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IoT AND CLOUD COMPUTING: ENHANCING SMART TECHNOLOGY ADOPTION THROUGH LIKELIHOOD-BASED ATTRIBUTE ANALYSIS

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Abstract

The contemporary paradigm referred to as the Internet of Things, abbreviated as IoT, has orchestrated a profound transformation of everyday life into intricately advanced forms. IoT has ushered in a multitude of enhancements, including smart residences, intelligent urban environments, energy conservation measures, automated public transit systems, and the automation of various industries. This has effectively metamorphosed our world into a global metropolis, wherein individuals can seamlessly engage, communicate, and securely share information, all thanks to the convenience offered by intelligent internet-enabled devices. Within the realm of information technology, it is imperative to scrutinize the factors that facilitate individuals' decisions to embrace and disseminate innovative IT-based procedures and products. Such an examination is pivotal to the ongoing evolution of information technology. In the forthcoming research article, we embark on a comprehensive exploration of the utilization of cloud servers, the evolution of IoT concepts, their far-reaching implications on both individuals and organizations, the realization of a diverse spectrum of utilities, and the meticulous analysis and selection of pertinent attributes aimed at enhancing cloud-based IoT capabilities, all achieved through the application of a likelihood distribution function.

Keywords: Cloud Computing, IOT, Power Monitoring System, Intelligent Monitoring.

I. INTRODUCTION

The fourth industrial cycle has emerged as a result of the convergence of the energy and digital revolutions. The implementation of emerging technologies in the power system, such as IoT, data centre computing, 5G connectivity, and artificial intelligence (AI), is promoting the power system towards becoming intelligent, digital, and networked [1].

Data innovation has changed our lives by presenting a few state of the art applications traversing from medical care to GPS route gadgets, eHealth and a lot more [2]. These projects not just helped us by conveying ordinary administrations to our entryway, however they likewise brought down our work in doing different positions. Mechanical combination empowers significant changes and encourages the advancement of new IT merchandise, strategies, and products [3].

The rise of the World Wide Web of things (IoT)-based gadgets has opened up new avenues for companies to carry out their routine operations with fresh views and consequences. Advances in information technology enabled firms to adapt to technical improvements in present operations by establishing new capabilities that foreshadow future opportunities.

In terms of disruptive tendencies in information technology development, the cloud provides a structure in which shared processing power, notebooks, personal computers, sensors, and many forms of communication software are connected to enable quick access to virtual resources [4].

IoT has made significant development in several domains, including intelligent management in linked fields. IoT is regarded as a revolutionary and inventive technology for accelerating industrial informatization and realizing conventional industry transformation. IoT, in broad terms, is the synthesis and working between online space and actual space (figure 1). The digitization, socializing, automated procedures, and thinking of everything around people constitute not only a valuable way of realizing efficient information exchange, but also a higher level of all-encompassing deployment of information management in human society [5].

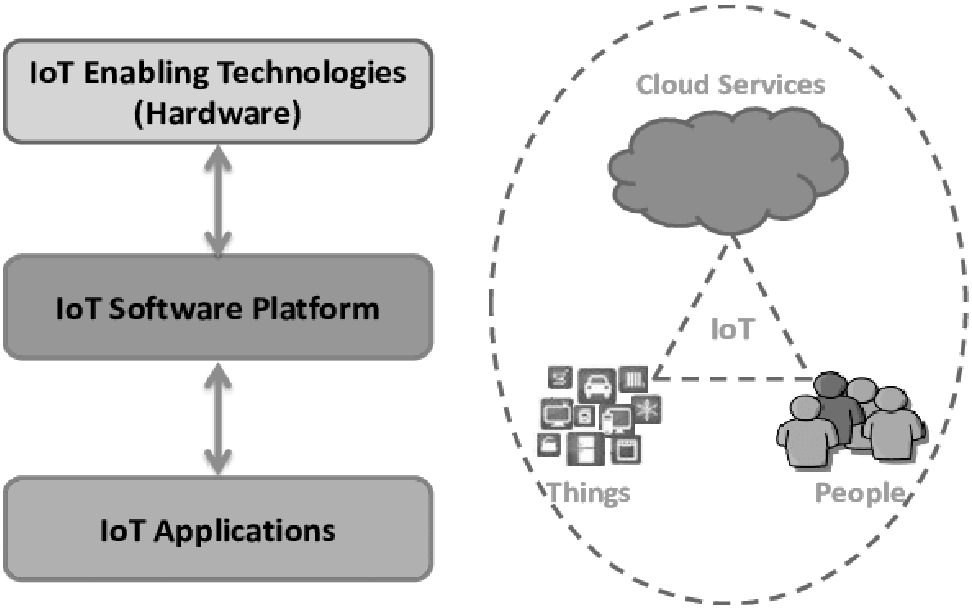

Figure 1: IoT Architecture in General

We may experience a significant shift as IoT technologies and devices become increasingly integrated into our daily lives. One such IoT progression is the idea of Brilliant Home. The frameworks (SHS) and machines, which incorporate web associated contraptions, home robotization frameworks, and reliable energy the executives frameworks [6].

When marketers began to share data over VPN networks, the industry of telecommunications gave rise to the term "cloud" [7]. Mists are virtual PC assets that regularly contain server bunches, capacity servers, broadband asset estimation servers, etc. [8]. Thanks to advancements in information technology, data and processing can now be transferred from machines and personal systems to enormous virtual data centres'.

It entails supplying hardware and software applications as internet connections in virtual data centres [9]. The National Institute of Standards and Technology (NIST) defines cloud computing as "a model that allows easy, 24/7 network access to a shared pool of adaptable computing assets (e.g., networks, storage, applications, and services), that can be lightning-fast provisioned and released with no managerial or service provider interaction." [10] "This cloud model encourages availability."

Virtualized assets are immediately given to clients as administrations over the Web through gadgets like PCs, laptops, cell phones, and PDAs that hyperlink to the cloud for program access, improvement, and capacity [11].

