Chapter 8
A Framework for the Actualization of Green Cloud-Based Design for Smart Cities

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8.1 Introduction

One of the basic requirements for a smart city is the software and hardware infrastructure. Data can be collected in real time with smart sensors with advanced monitoring systems that can be used for data analysis and decision-making. The smart city, for instance, has been described as a metropolis which can make full use of interconnectedness in physical substructure in 2008 by IBM. Also, the smart city can be interconnected by social infrastructure, business organization, and IT setup to produce collective intellect. This highlights the interconnectivity of the practical infrastructure of a metropolis. Most especially, the hardware infrastructure like network facilities and sensors in smart cities are of importance. Hall et al. [1] proposed a system that integrates and monitors cities with their critical infrastructure using network connections and decision-making algorithms to monitor target security and optimize resources.

Schaffers et al. [2] see smart cities' model city development using modern information technology and ubiquitous connectivity to improve urban residents' quality of life and achieve sustainable development and urban competitiveness. A smart city's mission is to create autonomous environments that are independent

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or less depending on people, and to combine and optimize environments centered on availability. Giffinger et al. [3] described smart cities as having smart infrastructure, smart citizens, smart government, smart transport, smart climate, and social upliftment [4]. A smart metropolis was defined by Giffinger et al. [3] as having a smart infrastructure, smarter individuals, sustainable cities, smart transport, smart buildings, and smart living. In their observations on the climate, rights, and development, Lazaroiu and Roscia [5] are much prescriptive and indicated that a smart municipality ought to provide a smooth budget, sustainable cities, an intelligent transportation, remote monitoring, and intelligent mobility.

In recognizing its essential nature and influencing the creation of its structure, a thoughtfulness of the fundamental of smart metropolises is of utmost importance. For example, the work on smart city assessment by the British Standards Institution (BSI) develops mostly on smart urban model, on the Publicly Available Specifications (PAS) 181 standards [6], as well as on the practice of the International Standards Organization (ISO) shared framework for the implementation of smart city by city leaders around the world [7]. As a modern paradigm of urban planning, the smart city has large technological branches. While several researchers and institutions have studied it, stakeholders following many different viewpoints have addressed different concepts [1, 8–10]. There has been no study from multiple backgrounds to carry out a clear grouping of smart municipal concepts. This chapter carried out and studied the concepts of the smart metropolis on the basis of a thorough study of the conceptual connotations and implementations of the smart metropolis, allowing for four phases: software and hardware infrastructure, spatiotemporal data and exploration, methods, and applications for cloud platforms.

Cloud computing and the Internet of Things (IoT) are two major ICT ideas which have emphasized the scientific society's relevance in recent times. The cloud computing concept [11] integrates and promotes the on-demand delivery of technology and information resources over the Internet functional description. Depending on the form of processing capabilities provided across the Web, cloud providers take a variety of forms like Network as a Service (NaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Storage as a Service (STaaS), and many more services that are accessible. These services provide higher efficiency, stability, broad supply, and improved QoS at a small asset average cost of ownership (TCO). The European Commission (EC) has already worked on a host of projects (e.g., RESERVOIR [12], VISION-CLOUD [13], OPTIMIS [14], CONTRAIL [15]) that have established Pan-European prototypic cloud resources while also improving specific cloud technology (e.g., power controlling, protection) and software.

Simultaneously, the IoT paradigm focuses on the identification and utilization of a complex set of physical and virtual objects (i.e., traditional and cyber viewpoints) connected to the Internet [16]. IoT enables communication among different items as well as in-context activation of their resources (infrastructure) for value-added implementations. Radio-frequency identification (RFID) and wire-free sensor networks became the roots of earlier Internet of Things technology and provide practical benefits in a variety of fields, like production, transportation, exchange, retail, environmentally friendly systems, as well as other industries.

Cloud computing and IoT are thus two main innovations for achieving the ubiquitous concept of connectivity. The cloud will offer vast and long-term computing and processing services for tailored ubiquitous applications distributed by IoT as well as essential back-end facilities. Internet of Everything (IoE) refers to a global, interconnected network of physical objects that are designed to detect or interact with other objects, devices, or personal computer. IoE is a core component of the future clever environment which can be defined as a Web system with personalized capabilities generated from specialized standards where digital and physical entities can interact effortlessly.

