Fog Computing Based on the Transmitters and Receivers near These Devices according To the Geographical Area. Where the Resources of These Passive Devices or the Semi-Passive Devices Close To Them Are Utilized

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Abstract: - Fog computing is a decentralized computing structure in which resources, including data and applications, are placed in logical positions between the data source and the cloud. Both fog and cloud computing provide storage, application, and data storage for users, but fog is closer to the end-user and has a wider geographical distribution. In this research, we will examine it and review the related works.

Key Words: — ***Fog computing, Fog architecture, Fog.***

I. INTRODUCTION

Characteristics Fog computing is a distributed infrastructure in which data, computing, storage, and applications are distributed locally between data generators and the cloud.

Both fog and cloud computing provide storage, application, and data storage for users, but fog is closer to the end-user and has a wider geographical distribution. The purpose of creating fog computing is to bring basic analytics services to the edge of the network, which, by bringing computer resources closer to the required location, increases system performance and reduces the distance at which data must be transmitted, and so on. This is because the system performs better. The origin of Fog computing is the same as cloud computing, and like cloud computing, it has data, storage, and applications and is not located in a specific location. Another advantage of Fog computing is that it can be accessed anywhere in the world.

Manuscript revised September 20, 2021; accepted September 21, 2021. Date of publication September 23, 2021.

This paper available online at www.ijprse.com

ISSN (Online): 2582-7898; SJIF: 5.494

One of the uses of fog computing is an intelligent electrical network. These smart grids are somewhat dynamic, operating intelligently against power consumption, and reducing output when power consumption is not cost-effective.

A smart grid needs a lot of data on electricity generation and consumption to be efficient.

IoT applications such as smart grids are another area where fog computing is used. Each vehicle can generate a bit of data depending on its direction and speed and send this amount of data to fog and other vehicles.

Using traditional methods of existing hardware and software is not able to manage and process this large amount of data in an acceptable time. Therefore, according to the cloud-computing model, this big data is usually considered that cloud technology leads to the use of large resources remotely and at a reasonable cost. [1]. as the size of the cloud increases, network latency will increase as much as it is not acceptable for critical Internet applications. There are limitations to using cloud technology, and one of the most fundamental limitations is the connection to the cloud and end-to-end devices on the Internet, which are not suitable for some sensitive applications.

In addition, cloud-based applications are usually multi-component and distributed, which makes it common to deploy separate application components on multiple clouds, which is greatly delayed due to overhead due to cloud communication [2]. One of the solutions that have been introduced to address these limitations of cloud computing is an extension of cloud computing called Fog computing, which is a good example for many IoT services. Fog computing is an example that has been introduced to address these limitations.

The Fog computing architecture extends computing to the edge of the network and distributes computing, processing, and data storage to end-users. Fog computing can provide a mechanism for marginal devices to operate for a reasonable time without interruption, even if the cloud connection is lost, as well as protecting confidential information and sensitive data. It also provides a better real-time response than other cloud-based models [4]. Compared to cloud computing, Fog computing has relatively small computing resources such as memory, processing, and storage, however, it can process data generated from different devices.

Fog computing is basically a cloud extension, but it is closer to objects that work with IoT data.

The rest of the article is organized as follows: Section 2 examines the Fog computing. We then provide a summary of Fog computing studies in Section 3, and the conclusions are presented in Section 4.

II. Fog Computing

Three-layer architecture [20] is one of the basic and widely used architectures in fog calculations. Figure 1 shows the architecture.

End devices: This layer includes IoT enabled devices including sensor nodes, smart devices. These devices are commonly known as terminal nodes.

Fog: This layer is known as the fog calculation layer. Fog nodes in this layer consist of network devices such as routers, gateways, switches, and access points (APs). These fog nodes can share storage and processing capabilities together.

Cloud: Traditional cloud servers and DC cloud servers are in the top tier. This row has sufficient storage resources and calculations.

According to [7][8][9], the architecture of fog computing consists of six layers - physical and virtualization, monitoring, pre-processing, temporary storage, security, and transport layer - as shown in Figure 2.