A. Edge Computing In The Internet Of Things With Low Power

Given that data is being generated at the network's edge more frequently, processing data there would be more effective. Because cloud computing is not always effective for processing data when the data is produced at the network's edge, previous work such as micro Data Centre and fog computing has been introduced to the community. The reasons why edge computing is more effective than cloud computing for some computing services are listed in this section, followed by our definition and explanation of edge computing.

As illustrated in Figure 2, implementing computer edge technology, digital assistants, and 5G technologies for communication in three important situations increases power system performance and makes it more intelligent and automated [12].

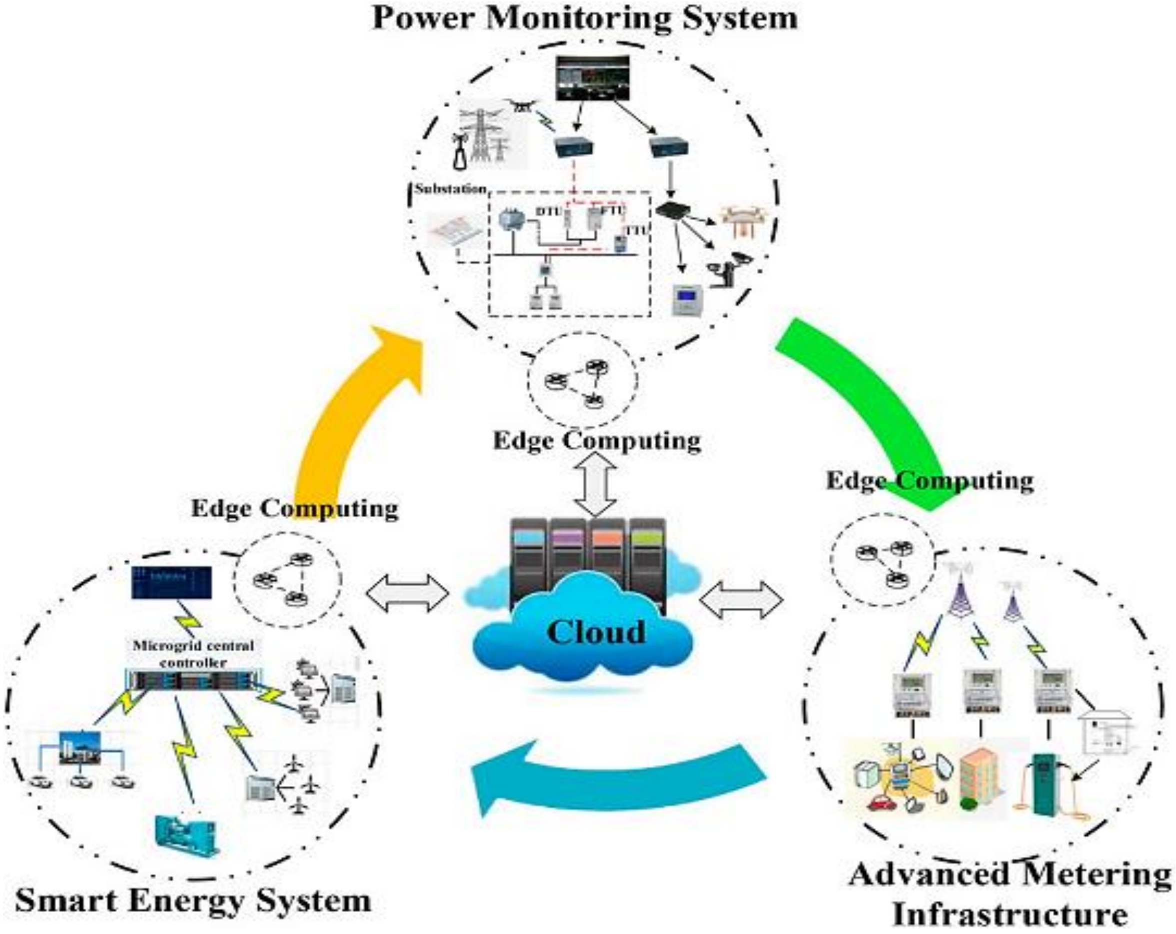

Figure 2: The Three Iot-Based the Power System Situations in the Advanced Computing the Environment

To use all of the cloud computing services, IoT must be integrated with cloud technology. Researchers are attempting to integrate various technologies in order to make life simple and secure. IoT is a changing equipment that unites diverse items over a communication medium to improve various organizational operations.

However, IoT is devoted to providing the best available solutions to cope with data and information security challenges. As a result, security is the most essential worry of IoT in business as well as trade. As a result, developing a safe channel for collaboration across communication platforms and privacy issues is an ongoing concern in IoT, and developers working with the Internet are working hard to achieve this [13].

Since the computing power on the cloud exceeds the capacity of the things at the edge, moving all computing tasks to the cloud has proven to be an effective method for processing data. However, in contrast to the rapidly increasing data processing speed, the network's bandwidth has reached a standstill. The speed of data transportation is turning into a bottleneck for the cloud-based computing paradigm as a result of the increase in the amount of data generated at the edge. The Internet of Things (IoT) will include almost all types of electrical devices, including air quality sensors, LED bars, streetlights, and even a microwave that is connected to the Internet. These devices will both produce and consume data. It is safe to assume that in a few years, the number of things at the network's edge will increase to more than billions. As a result, the amount of raw data they produce will be enormous, making traditional Cloud computing inefficient to handle all of this data. This indicates that the majority of IoT data generated will never be sent to the cloud and will instead be used at the network's edge.

Data producers create raw data and transfer it to the cloud, and data consumers send requests for consuming data to the cloud. This structure, however, is insufficient for IoT. First, there is an excessive amount of data at the edge, which consumes a lot of unnecessary bandwidth and computing power. Second, the requirement for privacy protection will be a barrier for cloud computing in IoT.

