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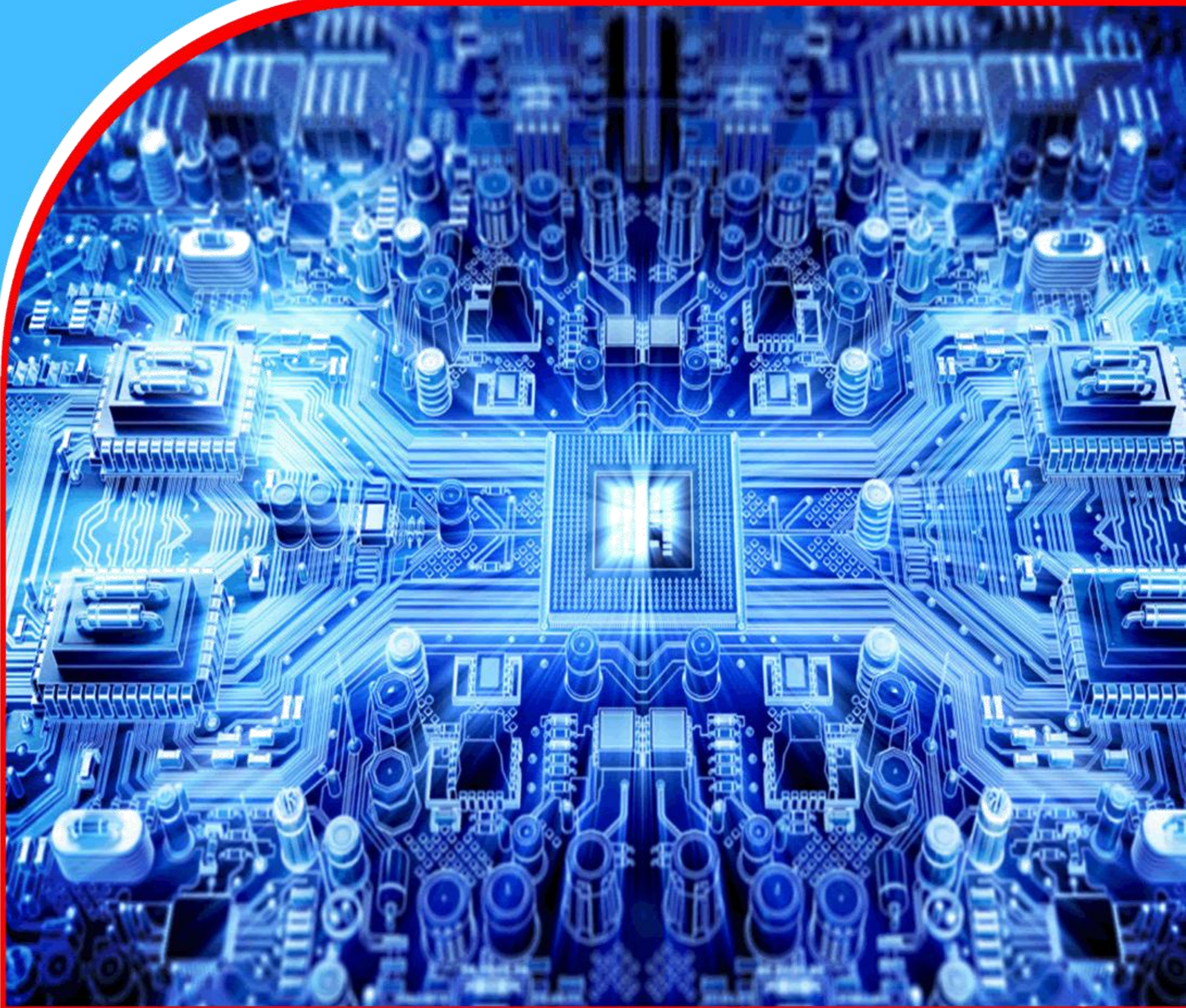

THE FUTURE OF FOG COMPUTING IN KENYA

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Abstract

The study, titled "The Future of Fog Computing in Kenya," discusses fog computing, computing evolution, and the Internet of Things. It has layers ideal for fog networks. The architecture depicts the functions performed by each layer, the protocols, devices, and their functionality at various layers. Fog computing extends cloud computing and helps mitigate its difficulties. The study also goes forth to explain the various sectors where fog-computing technology is applied and the various merits associated with it. In order to improve present technology, this article will greatly help researchers in Kenya and beyond by giving ideas and suggestions as a way to focus on the COUNTRY'S VISION 2030.