IoE links entities and individuals that can interact through different sensors and devices, radio-wave recognition via Bluetooth communication, etc. These "smart" items come in a wide range of measurements and capacities, combining basic objects with integrated sensors, household equipment, autonomous machines, cars, trains, and wearable items such as clocks, arm necklaces, or shirts [14]. Their value lies in the infinite amount of knowledge they can collect and their potential for interaction, cultivating continual control or review of information that reveals unique ideas and encourages new behaviors. With IoE, the universe is getting technologically more sophisticated, and an intelligent user can interact with items, and entities can interact with new particles devoid of user involvement.

Yet IoT can affect our environment in a few different ways. Any item of IoT, from its development through its use to its depletion, poses pollution risks. Production of sensitive devices, personal computers, laptops, and their countless sections absorbs fuel, resources, chemicals, and water and generates hazardous leftover. Both of these items and processes would increase atmospheric carbon discharges and impact the environment. In addition, the gross energy usage of servers, personal computers (PCs), displays, knowledge conversion facilities, and ventilation towers for data centers is increasing. Emissions of greenhouse gases will rise exponentially with rising energy usage. Each PC being used regularly emits an immense amount of pollution. Digital devices, sensors, and PC components used in IoT will enclose radioactive substances. Also consumers have a huge amount of outdated devices, electronic appliances 2 or 3 years postdelivery, and most of them in dump sites are also contaminating the earth. It is indicated that roughly 20–50 million, a huge range, computer components as well as cell phones are discarded each year, which is the biggest shortage. There is also tremendous strain on the IoT similar companies, enterprises, and people who develop IoT-associated artifacts and structures to create IoT schemes that are environmentally sustainable and renewable during its life span, i.e., from delivery to passing away to reawakening [17].

As IoT is embedded with several sensual components, it allows data to be detected and transmitted using innovative connectivity technology that eventually improves energy efficiency. Yet just telecommunications and information systems account for around 2% of carbon (IV) oxide discharges. The planet nowadays is absorbing eco, and it is our collective duty to protect our climate. It is not green with jealousy, but green as if it were being more mindful, energy saving, conforms to global norms, and environmentally friendly. The effective use of computational tools such as Energy Star, prohibition of dangerous chemicals, etc., might be helpful to handle them further effectively during their life span and also at the point of removal. Information systems that are environmentally friendly (IT) are an ecologically friendly computing activity. It intends to minimize the harmful environmental effect of the IT scheme by developing, producing, running, and positioning devices, sensors, goods, etc. in an ecologically sustainable way. Green IoT's real goals are to reduce the use of hazardous radioactive chemicals. It does have the potential to boost power consumption over its life span and to encourage the biodegradability and reusability of outdated goods and surplus plant material. Green IoT practices energy-efficient techniques employing sophisticated hardware and software that minimize the greenhouse effect of current implementations and limit the level of the conservatory outcome on the IoT system [18].

Sustainable IoT-based smart cities focus on sustainable buildings, green construction, green systems, green deployment, green recycling, and even ecological transformation with minimal environmental impact. Green modern aviation and engineering processes, green smart buildings, green sophisticated housing, green smart e-health, green smart logistics, green smart retail, supply chain performance, green smart packaging, green intelligent waste, green intelligent environment monitoring, and so on are all part of these innovative smart cities. Smart urban IoT provinces and items such as cell phones, servers, tablets, vehicles, and electronic gadgets can connect with each other with recognizable power addresses. These sensing instruments can interact smartly through the network technology and also provide green assistance for the management of various activities for people. Numerous technologies [19], i.e., recognition, connectivity, data, and data transmission innovations with lower energy consumption, can be assisted. When planning and creating smart cities focusing on green IoT, energy-efficient protocols are expected to be implemented.

The purpose of this chapter is to suggest an architecture for smart green cloud cities. In addition, the chapter analyzes the functionality of cloud and IoE frameworks in the sense of intelligent metropolis application. The remainder of the chapter is arranged as follows. Section 8.2 outlines the prospects and challenges of smart cities. Section 8.3 lays out the analysis methods and structure adopted. Information on the application of proposed method is seen in Sect. 8.4. Ultimately, the results drawn so far are outlined in Sect. 8.5.

8.2 The Prospect and Challenges of the Smart Cities

The smart city concept has already been popular for almost two decades, and its popularity has steadily increased owing to current technical developments, such as digitized sensors and data structures, expanding its skills to maintain sustainable growth and enhancing the living conditions of local populations. Early literature on smart cities was mainly focused on sustainability, new infrastructure, or information in the early 1990s. It was not until the 2010s that the term “smart city” became a common idea and accepted as an independent study area of its own. Since 2008, the volume of study on smart cities has been increasing enormously [20].