B. Cloud Computing Functions In Iot

IoT devices and the cloud are a pair of platforms that have shown to be advantageous in a variety of ways. A high percentage of viewers are aware of IoT rules pertaining to intelligent cities, intelligent houses, and so on [14]. The Internet of Things (IoT) is critical for integrating smart city answers into commercial instruments and opening the path for excellent advice from healthcare, logistics, public transportation, the energy, and a range of other sectors [15]. The cloud is close behind. There are various advantages of using cloud computing in IoT.

In terms of functionality, cloud computing and Internet of Things are incredibly compatible, and both strive to improve efficiency of daily tasks. While IoT connects with connected communities, it develops a tremendous amount of data. The use of cloud technology [16], on each hand, opens the door to new experiences. Internet of things and cloud computing work together to improve integration across the board, from service possibilities to remote data access.

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They serve as accessible and sensible storage, and nonetheless there are several places where the gap between internet of things and the cloud might be examined.

- Cloud-based technology has made a significant difference in commercial service and individual application solutions [17]. Furthermore, the amplitude and nature of cloud attitude statistics enable data to be accessed remotely. As a result, it is known to be a solution for conveying information via network channels and direct linkages depending on company individual tastes.
- The use of the cloud is an ideal IoT assistant for addressing difficulties posed by commercial corporate data. As a technology, the cloud showcases an active platform for building crucial applications for better utilization of internet data.
- The acceleration and quantity: the two primary cloud computing solutions are an unrivalled combination, while IoT adds connectivity and mobility [18]. As a result, the possibilities of IoT and the cloud are strengthened through collaboration. Other elements demonstrate the importance of the cloud in IoT access.
- With the growing usage of IoT devices, a substantial amount of time is necessary to manage an extensive variety of devices and regulate over-speed, based upon the building infrastructure. The cloud provides the benefit of an appropriate setting during this aspect.
- The cloud increases IoT data security and privacy. Internet of Things (IoT) pieces are easily transportable and, with the help of the cloud, may incorporate important safety technologies, upgrades, [19], and discoveries. The cloud enables consumers by providing comprehensive security features through strong authentication and encryption agreements.

C. Fog Computing

Although one of the best computing paradigms for processing data for IoT applications is cloud computing. More effective methods are needed because centralized resources used for data processing have a delay and a limited amount of bandwidth. A distributed paradigm and extension of the cloud, fog computing brings computing and analytical services close to the network's edge.

Fog computing is a paradigm that scales up the cloud and can handle heavier workloads. Any device that has the ability to compute, store information, and connect to a network serves as a fog node in fog computing. Personal computers, industrial controllers, switches, routers, and embedded servers are just a few examples of these gadgets. Figure 3 highlights the algorithms used in fog edge computing. Details about these algorithms won't be part of current research work.

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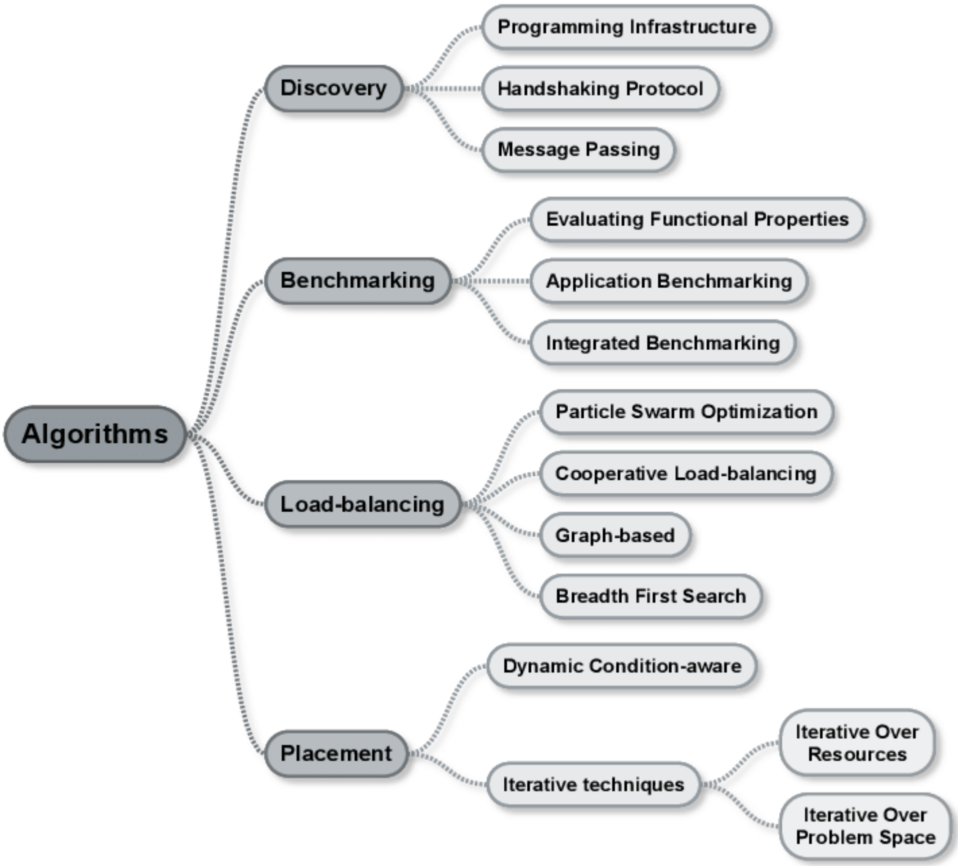

Figure 3: Algorithms Used In Fog Edge Computing

D. Aims

- To examine the many cloud features in order to persuade organizations to migrate to the cloud.
- To investigate the effects of cloud-based computing on companies and society.

II. LITERATURE REVIEW

The quick progression in Universe of Things (IoT) advancements lately has empowered the association of a few brilliant things and sensors, as well as the foundation of consistent correspondences between them, coming about in a severe required for information representation and data stockpiling stages, for example, registering in the cloud and mist processing [20].

