecting the consequences of the contrast experiments, it is shown that the proposed energy prediction model can predict the energy consumption of cloud servers with high accuracy [21].

B. Energy Device

SC and the (IoT) characterize the future in urban areas. Different energy devices in SC can be used to create an extra sustainable and secure city. The authors advise an architecture that combines the data from exclusive devices. And the amount of traffic generated for every machine ought to be considered. Therefore, authors recommend the use of data aggrupation in every device to decrease the amount of generated traffic in the network and thus the energy consumption.

The IP of all devices and their data is grouped and forming a packet with all the information from one system. Thus, because of the use of a decrease variety of headers for transmitting identical data the generated traffic is reduced. The results exhibit that data aggrupation saves up to 70% of the generated traffic [22].

The authors have viewed EDs as computing services functioning at the crossroad of electrical, thermal and data networks and have described optimization methods to make the most their energy flexibility. To exchange power flexibility authors have defined an Energy Marketplace which allows EDs to act as energetic energy players integrated into the smart grid, contributing to smart city-level efficiency goals.

Four modern commercial enterprise situations that allow next technology smart Net-zero EDs acting as energy presumes at the interface with smart electricity grids within smart city environments. The study showed that EDs have a great amount of power flexibility which may also be shifted and traded to interested stakeholders accordingly permitting them to gain new revenue streams not foreseen earlier than [23].

Internet of Things (IoT) devices can apply mobile edge computing (MEC) and energy harvesting (EH) to provide high-level experiences for computationally intensive applications and concurrently to prolong the lifetime of the battery. The proposed a reinforcement learning-based offloading scheme for an IoT device with EH to select the edge device and the offloading rate according to the current battery level, the previous radio transmission rate to each edge device, and the predicted amount of the harvested energy.

This scheme enables the IoT device to optimize the offloading policy without knowledge of the MEC model, the energy consumption model, and the computation latency O model. Further, we present a deep RL-based offloading scheme to accelerate the learning speed. Their performance bounds in terms of the energy consumption, computation latency, and utility are provided for three typical offloading scenarios and verified via simulations for an IoT device that uses wireless power transfer for energy harvesting leading to RL-based offloading scheme reduces the energy consumption, computation latency, and task drop rate, and thus increases the utility of the IoT device in the dynamic MEC in comparison with the benchmark offloading schemes [24].