Keywords: *Fog computing, real-time systems, IoT, edge computing, technology.*

1.0 INTRODUCTION

Completing a goal-oriented task that requires, benefits from, or results in a computer [3]. However, it emphasizes the Internet of Things (IoT) and fog computing. The Internet of Things connects smartwatches, sensors, and cars. Data that is difficult to process is transmitted to the cloud to be processed over time. Performance is improved because computer resources are given at the network edge. However, experts have highlighted worries regarding the security and privacy of IoT-based fog computing. While new computer paradigms and IoT devices are rapidly developing, security is receiving little attention [4]. Fog computing is a replacement-computing paradigm that extends cloud computing and helps mitigate its difficulties. Cisco [5] suggested fog computing, extending cloud computing to the network edge through routers and gateways. This cloud-centric topic field layout cannot fulfill latency-sensitive applications.

Currently, no universal definition exists for FC. On the other hand, according to [6]. Fog nodes are the building blocks of fog computing, which includes pc, portable, good edge device, automotive industry, and thermistors. Therefore, the entire device of a fog node, is combined, abstracted and considered one logical entity capable of conveniently capital punishment dispersion services as if they are all on one device [7]. Picking relevant research questions is critical to the success survey study. This report concentrated on the most pertinent fog computing technologies, perquisites, and applications. The study's ultimate purpose is to understand fog computing and its implementation in the country.

VISION 2030 is Kenya's 2008- 2030 development plan. On June 10, 2008, President Kibaki announced it. "A new industrializing, intermediate country that generates a good standard of living for all its residents by 2030," says the organization's statement of purpose [1][2]. Along with the countries Vision 2030, this paper presents the results of technical love and patriotism.

1.1 FOG COMPUTING ARCHITECURE.

A fog structure is a multi-layered model. The model is ideal for advancing a fog network. The design allows for an overview of the different layers' features and functionality [12]. The fog architectural style recognizes the protocols used at various layers, the devices used at various layers, and their functions. This architecture has one cloud and two fog layers (Fig. 1.1) fog computing has six layers, according to Mukherjee et al. [13], Aazam and Huh [14,15], and Muntjir et al.[24] as given on figure 1.2.

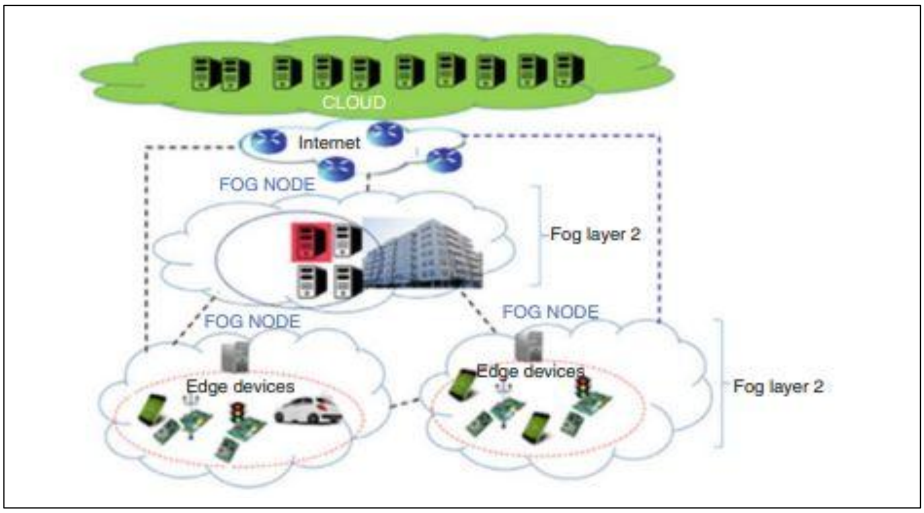

Figure 1.1 [12]