To improve the continuity for mobile network systems for next-generation Internet of Things (IoT) applications, balance network load, and ensure an improved level of user service know-

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how, [21] this article first defines the computing migration a structure for the next-generation network, and then describes the idea and topics of mobile edge computing (MEC), which involves using software-defined a network (SDN) with network function virtualization (NFV). Figure 4 highlights the opportunities and challenges in edge computing.

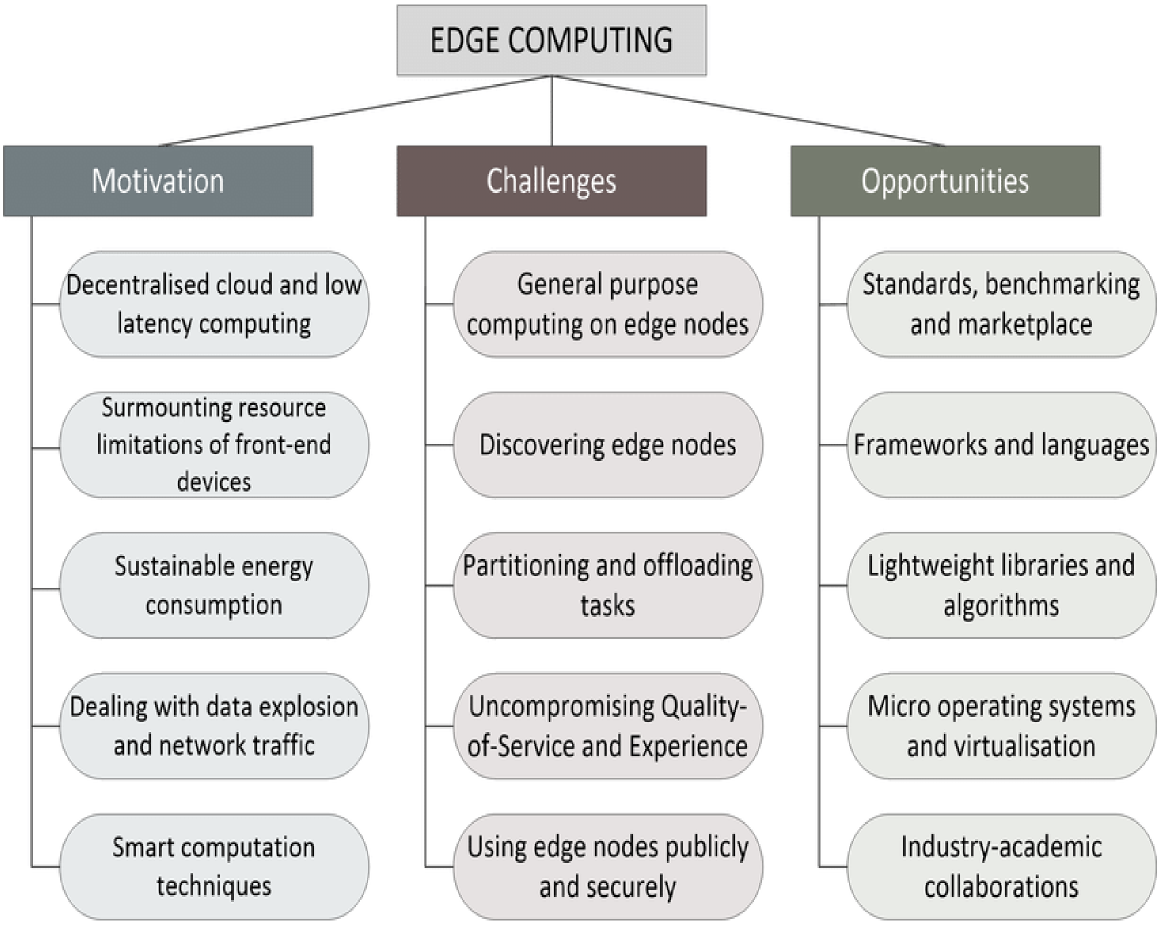

Figure 4: Opportunities and Challenges in Edge Computing

Precision Agriculture (PA), defined as the inclusion of information, communication, and control technology in agriculture, is becoming more popular by the day. The World Wide Web of Things (or IoT) and cloud-based software concepts have opportunities to improve PA connection. Nonetheless, their application in this sector is typically confined to high-cost circumstances, and most of them are not matched to semi-arid environments or do not cover entire PA management processes in an effective manner [22]. As a result, we offer a versatile platform capable of meeting soilless growth requirements in full reusing indoor greenhouses utilizing moderately salty water.

Block chain is a rapidly emerging technology that plays an important role in criminal investigation. In recent years, security has become a major danger to all businesses, including the health record industry (EHR), financing, Smart Utilization (SA), supply chain operations

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(SCM), and the Internet of Things (IoT) environment [23]. In this study, we created a unique framework for monitoring the actions that occur on certain data evidence. We build a cloud-based Software referred to Network (SDN) that includes 100 smartphones Nodes (IoT gadgets), and open flow switches, Block chain-based controllers, a cloud server, an authentication server (AS), and an investigator.

By applying cloud services, mobile device capabilities are discovered to be bigger than previously. The cloud paradigm provides a variety of services, and mobile devices often allow the execution of expensive apps on resource-constrained mobile devices to be offloaded to resource-rich cloudlets, boosting the mobile device's processing capabilities. However, accessing cloud services with minimal reaction time and energy usage remains a significant research challenge [24].

Multiple sources are continually creating a massive volume of data as the Internet of Things of Things (IoT) grows at an exponential rate. Because the energy and storage venues of the end tools are highly confined, it is imprudent to keep all raw data locally in the IIoT devices. Independent of the various resource limitation features, self-organized processes and limited in range the World Wide Web of Things (IoT) communicating facilitates turned over data and computation in the cloud [25].

III. MONITORING THE TRANSMISSION LINE

In the one combination, in order to implement competent inspection of the electricity line, unmanned aerial vehicles acquire image, video, [26], among other data of the panorama of the power they transfer using the pan-tilt fixed-focus camera. The front-end telecommunications detection module detects and locates the captured video stream as well as the cable's overhead condition.