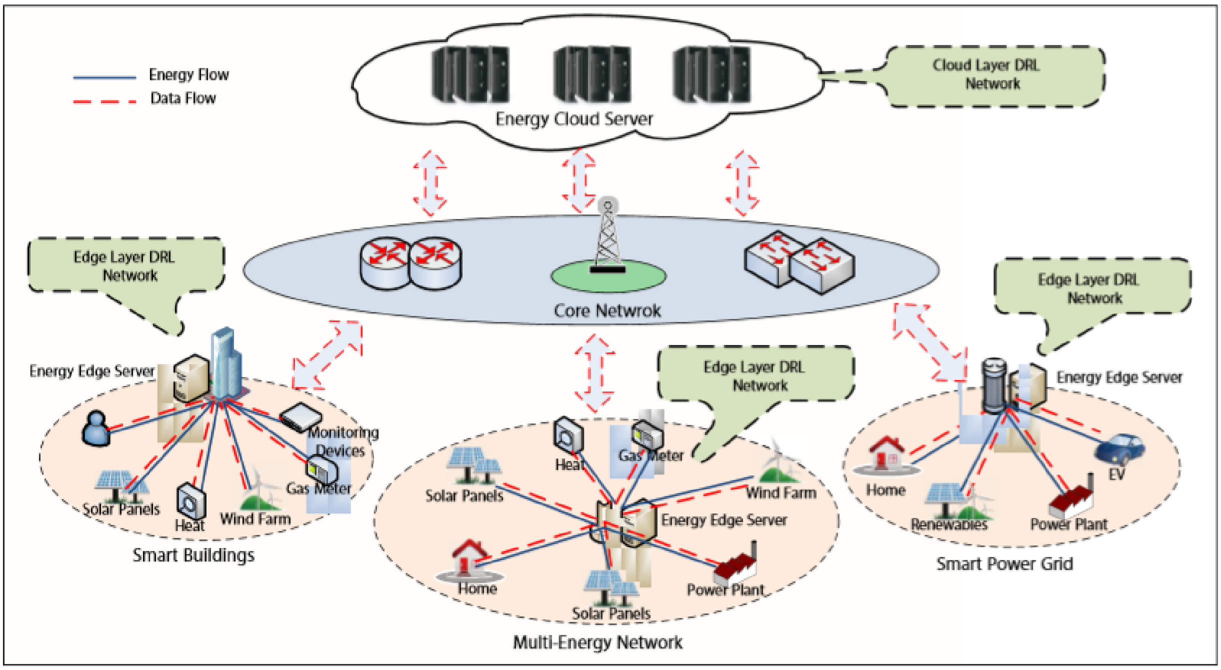

Fig. 1: Energy Management

C. Energy Edge Server

The provided illustration of figure 1, clearly shows mainly three smart city components that are IoT-Based, that is to say, smart building, Multi-energy Networks, the smart power grid. Followed by the Core Networks and lastly, energy cloud server. Mobile edge computing has become a key technology in IoT and 5G networks, which provides cloud-computing services at the edge of the mobile access network to realize the flexible use of computing and storage resources.

While most existing research focuses on network optimization in small-scale scenes, this paper jointly considers the resources scheduling of servers, channels, and powers for mobile users to minimize the system energy consumption. It's an NP-hard problem that can only be solved through the exhaustive search with the complexity of an exponential level. The lightweight distributed algorithm proposed in this paper based on the Markov approximation framework can make the system converge to an approximate optimal solution with only linear level complexity. The simulation results show that the proposed algorithm can generate near-optimal solutions and outperform other benchmark algorithms [25].

SC infrastructures are less capable of improving power usage efficiency and integrating renewable energy. In the desire to solve a challenge, a new framework proposed - edge computing was proposed, which leverages device-to-device communication and energy-harvesting to realize sustainable and collaborative task execution. Further with smart street lighting and smart bike-sharing the basic architecture, model and optimization of edge computing presented and research inspirations, practical challenges and directions towards edge computing are identified that Edge is not the only road towards sustainability, future alternatives that can work in conjunction with Edge server to comprehensively edge computing are discussed [27].

Table 1: Summarized Energy challenges

Categories	Challenges	Proposed Models	Solution	References
Internet of Things	The integration of transmitting, computing, and caching is having a profound effect on the improvement of bendy and efficient IoT in SC.	A scalable and sustainable IoT framework that integrates UDN-based hierarchical a couple of access and computation offloading between MEC and cloud to support the SC vision.	Decrease the end-to-end lengthen and energy consumption of computing data from big IoT gadgets	[8]
	Optimally allocate limited resources to all hosted applications	Pushing the computing and storage assets to the proximity of quit IoT devices	Response time minimization	[9]
	Resource-constrained nature of these tiny devices	Two Hybrid Adaptive Bandwidth and Power Algorithm, and Delay-tolerant Streaming Algorithm	Optimizes power drain, battery lifetime	[10]
	Optimizing energy consumption	LoBEMS (LoRa Building and Energy Management System)	Improve overall building efficiency	[29]
	Resource management	Resources can be managed by imposing protocols, algorithms, and strategies	Enhance the scalability, reliability, and stability	[30]
	Big demand for wireless bandwidth	Cognitive radio	Spectrum-based functionalities	[32]
Smart cities	dealing with recent urban challenges	Diverse conceptualization	Improve smart city potential	[1]
	recent developments in SC initiatives	author considered initiatives in over three categories	contributing to the global smart city movements	[2]
	Urban innovation impact of Smart City policies	Archetypal SC programs	obtained depicted all the possible technological spillovers from technologies directly involved in SC policies	[3]
	Operational challenges	Three-layered architecture cloud, fog, and consumer layer	Minimize the computational cost	[4]
	Electric Vehicles energy management in SC	Deep learning approach	Enhancing the energy consumption of electric vehicles	[5]
	energy prices and CO2 emissions	Combine CitySim and Tensor Flow algorithms	Power financial savings and demand response, respectively	[6]