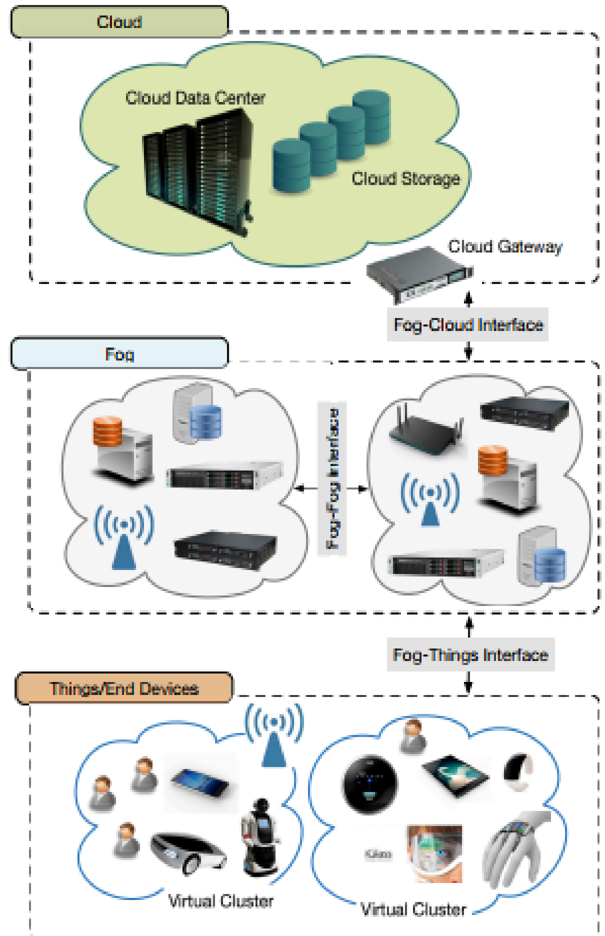

Fig.1. Three-tier fog computing architecture [20].

The physical and virtual layers include various types of nodes such as physical nodes, virtual nodes, and virtual sensor networks. To better understand the environment, these nodes are geographically distributed and are responsible for sending data collected through gateways. In the monitoring layer, the use of resources, the availability of sensors and Fog nodes, and network elements are monitored. This layer is responsible for controlling energy consumption and performance and tasks performed by nodes and Fog and programs and services located in infrastructure [36]. The preprocessing layer performs data management tasks. It is responsible for data processing to extract meaningful information, then the extracted information is temporarily stored in the temporary storage layer. Once transferred to the cloud, they no longer need local storage and may be removed from temporary storage media [7][8].

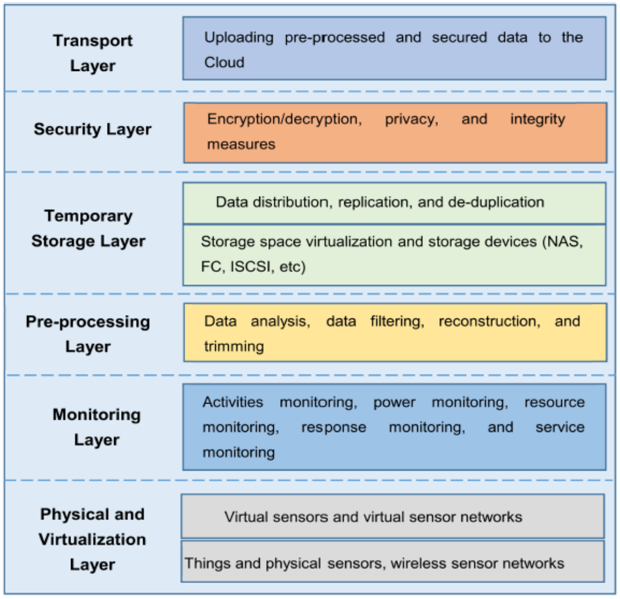

Fig.2. Fog computing layered architecture].

At the security layer, data is encrypted/decrypted for protection. Finally, at the transfer layer, preprocessed data is loaded over the cloud to create more useful services [7][8] Based on Fog's limited resources, a communication protocol for Fog computing must be efficient, light, and customizable. Therefore, the choice of communication protocol depends on the Fog application scenario [6].