Table 1: Typical Transmission Line Monitoring Sensor

Sensor	Total size in data collection per monitoring cycle	Installation Position
Wind direction sensor		
Temperature sensor	4	A
Wind speed sensor	4	A
Humidity sensor	4	A
Rain sensor	4	A
Strain sensor	4	A
Accelerometer for tilting	8	A/B
Conductor temperature sensor	4	B
Accelerometer for vibration	4	A/B
Magnetic	4	A/B
Accelerometer for line galloping	5120	C
Magnetic field Sensor for Power Quality graph	4000	B

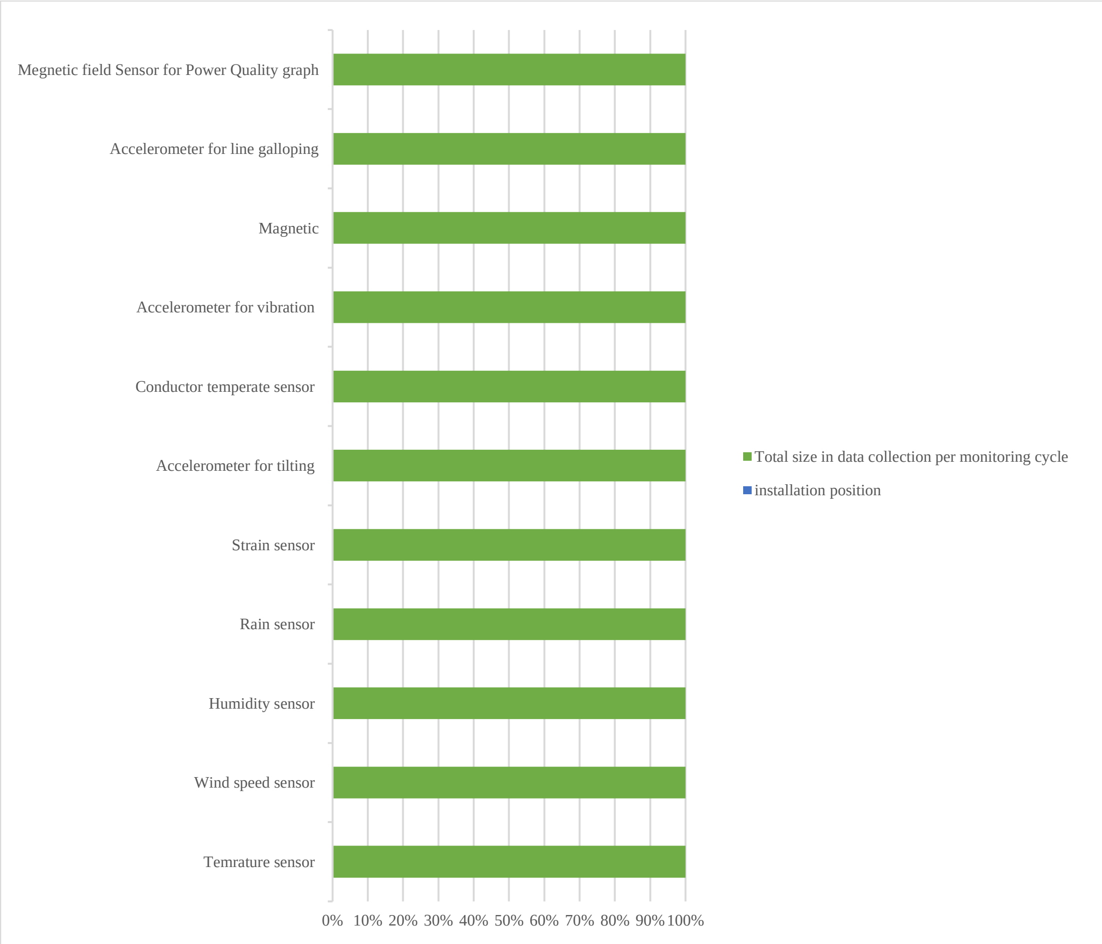

Figure 5: Typical Sensor Used In Transmission Line Monitoring

A. Intelligent Substation Monitoring

The protection operation is carried out, and then the protection stored and data is communicated to the local control layer after layer via MMS messages, allowing the monitoring data to be analysed and processed [27]. Furthermore, a remote controller host at the station power layer communicates it to the assigned centre through the monitoring system's communication protocol and awaits the dispatch centre’s analysis leading to and task dispatch.