Table 2: Summarized Energy Challenges

Categories	Challenges	Proposed models	solutions	References
Energy Management	to furnish demand response	DMES stochastic optimization model	for identifying transitive energy rate alerts and cash flows	[11]
	a discount of CO2 emission	Multi-population global-best modified Genius storm optimization (MP-GMBSO).	optimization of energy networks	[12]
	To achieve higher efficiency	A decision-making framework	Improving energy utilization effectivity and reducing machine running costs	[13]
	energy saving	the finest administration of electricity saving and occupant remedy	thermal comfort, visible comfort, and indoor air quality	[14]
	energy measurements	low value smart electric powered meter	high stage of dimension accuracy	[17]
	data traffic ensuing from numerous data applications	context-aware traffic scheduling (CATSchA) algorithm	lowers the delay while retaining the throughput and link efficiency	[18]
	offloading at a low transmission charge	energy-efficient and deadline-aware task offloading approach	minimize the energy consumption of energy devices	[20]

A. Application Layer

This work presents the efforts on optimizing energy consumption by deploying an energy management system using the current IoT component/system/platform integration trends through a layered architecture. LoBEMS (LoRa Building and Energy Management System), the proposed platform, was built with the mindset of proving a common

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viding
critical data in order to improve overall building efficiency. The actions that led to the energy savings were implemented with a rule set that would control the already installed air conditioning and lighting control systems. This approach was validated in a kindergarten school during a three-year period, resulting in a publicly available dataset that is useful for future and related research. The sensors that feed environmental data to the custom energy management system are composed of a

set of battery-operated sensors tied to a System on Chip with a LoRa communication interface.

These sensors acquire environmental data such as temperature, humidity, luminosity, air quality but also motion. An already existing energy monitoring solution was also integrated. This flexible approach can easily be deployed to any building facility, including buildings with existing solutions, without requiring any remote automation facilities. The platform includes data visualization templates that create an overall dashboard, allowing management to identify actions that lead to savings using a set of pre-defined actions or even a manual mode if desired. The integration of the multiple systems is a key differentiator of the proposed solution, especially when the top energy consumers for modern buildings are cooling and heating systems [28].

The IoT is to serve humanity across special domains of life masking industrial, health, home and everyday operations of Information Systems. Due to the large range of heterogeneous network elements interacting and working below IoT primarily based energy management, there is an enormous need for resource management for the clean going for walks of IoT operations. The key component in IoT implementations is to have resource-constrained embedded devices and objects participating in IoT operations. It is important to meet the challenges raised all through management and sharing of resources in IoT based totally management system. Resources can be managed by imposing protocols, algorithms, and strategies that are required to enhance the scalability, reliability, and stability in IoT operations throughout exclusive fields of technology [29].

In order to clear up the problem of energy administration in SC, the energy administration platform of the Internet of things is applied. The method of the electricity consumption measurement data gets entry to, to the energy administration platform of the Internet of things is studied. According to the different communication protocols used by the energy administration subsystem, the get right of entry to techniques of technology, Web Service and open database connectivity and front-end communication are discussed. The effects exhibit that the SC energy management device based on the Internet of things can meet the wishes of the SC construction. This lays the basis for the diagnosis and energy-saving evaluation of urban energy consumption [30].

B. Cognition layer

The evolution of IoT devices has generated a big demand for wireless bandwidth in order to meet the operational wants of new generation IoT applications. As such, cognitive radio has acquired tons of interest in the research community as a necessary capability for addressing the bandwidth wishes of IoT applications. The proposed solution check out the structure frameworks and potential purposes of cognitive IoT and further discuss the spectrum-based functionalities and heterogeneity for cognitive IoT. Security and privacy problems worried in cognitive IoT are additionally investigated [31].

Deep learning represents a promising alternative when it comes to presenting algorithms that manner a big extent of data and enter variables coming from cognitive cities. But the use of deep learning applied sciences in the cognitive cities domain started solely a few years ago; in that regard, there are nonetheless many issues that want to be addressed and no longer has ample literature been developed. Authors provide a novel classification framework of cognitive cities using deep learning algorithms that are primarily based in contemporary surveys for recognized domains such as machine learning and smart cities, however, it adds the point of view of efficiency, sustainability and resilience that cognitive cities goal to solve [32].