The smart city framework is related to current smart infrastructure, technologies, and knowledge, along with responsible, interactive, and participative principles. In addition, broad and available data play a crucial part in converting metropolis processes into intelligent schemes to improve the value of scarce assets [21] and make healthier choice possible. Open actual facts will increase clearness and offer resources for developers to build applications and services. The contemporary smart city was already characterized in a multidimensional manner, based on its basic elements, varying from technological infrastructure to societal investment.

As IBM’s smart city concept emphasized the use of all relevant knowledge accessible to promote scarce capital, its smart city plan centered on developing interconnected data and analytical systems to enhance productivity and cooperation between government agencies [21]. In line with IBM’s opinion, the prevalence of research in this field concentrated on the elements of interrelated infrastructure, pointing to smart metropolises as sensor networks, smart sensors, concurrent facts, or convergence of information technology and communications (ICTs) [22–24]. Conversely, these market-driven concepts of smart city strategies were attacked for applying technology to empower people, not vice versa [25].

Examples of smart city programs have been introduced in different states. Barcelona’s sophisticated smart city project was built to create a safe, greener city, transform trade, and boost living standards [26]. As in the situation of Barcelona, the Vienna smart city initiative also concentrated on living conditions, resources, and creativity in accordance with clear objectives [27]. The Vienna case highlighted the engagement of team members in demand to minimize the distance between execution and perception of the investors. In the architecture of the smart city system, the main elements are evaluated accordingly, based on the preferences of the cities. Smart metropolises are constantly, and widely, reachable, information rich, collaborative, safe, and transparent; their advancement can be tailored to empower people and societies generally.

8.2.1 The Features of Smart Cities

In a realistic situation, smart cities combine three components, including infrastructure, citizens, and organizations; most researchers have defined these aspects as the primary features of a smart city [28–30]. The technology factor incorporates intelligent, digital, universal, and information standards [28], so the efficiency of ICTs and added infrastructure facilities is vital to the promotion of improved smart urban habits. It is necessary to strive towards a digital community.

ICT areas like computer science, engineering, electronics, and communication technology are the prevailing study fields for smart cities. These technical definitions correlate with the interpretations of the word “wise,” described as intelligent or educated [24, 31]. Through the progression of ICT, smart city networking and incorporation of large amounts of records produced by physical and configured app [29] have been the subjects of current efforts to describe smart cities. Smart cities' knowledge including big data processing, modeling, and analysis enhances organizational and structural systems for better decision-making [24] and IoT incorporation [32].

The human perspective of smart municipalities intersects with innovative, human, training, and intellect urban models [33], and a smart city wishes to support residents through supplying a respectable quality of living [34]. The previous study suggested that population progress and wealth creation were connected to the emergence of smart societies, as provided by the professional group of people with awareness and expertise on all facets of their lives [35]. Interconnected cities cultivate productive partnerships between people and other innovative and structural elements to enhance the standard of human resources. Since innovation is a key feature of smart cities, an environment for literacy, training, and awareness is required to build community asset [36].

Smart cities can be characterized as intelligent people's analytical skills. Recent debates highlighted concerns of social isolation, some of which discussed the inaccessibility to smart city initiatives for some residents [36]. The structural viewpoint of smart metropolises requires public authority and development to exchange values and include a larger spectrum of citizens in the course of reaching a choice [26]. The design of emerging technologies has both policy and socio-technical consequences; as such, strategic partnerships between all participants are crucial in evaluating the progress or inability of smart city projects [37].

Investor positions in smart city initiatives have also been explored to make use of the triple helix philosophical paradigm [38–40]. A digitally integrated community embraces a citizen-centered mindset that enables people to address their needs in decision-making mechanisms. While smart city initiatives offer preference to relational and participative attributes, their activities are largely focused on the viewpoints of the stakeholders. Concentrating on smart city programs from a resident's perspective [41–43] is required to improve smart city activities.

A smart city strives to change the feature of community life cycle and to maximize its spatial, economic, and environmental capabilities. Smart cities are offering various benefits:

1. Security and safety: which entails security cameras, expanded emergency management systems, and electronic resident warning signals; real-time city data should be accessible.
2. Climate and transport: this includes a regulated level of emissions, smart street lighting, traffic laws, and modern public transport options to minimize the use of vehicles.
3. Home control of electricity: tools involve prompt power pricing and efficient power management, potentially saving 30–40% of energy costs; the European Commission predicted that about 72% of European energy users will possess smart meters by 2020 [44].