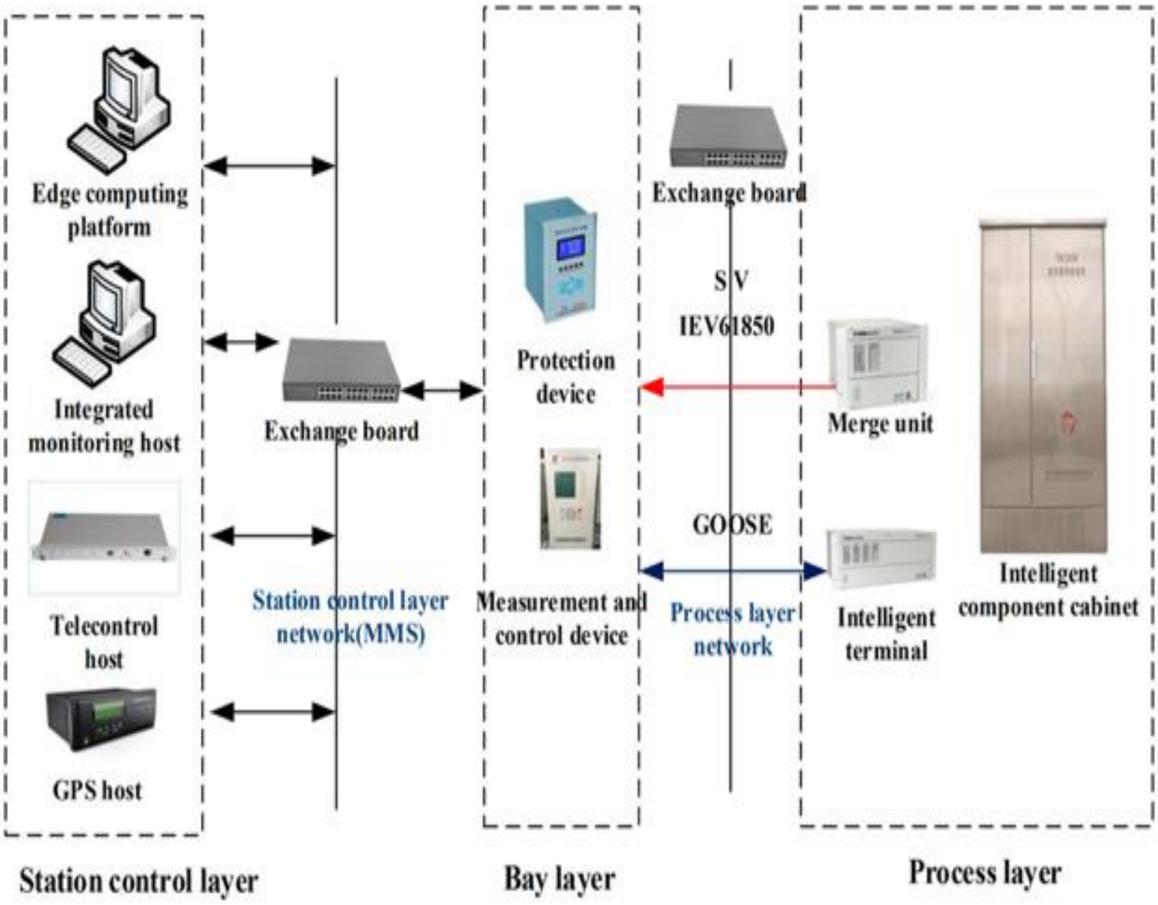

Figure 6: The Edge Computing Layout in the Substations Integrated Automation Framework

B. Cloud Computing Guidelines and the translation based on IoT

Smart network IoT solutions are in high demand across all industries today. Agriculture and Food, health, schooling, smart cities, which is retail, and countless additional industries are examples [28]. IoT is used in agriculture to reduce transportation costs and to anticipate pricing based on historical data analyses.

Many various forms of research are being conducted in the field of electricity conservation, with diverse approaches for IoT healthcare applications and for the forecasting of different sorts of health problems using varying approaches. In the area of health care, IoT and cloud computing are very useful for instantaneous patient health monitoring, [29], for which sensors and software is used, plain data is pushed to the cloud for analysis, and notification messages are sent via your physician followed by conservator to assess and forecast any type of condition or illness in the early stage itself.

For analysis and prediction, many computerized learning methodologies and information mining approaches are employed.

C. IoT Applications

In every industry, there is a high demand for IoT-enabled technologies that make life easier [30]. Among the fields listed here are.

- **Smart Cities**

The global community is gearing up for the next generation Internet of Things (IoT) technology which will dramatically increase the number of connected devices. The sensors will enable a more accurate representation of our environment through real-time data collection, and thus, significantly increase autonomy and efficiency [43].

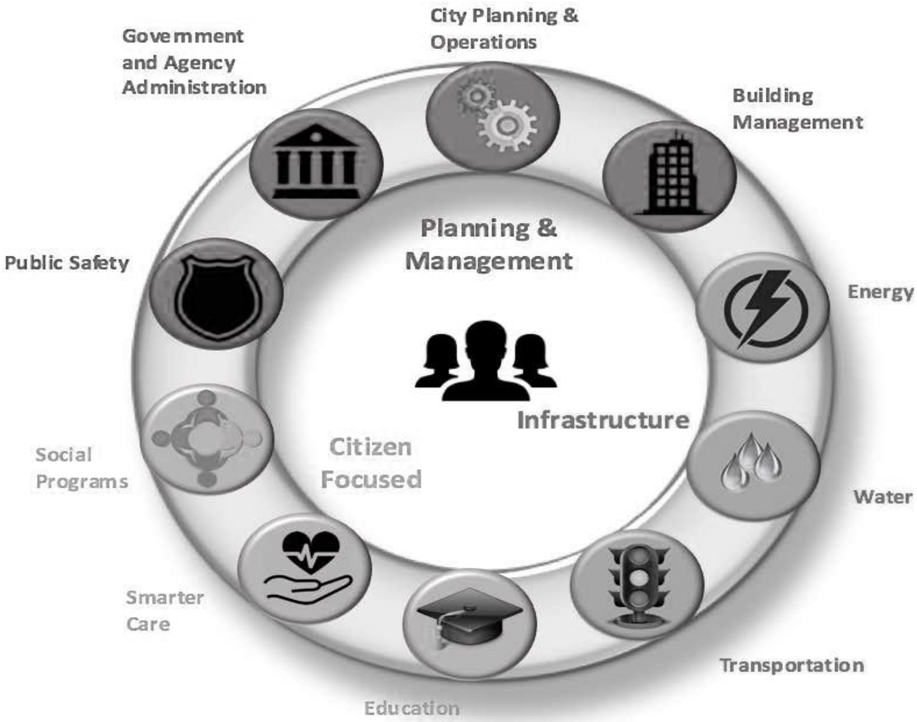

Figure 7: Example of Smart City Project

The Edge computing paradigm can be flexibly expanded from a single home to community, or even city scale. Edge computing claims that computing should happen as close as possible to the data source. With this design, a request could be generated from the top of the computing paradigm and be actually processed at the edge. Edge computing could be an ideal platform for smart cities considering the amount of data generated by these systems. It entails monitoring parking space availability in the area, calculating the energy discharged by cellular moves and network routers in order to inspect and improve both walking and driving experience. The analysed information can provide information about the road network with climate-specific cautionary signage and distractions and unforeseen occurrences such as fatalities or delays in traffic [31].