SC sustainability and resilience ought to be elevated via new learning and cognitive technologies that change citizen behavioral patterns and react to disruptive changes. These technologies will allow the evolution of SC closer to the so-referred to as "Cognitive Cities". The authors highlight the significance of the Semantic Web and semantic ontologies as a foundation for learning and cognitive systems. Energy is one of the city domains where learning and cognitive structures are needed. These study evaluations IoT-based energy management solutions developed to enhance SC power efficiency, sustainability, and resilience. The assessment focuses on learning and cognitive solutions that improve energy sustainability and resilience through Semantic Web technologies [33].

C. Network layer

With the fast improvement of compelling application eventualities of the IoT like SC, it will become drastically necessary to beef up the management of data traffic in IoT networks. Traffic classification is recommended in phrases of each ensuring network protection and enhancing the quality of service. authors propose an end-to-end IoT traffic classification method relying on deep learning aided capsule network for the sake of forming an efficient classification mechanism that integrates feature extraction, feature selection, and classification model. The proposed traffic classification method beneficially eliminates the method of manually deciding on traffic features, and is especially relevant to SC scenarios. Ultimately this method yields excessive classification accuracy [34].

With the make bigger of their population, cities need to adapt to offer greater efficient offerings and higher life quality. IoT has seen amongst the technologies that enable smarter transportation, waste collection, energy and resource management, etc. But this does now not come at no cost and new services arise via the collection and processing of a large set of disbursed and ubiquitous data. Proposed work discusses the necessities wished to achieve an SC, figuring out the essential technical challenges in the heterogeneity of devices, data, networks, protocols, and standards. To overcome these limitations, the authors suggest their imaginative and prescient of a Cloud of Meshed Cooperative heterogeneous Things targets to allow each standard city's entity to be exposed and fed on as a service. Beyond ordinary Cloud of Things services such as data abstraction and mutualization providing extra holistic functionalities by aiming at full interoperability [35].

SCs are contemporary revolutions that can cope with the complexities of growing city density. Smart applications dwell in the cloud data center, the place Internet of Everything devices or sources access these purposes to obtain city services. Accessing functions from the far-away cloud imply greater latency, big network traffic, and possibilities of security and privacy breaches. These issues are not sustainable for real-time applications. the study describes network necessities and challenges faced by applications and solutions to encounter them [36].

D. Sensing layer

The boundaries of sensor node resources in the IoT, the complexity of networking, and the open wireless broadcast communication traits make it prone to attacks. Intrusion Detection System (IDS) helps discover anomalies in the network and takes the quintessential countermeasures to ensure the secure and dependable operation of IoT applications. The study proposes an IoT feature extraction and intrusion detection algorithm for SC primarily based on a deep migration learning model, which combines deep learning mannequin with intrusion detection technology. In the experimental part, KDD CUP 99 was selected as the experimental data set, and over 11% of the data was used as training data. The experimental consequences show that the proposed algorithm has a shorter detection time and greater detection efficiency [37].

This unique section focus on the application of IoT in smart cities. SCs are developing rising innovation in academia, industry, and government. A smart city is described as a city connecting the physical infrastructure, the Information and communication infrastructure, the social infrastructure, and the commercial enterprise infrastructure to leverage the collective intelligence of the city. The proposed study in this part cowl the most current lookup and development on the enabling technologies for IoT based smart cities and to stimulate discussions on contemporary and innovative aspects in the area [38].

Current SCs are geared up with sensors producing massive amounts of data waiting to be tapped for "smart" decision making such as smart grid, smart transportation, smart buildings, and smart healthcare. The proposed work, the existing related work in the development of SC data sharing and integration are enumerated and the key technical challenges and limitations are identified and highlighted. Suggested a bottom-up publish/subscribe data sharing and integration model to overcome the technical challenges and boundaries in cross-domain integration of SC data. The proposed model shows a promising prospect for facilitating SC data sharing and extraction, transformation and loading when totally implemented [39], that will faculae the security and privacy in long run and evaluated performance as well [40].

V. CONCLUSION

In this study, a comprehensive survey on the proper Internet of Things-Based Energy Management in Smart Cities has been presented. The study showed that the IoTs have increased energy consumption, further the summarized table presented shows the state-of-the-art proposed methods in managing energy on different girds like smart home, smart building, and smart networks among others. SC has attracted an extensive and emerging interest from both science and industry with an increasing number of international examples emerging from all over the world.

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