4. Learning infrastructure: more funding is anticipated to spur scholastic access for everyone, lifelong education, distance education, and smart classroom technology.
5. Tourist industry: protecting the mineral resources of a community encourages the development of tourism; in relation, smart devices have direct and personalized access to data.
6. Health of individuals: adopting emerging technologies will enhance human health; individuals need complete access to better, accessible telemedicine and wireless wearable data transmission sensors fastened on clothing and implanted underneath the skin that may capture clinical records (such as temperatures, glucose, and pulse rate) and transmit in a timely or in real-time, and off-line through wireless networks. Alongside this opportunity, several factors need to be recognized and weighed before cities will reap the rewards. Here we describe most of the key concepts and design features of emerging technologies, like energy efficiency (ISO 50001), smart homes, vehicle networks, smart grids, energy storage, and standard of living (ISO 37120). We then look at latest smart city developments all over the place, highlighting some of the obstacles and possibilities for potential study. We also illustrate some of the threats presented by information management in the urban setting [44].

8.2.2 Green Smart IoT-Cloud-Based Smart Cities

One of the main objectives of the electronic age is to develop these intelligent machines and sustainable metropolises. Green IoT is an emerging component for building smart green cities. Over the next decade, houses will be the primary energy customers to release greenhouse gases to the planet. The easiest way to make the building smarter is by encouraging holders and administrators to gather energy and functional data in a fixed, unified position and incorporate predictive and automation skills around the organization to derive knowledge from that data. There seems to be a range of equipment/software solutions that can help you with crucial data on electrical demand and power use.

Through leveraging real-time data collection, building administrators may conduct an audit to address service-related issues proactively before they emerge. They can also imagine energy use, atmosphere, floor size, portfolio efficiency, etc. There is also a need to make smart green sustainable cities commercially feasible. This may involve ICT-based smart routing to reduce the expense of transmitting of vitality and increase the flexibility of these functionality schemes [45]. In IoT-based smart cities, entities or items are prepared through individual analysis to help by using a special means of recognition where those smart substances relay information such as position, status, type, meaning, or other sensitive indicators to other gadgets.

In certain capacities, these aspects are also heterogeneous. Green smart cities contain green smart houses, heaths, forestry, education, water networks, transport, and merchants, among others, which work effectively as well as keep the world

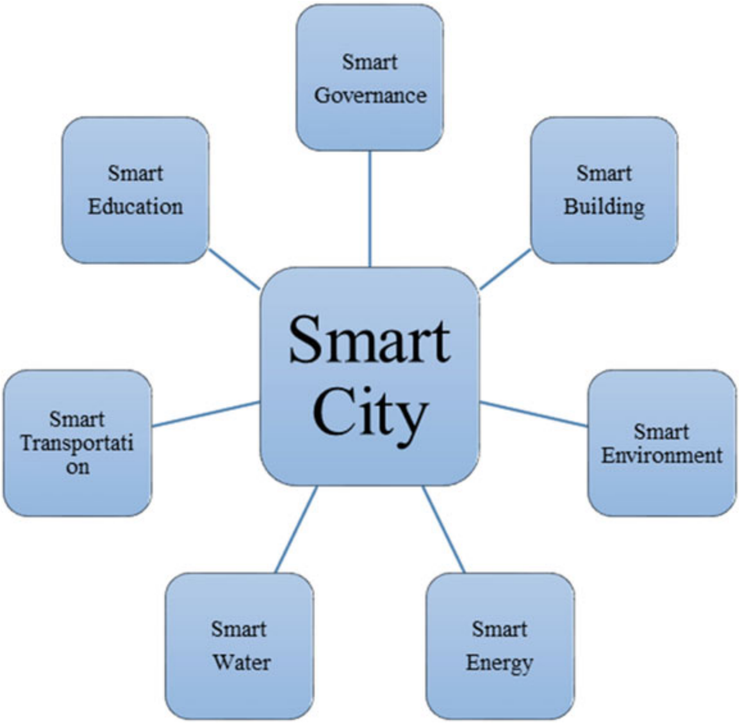

Fig. 8.1 The smart city components

clean and green [46]. The primary characteristics of a smart city can be seen in Fig. 8.1.

Some criteria have been created for these smart cities. There are international metropolis norms for community living, e-health, recreation, protection, schooling, transport, water, finances, etc. for the architecture of these smart cities. Smart authority, smart world, smart transport, smart individuals, smart budget, and smart life are core aspects of smart cities. Environmentally friendly smart cities include several essential characteristics, such as replanting regions, conservatories, green floors and roofs, towers, metropolitan centers, renewable energy conservation, fishing rivers, flood control, agriculture, and woodland regions, which have the benefits of evolution strategies.