- **Smart Buildings**

Residential buildings (domestic); commercial (services), including shops, offices, and schools; and transportation all contribute to the energy consumption of cities. Lighting, equipment (appliances), domestic hot water, cooking, refrigeration, heating, ventilation, and air conditioning (HVAC) are all included in the domestic energy consumption in the residential sector (Figure 8). Most of the energy used in buildings is typically consumed by HVAC systems. In order to reduce electricity consumption, HVAC system management is crucial. IoT devices may be crucial in reducing energy losses in HVAC systems as a result of industry-wide technological advancements. Unoccupied spaces, for instance, can be identified by locating some wireless thermostats based on occupancy. When an unoccupied zone is found, steps are taken to reduce energy use.

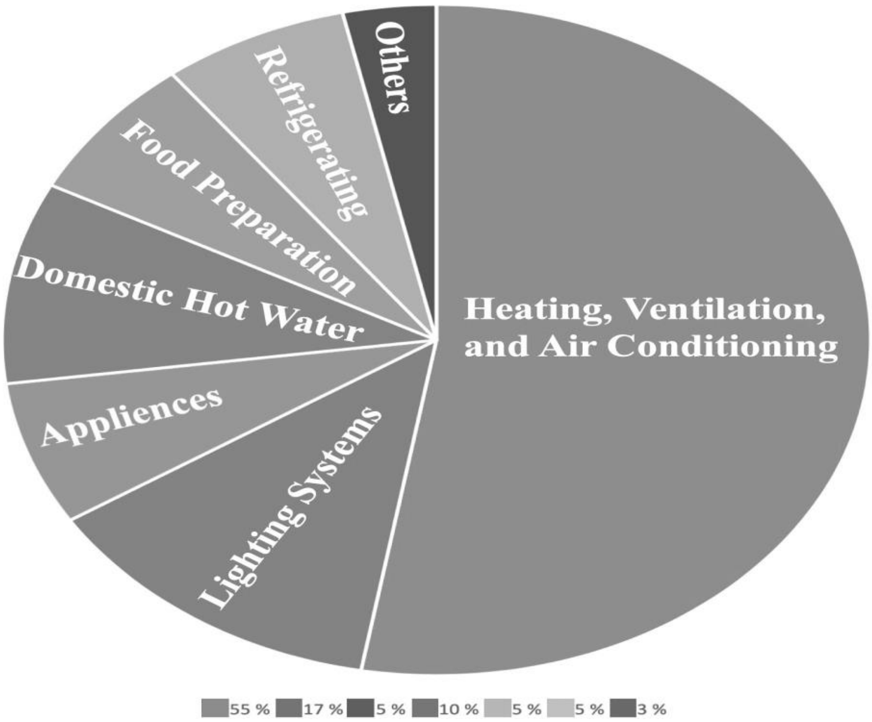

Figure 8: Share of Residential Energy Consumption

- **Smart Security**

The definition involves tracking of people in unknown and prohibited places, liquid monitoring in data centres, sensitive building sites, and warehouses to prevent issues and corrosion, [32] uncovering gas leaks and even levels in manufacturing, chemical plant, and mine settings.

- **Smart Medical Field**

This includes living help for the elderly or disabled, observation and tracking of surroundings in freezers. These should hold antibiotics, vaccines, and organic components, and inspect clinical conditions at health centres and at the homes of the aged.

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- **Intelligent Agriculture**

Monitoring the moisture level of the soil and agriculture diameter of branches to control the density of sugar in grape seeds and grapevine health; regulating microclimate conditions to improve harvesting of fruits and vegetables and quality; and researching field environmental factors to estimate variation in ice pairs, rainfall, a lack of water snow, or the winds [33]. This includes living help for the elderly or disabled, following up on and keeping track of the surroundings of freezers that hold antibiotics, vaccines, and organic components, and inspecting the conditions for patients in hospitals and throughout the homes of the aged.

- **Smart Industrial Control**

Auto-diagnosis of the issue and system control, oxygen and dangerous gas monitoring within chemical plants to guarantee employee and product safety, [34], temperature monitoring throughout the industry.

- **Smart Entertainment And Media**

IoT provides strong connectivity between persons by transmitting media to each other via moving data from one area to another via the cloud.

- **Smart Legal System**

The Smart Court system is made feasible by adding sophisticated predictive analytics, more effective facts, and automated processes to court systems, which strengthen strategies, remove unnecessary procedures, handle corruption, reduce expenses, and raise pride [35].

IV. EXPERIMENTAL SETUP AND RESULTS

Companies are always attempting to pick appropriate characteristics to address global competitiveness problems [36]. Decisions become more complicated since decision-makers in a cloud computing setup must evaluate a wide range of acceptable attributes based on conflicting criteria. As a supplement to these selection methods, many multi-decision decision methodologies are now accessible.

A. To Assess Cloud Features Using A Probability Distribution Function In Order To Improve The Performance of IoT Applications

Specifically research papers [37], the probability appropriation capability is utilized to give weighting standards to every extraordinary trademark contingent upon its occurrence, application, and significance. The weighting models picked are as per the following [37]. The essential objective of this dissemination measurement in this study exertion is to recognize the most regularly used trademark in the business of cloud improvement.

The calculation of an event's likelihood is known as probability. It is meant by (PX), where "X" addresses the occasion and "P" shows the likelihood of the event. It may be expressed via numbers as

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$$P\ (X) = \frac{Number\ of\ favourable\ outcome}{Total\ Number\ of\ favourable\ outcomes},$$

$$P\ (X) = \frac{n\ (X)}{n\ (S)},$$

The measure of central tendency distinguishes the entire collection from its information or transportation over a particular value. It offers a detailed description of the full dataset [38]. Mean is represented by

$$Means = \frac{Sum\ of\ All\ data\ Points}{Number\ of\ data\ Points},$$

$$u = x \times P(x),$$

Utilizing this statistical investigation, the traits are ranked in terms of their frequency of occurrence in the most relevant research [39]. The greater the likelihood of this feature, the greater its importance to cloud providers.