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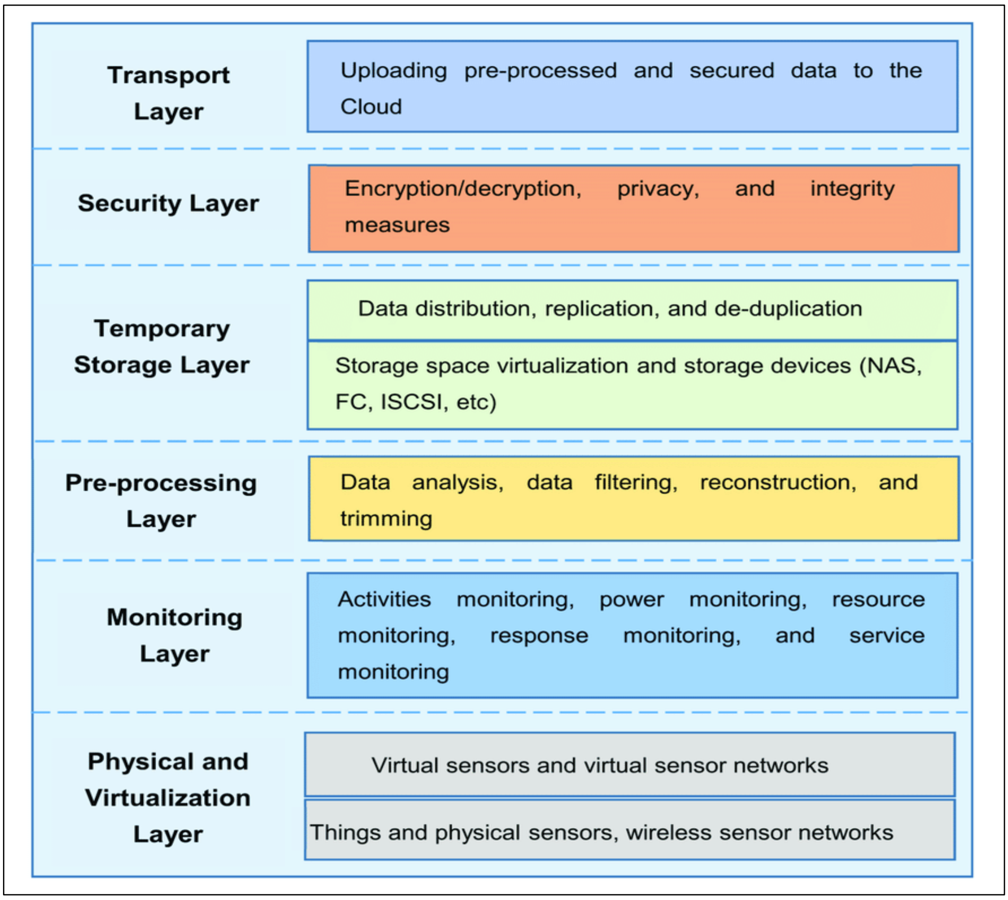

Fig 1.2 Fog-cloud structure [5]

- **Physique and Virtualization**

It is a network layer (Physical and virtual) (Physical and virtual). The nodes, which are scattered around the world, collect data. Sensing technology is used to capture their surroundings. Nodes with sensors collect data from their surroundings and send it to higher layers for processing. A base station can be a dedicated device, like a handset, or an element of a complex object, like a temperature sensor in a car.

- **Monitoring Layer**

This layer monitors nodes for various tasks. Nodes can be monitored for their working time, temperature, and other physical properties, as well as their maximum battery life. Applications' performance and state are tracked. The amount of battery power ingested by the fog devices is monitored.

- **Preprocessing**

This layer manages a variety of data operations, most of which are analysis. This data is cleaned and checked for errors. Data analysis can necessitate mining meaningful and relevant information from lots of data collected by end devices.

- **Temporary Storage**

Assists in non-permanent data replication. This tier uses storage virtualization like VSAN. Data transferred to the cloud leaves the temporary layer.

- **Security**

Encryption and decryption are handled by this layer. It also addresses use-based, database-based, and location-based privacy in fog computing. It ensures the data sent to the fog nodes is secure.

- **Transport Layer**

Private data is sent to the cloud layer for long-term storage. Facts are collected, then uploaded for efficiency. Facts are screened before they are sent to the cloud via smart-gateways. Because fog computing is resource constrained, the communication protocols used are compact and efficient.

1.2 FOG COMPUTING VALUES

High-virtualization environment that connects IoT devices and data hubs (cloud computing). It also offers networking services [34]. Fog Computing includes:

1. Privacy

Fog computing can regulate privacy [17]. Sensitive user data may be evaluated locally instead of centralized cloud infrastructure. The IT staff may then monitor and operate the gadget. A portion of data may also be transferred to the cloud for analysis.

2. Efficacy

Customers may use fog programs to customize the machine's operation. With the correct tools, developers may quickly create these fog apps. After development, they may deploy it anytime they want. Cloud computing uses a lot of energy, but fog computing can help save it. The equipment that produces metadata for the perimeter client sites save energy idle time affects energy consumption [18]. However, FC saves sensory energy. Firstly, the gateway can act as a allowing the system to sleep. When the sensor is active, the changes [19] Lithium ion hubs can run users and services. Similarly, Datacenters are widely dispersed in the air and securely connected. Unlike batteries, these devices run on wind and solar energy. FC aims to reduce network and computation power consumption by recursively scaling assets [20].