A community is not smart because the different processes that constitute it are not able to share and operate together in systems. Contact relies primarily on e-mails, calls, teleconferences, optic fiber connections, online forums, wireless and various simulations, etc. Several smart procedures in the country, which are the key development sections of the region facilities, rely on the strong base of transmitting capability, i.e., connectivity, so this would enable to relay essential information by, e.g., vacant parking spaces, usage of vitality, car crashes, and weather patterns, among others. This information can be processed by the metropolis via cell devices or other digital equipment or sensors, and the platform can recommend other smart options for going all over the place. In order for the smart city method to operate seamlessly, both people and machines must have the power to interact with one another. ICT is thus a large part of the reliability of the abovementioned method [47].

8.2.3 *Prospect and Challenges of Smart Cities*

The challenges faced by smart cities and the prospects or opportunities that are there are explored in this section. Smart cities need attention for development and adoption.

Challenges of Investment: Lack of investment from potential investors is the major challenge that smart cities are facing, especially the green smart cities that require lots of investment into building low-energy equipment. The definition of smart cities represents a high investment opportunity and economic opportunities, but only a few rise up to the challenge.

High Power Utilization: According to the US International Energy Agency, clean energy accounted for approximately 21% of international power supply resources in 2011, with a predicted growth to almost 25% by 2040. The shortage of renewable capital in predicting energy demand for the remainder of the modern era shows a destructive part in investing in smart cities. The prospect of power prices and availability is unclear mainly in line with their reliance on the expected geopolitical, socioeconomic, and demographic perspectives [44].

Smart Residents: Social facets must also be taken into justification. The quality of a city relies heavily on residents' involvement in smart city initiatives, through various networking channels (such as the urban web site, social networks, and mobile applications). Smart cities require people to be constantly linked—in open spaces, in unrestricted transit, and at home to exchange their expertise and experience. The goal is efficient use of ecosystem services and a greater standard of living for community members; for instance, they may evaluate their domestic consumption of voltage, gas, and water from their devices. Appropriately managing this societal component is a difficulty, as it is a critical element of the smart city's technology that, when properly exploited, offers benefits for both people and the environment.

Protection: Privacy would play a vital role in every smart city plan. People communicate with smart city facilities via smartphones and laptops linked through diverse networks and systems. Smart cities, focused on the use of ICT, are also crucial to be skilled at dealing with essential concerns about privacy (such as spying and disclosure). Privacy can be divided into three components: respondent, consumer, and host. Another author suggested a definition of residents' safety focused on the regulation of predictive disclosure, including mechanisms for protecting the anonymity of information about people while revealing their results

[48]. Instances of such approaches are the extraction of personal data (procuring and covering someone's records), security of protection of data mining (relationship among organizations to extract outcomes without disclosing all data), position of privacy, secrecy and pseudonyms, secrecy in RFID, and data protection in surveillance cameras.

Cyberattacks: As for other technologies, smart cities are vulnerable to cyber threats, and the latest urban area under threat is wide open. IOActive Laboratories reported numerous sources of cyber threats: absence of cyber security monitoring, inadequate or nonexistent security features in embedded computers, poor security measure application, cryptography (obsolete and unreliable cryptographic algorithms), lack of network emergency services, large and complicated assault areas, patch deployment problems, unsafe legacy networks, and lack of cyberattack emergency management (DoS).

The 2015 conference described many problems, such as data transmission limitations, physical implications for cyber threats, processing and storing of vast volumes of information in the cloud, and manipulation of city data by hackers. As daunting as these challenges are, several opportunities that smart cities possess are making relevant authorities and even nations to start investing in it.

The development of a robust IoT/cloud integration is a huge prospect for smart cities' development. These activities are in transition as well as in the United States (Free Software IoT Cloud) and even in the European Union (OpenIoT Model) with a view to developing middleware infrastructure for cloud sensors that will allow the on-demand provisioning of IoT services. In addition to research into open software sensing devices, there is a broad array of market online cloud-like innovations that motivate end users to connect their devices to the Internet while also facilitating the development of initiatives that use those devices and similar sensor platforms. COSM, ThingSpeak, and Sensor-Cloud are examples of commercial devices [49].

Another prospect of a smart city that is driving its emergence in most countries now is the safety and peace of living offered by smart cities. Once you have an environment that is devoid of crime, everybody will live in peace. It goes a long way to prolong the life span of its citizens. In addition, the green smart city will allow people to live a healthy life that will reduce mortality rate. All these and many more are what is driving the establishment of smart cities that can be seen all around the globe.