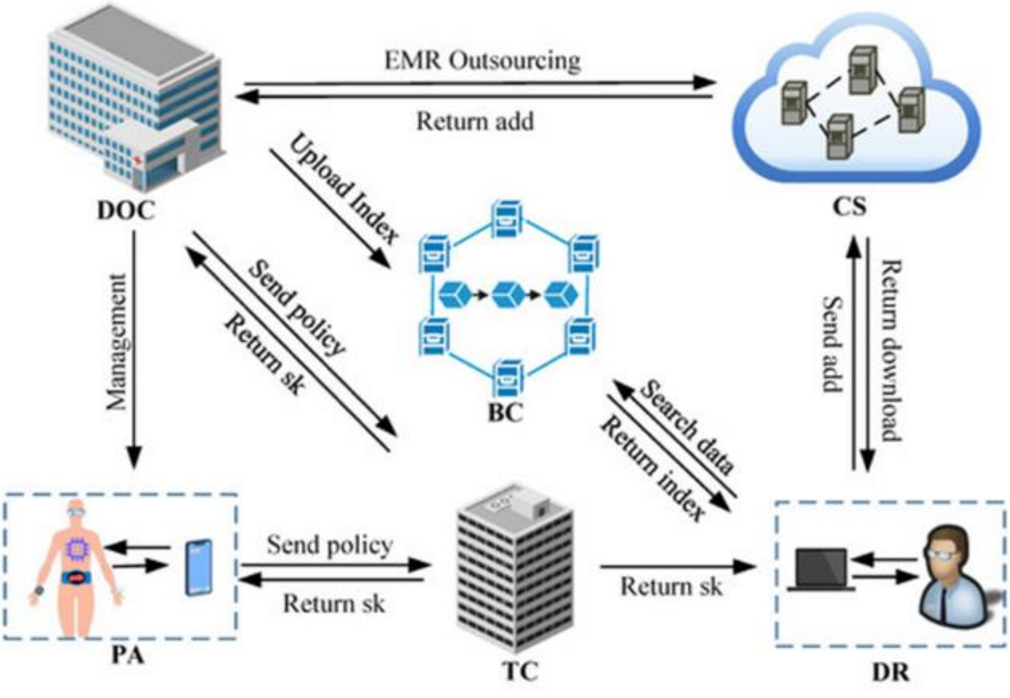

Figure 9: Collaboration on the Cloud Network

IoT is completely devoted to giving rising public and monetary benefits as well as improvement to people and society overall [40]. This incorporates a wide assortment of public utilities like improvement of the economy, water quality support, [41], modern development, etc. In general, IoT endeavours hard to accomplish the Assembled Countries' social, wellbeing, and monetary objectives. A further serious concern is natural maintainability.

To conquer an unfriendly impact, IoT engineers should be cautious about the natural effect of IoT frameworks and gadgets [42]. Energy use by IoT gadgets is an illustration of the ecological issues. Energy utilization is quickly developing because of web empowered administrations and state of the art gear.

V. CHALLENGES

Usage privacy and data security protection are the two services that ought to be offered at the edge of the network. If IoT is implemented in a home, the sensed usage data can be used to learn a lot of privacy-related information. By observing the reading of the electricity or water usage, one can quickly determine whether a house is vacant or not. Supporting the service in this instance without sacrificing privacy is challenging. By masking every face in the video, for instance, some private information could be taken out of the data before processing. We think it might be reasonable to protect data security and privacy by keeping computing at the edge of the data resource, or at home.

The ownership of the data obtained from Edge-related activities comes in second. Similar to what happened with mobile applications, the service provider will store and analyse the end user data collected by the things. To protect privacy, it will be better to let the user fully own the data and leave it at the Edge where it is collected. Similar to how health record data is stored, end user data gathered at the network's edge should be kept there, and the user should have control over how the data is used by service providers. Highly private data may also be removed by the things during the authorization process in order to further safeguard user privacy.

The third problem is the absence of efficient tools to guarantee data security and privacy at the edge of the network. It's possible that the current security protection techniques cannot be used because they are resource-intensive because some things have limited resources. The highly dynamic environment at the network's edge further exposes or renders unprotected the network. To standardize and store health data for privacy protection, some platforms, like Open mHealth, are recommended. However, more tools are still required to handle various data attributes for edge computing.

VI. CONCLUSIONS

At the periphery of the network, edge computing seamlessly integrates network, computation, and storage resources. This paradigm has gained prominence owing to its capacity for swift and dependable data processing at the network's periphery. Consequently, an increasing number of services are transitioning from centralized cloud environments to the edge. In this paper, we present our delineation of IoT (Internet of Things) and edge computing, rooted in the concept that computing should occur in proximity to data sources.

Our research delves into various facets, including the utilization of cloud servers, the evolution of IoT concepts, their ramifications for individuals and organizations, the realization of diverse utilities, and the evaluation and selection of pertinent attributes to bolster cloud-based IoT capabilities, employing a likelihood distribution function. The landscape of information technology is poised for transformation with the advent of cloud computing, an arena that holds immense potential for augmenting organizational processes. Within our study, we employ a probability distribution function to assign weightage to features based on their frequency of occurrence and relevance. The primary objective of this probability distribution function is to discern the most frequently employed characteristics in the realm of cloud development.

We present multiple scenarios wherein edge computing may flourish as a consequence of offloading tasks from the cloud in intelligent environments such as homes and cities. Notably, we underscore the opportunities and challenges that warrant careful consideration, including issues related to privacy and security. Further research in web-based computing and analysis stands to contribute to energy conservation and advancement by reducing costs and elevating customer satisfaction. While platforms like Open mHealth are proposed for standardizing and safeguarding health data, there is an ongoing need for additional tools to manage diverse data attributes within the context of edge computing.

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