3. Safety

Fog computing may link several devices to a single network. As a result, operations are scattered over several endpoints in a complicated distributed system. This helps discover possible risks before they affect the whole network. Safety is a vital element of any system. Fog Computing, with many nodes and complex framework, requires incredible security. FC has the needed safe guards and procedures [21]. Fog computing is in fine shape and can tackle local performance and constraints. Its baseline programs and services are at the customer location [22]. Security is a critical concern in FC, particularly when data is transmitted and the Fog is routinely utilized. FC improves in location awareness by spotting Fog nodes [24]. Because the Fog is directly to the end device, it also has a lower latency [23]. FC's connectivity to end-device provides evaluation of interconnected devices [22].

4. Width

Costly Data Transmission Bandwidth Depending on Resources Data can be processed locally rather than sent to the cloud, hence reducing bandwidth needs. This bandwidth reduction will be useful as the IoT expands. Fog computing slows data center signal transmission. Filtering and reduction reduce data sent to datacenters [25]. The remote node can respond to device requests using locally cached data [26]. Another study found that edge data processing reduced bandwidth consumption by half [27]. The activities are thought to meet application service provider needs. So they created a framework that reduces data between a cloud server and an endpoint. It shows network infrastructure benefits at the cost of latency.

5. Low Lag

This reduces latency. The data may be processed locally. This is great for time-sensitive services. Interactive services demand instantaneity. Sensor data is used by intelligent mobility systems and cloud-based UAVs. Because processing and storing data takes time [28]. In order to keep the controller close to the devices, FC was created. Closer proximity to the device reduces access time [29]. Complex computations take longer on low-resource sensors and can be delegated to more capable fog calculation nodes.

Delays are predicted [25]. Important programs require fast data processing. The cloud is inefficient. Fog computing is critical here [31]. It must be able to compute and network to benefit from IoT. Cloud computing powers most IoT systems [30]. Thus, cloud-based IoT systems have many issues.

Limited mobility and high cloud server load. Low latency could help online games and transit defense. It is kept on long-term storage devices when the cloud is used to reduce unprocessed data captured by a cluster of devices. Aggregation, filtering, and processing simplify data storage. Call sensor loops. Network traffic from edge to datacenter can be reduced [32].

6. Web Optimization

Fog Computing improves the usability of a website. We can get through, execute, and integrate the content of each HTTP request for redirection, template files, scripts, and photos with the help of the web. Cookies and MAC addresses, as well as local area network conditions and cache files, can be used to track users [33]. Feedback scripts can be used on web sites to measure the performance of the user's browser. As a result, the Fog node gains a better understanding of the current zone, visual frequency (if wireless), and bandwidth constraints [22].

1.3 FOG APPLICATIONS

- *Connected Vehicle*: It can park itself, eliminating the need for a human to do so [10]. The Intelligent Transportation System (ITS) has established automobile connectivity for safety and efficiency. An intelligent transportation system uses V2V and V2I interactions to establish links (V2I). This is a major Internet connection solution. Autos have high levels of real-time contact, so communicating with road signs and access points makes sense. [8].
- *Smart Traffic Lights*: Infrared fog computing allows traffic lights to open based on flashing lights. A bike or a person can be detected and tracked. Sensor lighting detects activity. Flashing lights trigger fog computing to clear lanes.
- *Augmented Reality*: Augmented Reality: Even millisecond delays can cause major interface issues. Fog computing-based solutions thus have enormous potential [8]. Zao et al. [9] proposed a fog and cloud-based brain computer interaction game.
- *Smart HealthCare:* Contamination causes bacteria and viruses that cause diseases. Smart healthcare includes smart IoT that can track patients' activity and post data to fog nodes, which are then noticed by medical personnel who recommend appropriate steps to patients [11].

- *Waste management:* The world is becoming more polluted. To save the planet, natural resources must be prioritized. It's time to take trash and groundwater loss seriously! Smart garbage management may be one way to improve the environment [9].

CONCLUSION

The study gives an analysis of fog computing, computer technology advancement, and the Internet - Of - things. Fog architecture has layers ideal for building fog networks. The architecture depicts the functions performed by each layer the protocols, devices, and their functionality at various layers. Fog Computing, an outgrowth of Cloud Computing, improves efficiency and latency. Cloud computing can help organizations meet the ever-increasing need for IT services. Fog computing can retrieve and translate data for IoT applications.

RECOMMENDATIONS

We must recognize that, because the digital era began with the development of computers and communication technologies, these technologies are also evolving. Indeed, the ongoing advances in information and communication technology have allowed the scope of human activity to increase in the electronic space on a constant basis, resulting in a range of changes in how economic activity is done. Thus, there is an increased need to use technical ways of business conductivity inorder to achieve the COUNTRY'S VISION 2030.

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