8.3 Literature Review

The smart city, as the most innovative urban type, has come to be the planned superior for metropolises that aspire to accomplish growth. Scientists are currently conducting studies of functional applications focused on the conceptual context of smart cities using emerging information technologies like smart healthcare [50, 51], smart transportation [52, 53], smart tourism [54–56], and smart management [57]. Record preceding studies, however, have concentrated on exploration and smart city building in a distinct capacity of study. There are likewise scarce smart projects that focus on different subject areas, like Modern Matsushima New Town in Korea and Intelligent Island in Singapore, but due to the government's impetus, they continue to only consider a community as the research object and perform intelligent urban growth in those fundamental areas, such as smart transit, living, and leisure environs.

A statement by the United Nations states that almost two-thirds of the global populace will be settled in urban regions by 2050, increasing their population densities to much more than their saturation rates [58]. The development of goods, services, and infrastructure by then will not be capable to meet the requirements of the urban residents [59]. In such a situation the role that will be played by IoT will become unmatched due to its ability to allow objects to interconnect and to interact with humans in their service in a smart and effective way [60]. The basic aim of IoT will be to measure, understand, and analyze the residence of objects for the betterment of the environment. As per this, many communication science and objects like appliances, monuments and parks, heritage sites, cultural works, and art [61] will be embedded with IoT. One of the most essential features of IoT is its influence on human life [62].

Apache Storm introduced a scalable structure for home automation [63] and such scalability depends on local reasoning. A number of different designs for smart cities have been introduced till now such as the one by Vlacheas et al. [64] that proposes a framework for strengthening IoT for its deployment in smart cities; another design by Adeniyi et al. [65] talks of an experimental architecture of IoT that has been currently implemented at Santander city; another design named as Lea and Blackstock [66] marks smart city as a network of IoT hubs. On the other hand, economic policies, pricing methods, and their relationship with IoT along with communication and collection of data were studied by Zanella et al. [67]. Survey of smart city architecture was conducted by Da Siva et al. while the security parameters were focused on by Schaffers et al. [68]. Applications for specific smart cities (logistic mobile application) were proposed by El-Baz and Bourgeois [69].

A brief about the global deployment of smart cities was lined by Pellicer et al. [70]. Another survey that tells about sensors and their use of semantics in the cloud for IoT to cut the odds of separation between CoT and IoT was provided by Petrolo et al. [71]. A review of the electric vehicle changing application was given by Shuai et al. [72], whereas Wang and Sng [73] presented an in-depth learning survey of algorithms that included video analytics too. The application of wireless sensor network was the work of Rashid and Rehmani [74]. The investigation is highly different due to the data-centric views of the components of smart cities. A summary of the study on the data life cycle for traffic management system deployment in a smart city was given by Djahel et al. [75]. Various requirements of a smart city have been briefly discussed by the author and a smart and organized generic reference of the framework for designing an urban Internet of Things has been revealed. The experimental study of PADOVA was revealed by Cenedese et al. [76]. Services, policies, platforms, connectivity models, IoT infrastructure, and related aspects have been discussed by Lea and Blackstock [77]. The conception throughout the shape of a structure, smart city, and all the important requirements is presented by Zanella et al. [67].

Cities can be made smart by the application of IoT and this level of smartness may be further increased by combining IoT with cloud computing making a new computing paradigm, that is, CoT [14]. The author has dug deep into the evolution of smart cities and has made a detailed study on it in the last 20 years. Comparisons of smart cities with digital cities and their definitions, which could support all aspects of performance evaluation of a framework and city development strategy, have been made [78]. A very clear and unambiguous plus a comprehensive and verified description of a smart city has been presented by the author. The definition has been based on studies of concepts and surveys related to smart cities around the globe.

Along with it, discussions of numerous resources that the smart city will provide have also been included [79]. A structure for the design of intelligent metropolis which includes the utilization of IoT and cloud along with design requirements has also been proposed in Sheng et al. [80]. It is notable that Malaysia and Australia are at the top for cloud computing, the UK is leading in smart homes, and India is at the top in smart cities. Major advances in smart homes and cities in the forthcoming years are expected as the former technologies mature. A dual smart city approach and how they give rise to peculiarly diverse consequences were studied by Myeong et al. [81]. It was found out that reinforcing a culture of creativity by educating government officials and staff members is a crucial way to attain a comprehensive and viable smart city transition that can withstand changes in management.

8.4 Framework for Green Smart Cities

The IoT provides computing tools as extremely flexible as Web services. With the exponential advancement of IoT and cloud technology, a growing number of individuals, organizations, and businesses prefer IoT and cloud platforms for storing and manipulating their data. Cloud computing has major benefits including cloud storage, connectivity, data sharing, hardware and software cost savings, etc. Many security challenges attributed to the IoT environment, however, have not yet been addressed, especially in traditional computer environments [7, 42]. Moreover, protection and privacy concerns have been observed to seriously limit the practical implementations of IoT technologies [7]. To tackle these major problems, it is essential to propose and develop new algorithms and methods to secure the IoT platform and infrastructure (Fig. 8.2).

8.4.1 Green IoT/IoE Devices

At the bottom of the framework is the green IoT/IoE sensors which can help various types of sensors that run with lower energy consumption and are mounted in different networks in smart cities. Figure 8.3 explains how to save power by

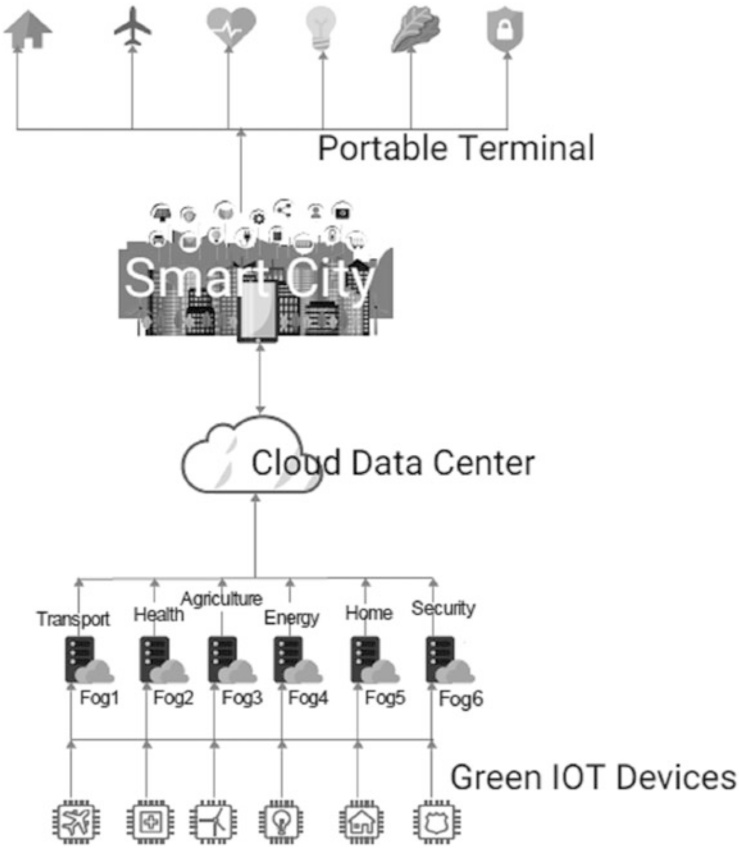

Fig. 8.2 Framework for green smart cities

using automated pause to awake the device once it is needed. Different categories of sensory models are available, such as RFID, networks with remote monitoring, and public tracing. RFID is an electronic recognition tool used to identify branded materials. These passive RFID tags do not use batteries and can use energy from the reader's detection impulses to transmit the code to the RFID scanner.

These structures may be effective for a range of uses, for instance marketing and quantity chain control for emerging technologies. Wireless sensor network (WSN) has a vital role to play in digital detecting claims. It is a viable option for applications pertaining to transporting and resource sharing that can capture, store, and interpret essential information obtained from a number of environs. Wireless networks are smaller in size, less expensive, smarter, and more commonly used (e.g., enclosed camera). The IoT/IoE proposed here will be energy. Figure 8.3 displays the green IoT/IoE devices in green cities.

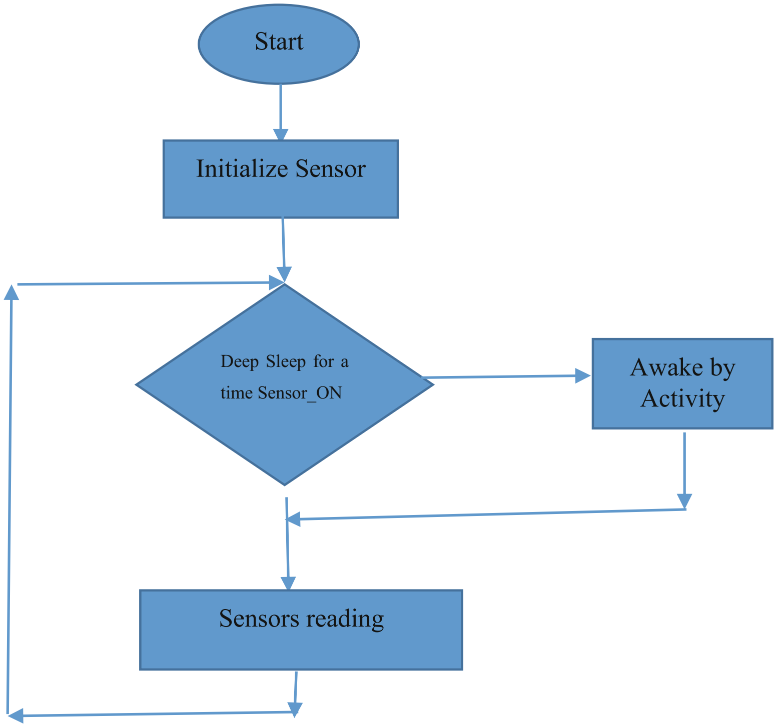

Fig. 8.3 Flowchart of a green IoT/IoE device

8.4.2 Fog Infrastructure

Fog computing is a decentralized computation technology that uses a single or a combined grouping of end-user clients or an edge computer to deliver a large quantity of storage. Some user services are managed on the edge devices of a smart computer and some application services are addressed in a data center—cloud [82]. The purpose of fog is to increase performance and lessen the volume of data that needs to be moved to the Internet for data collection, storing, and processing. This is done for purposes of productivity and defense and enforcement [83].

The fundamental principle of fog computing is that much of the operations occur on a mobile computer or on the edge devices on a smart router or other connectivity devices. Fog computing will be used in virtually any aspect of the smart city project—critical data can be submitted to the highest level of power, while the majority of data can only be used in nearby regions. IoT produces a lot of information and it is necessary to isolate it at the closest point in order to save the pace of computation, throughput, reliability, and decentralization.

8.4.3 The Cloud Services

Cloud storage services have been an integral part of these new innovations, and serve as an intermediary interface between IoT and consumer applications. Cloud computing provides a medium for data collection, post-processing, and modeling. The data stored on the fog server is stored on the server. The fog server links to the network using a regular Ethernet link to upload data locally. The cloud provides access to large volumes of computing resources and data analysis capacities that are not usable in either the edge sensor network or the fog servers. When a new data line is processed by the fog server, it schedules and reports multiple messages to the predefined region of the cloud IoT service. Each channel carries a basic time stamp data sensor and client choices. The cloud IoT program transfers messages sent to the data center service for storing and processing.

8.4.4 Smart City

In recent times, a major growth in global electricity usage and the amount of computation appliances and other items has driven government and commercial organizations to adopt the smart city model. The socioeconomic, fiscal, social, and environmental dynamics in cities are the key factors for the drastic rise in emissions, traffic, disturbance, violence, terrorism threats, oil production, road crashes, and global warming. Nowadays, communities are the main causes for the global warming. They occupy below 2% of the earth's crust, absorb 78% of the total energy production, and account for more than 60% of all carbon pollution (http://unhabitat.org/). Innovative methods are being created essential for the solution of social, economic, and environmental problem impacts on communities.

The smart city that will come out of this framework will boost energy performance and reduces greenhouse gas emissions. This smart city will become an incredibly metropolitan environment that meets the needs of businesses and organizations, health, agriculture, transportation, and especially citizens. The central administration policy will allow the city to be run in an effective way and at reduced cost. All portable devices will have the opportunity to be connected in a secured environment with authentication system that will be hard to break in.

8.5 Conclusion and Future Directions

There has been strong interest in the potential use of smart cities globally for the enhancement of everyone health. Countless smart city models have been presented based on various network technologies, with multiple attributes. Every smart city application is based on a certain architecture; therefore issues like interoperability, transparency, and convergence arise. In order to overcome these challenging conditions, the emerging smart city architecture suggests to use the cloud-IoT smart networks to produce power-efficient and sustainable cities. This makes it easy to set up smart metropolises that are clean, sustainable, and naturally aware. Sensor level includes all green IoT across wireless sensor networks allowing consumers to use various applications across cloud services and processes. In the future, smart city planners, engineers, and builders should have modular, budget solutions to the problems they face. Another specific field of study is the expectation of how to develop the most current developments that can be used to enlarge current smart city systems and technologies by incorporating new components.

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