Fog computing has the following features [18]:

- Low latency and location-awareness
- Save bandwidth
- Supports geographical distribution
- End device mobility
- The processing capacity of a large number of nodes
- Wireless access
- Real-time schedules
- Heterogeneity
- Interoperability
- Data security and privacy protection
- Low energy consumption

In [18] comparisons have been made between fog and cloud computing and edge computing as shown in Table 1 -2 -3, also key technologies of fog computing is shown if figure 3.

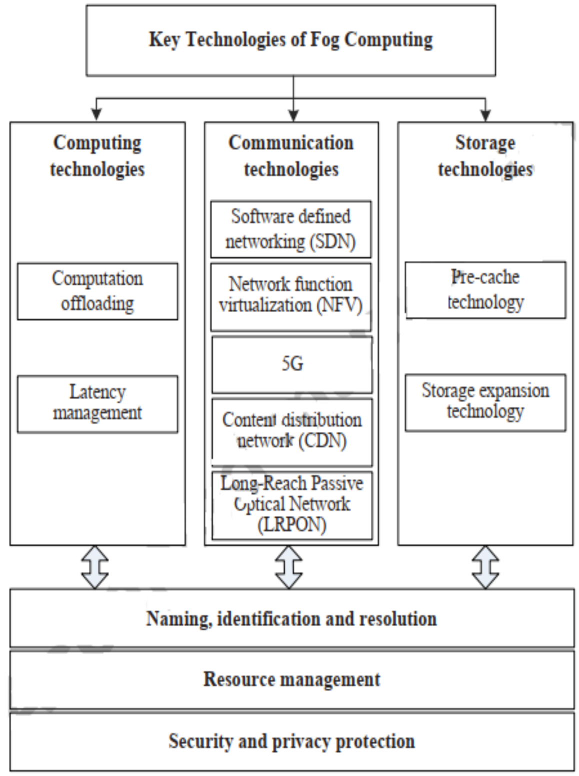

Fig.3. the key technologies of fog computing [18].

Figure 4 shows the existing free problems through their main challenges in resource management approaches in fog computing based on further paths in this problem [25].

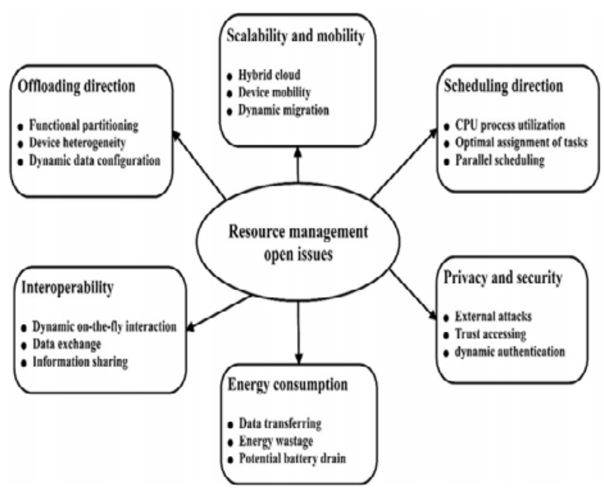

Fig.4. The main challenges of resource management in fog computing [25].

Table.1. Comparison of cloud computing and fog computing [18].

	Cloud Computing	Fog computing
Latency	High	Low
Real time interactions	Supported	Supported
Mobility	Limited	Supported
Location awareness	Partially supported	Supported
Number of server nodes	Few	Large
Geographical distribution	Centralized	Decentralized and distributed
Distance to end devices	Far (multiple network hops)	Near (single network hop or few network hops)
Location of service	Within the Internet	At the edge of the local network
Working environment	Specific data center building with air conditioning systems	Outdoor (streets,base stations, etc.) or indoor (houses, cafes, etc.)
Communication mode	IP network	Wireless communication: WLAN, WiFi, 3G, 4G, ZigBee, etc. or wired communication (part of the IP networks)
Dependence on the quality of core network	Strong	Weak
Bandwidth costs	High	Low
Computation and storage capabilities	Strong	Weak
Energy consumption	High (especially the energy consumption of data center coolant system)	Low

III. FOG-COMPUTING RELATED WORKS

Let In this section, we review the work related to Fog computing, which has been presented by various researchers in recent years. These research articles cover various aspects of Fog computing.

Mohammad Aazam et al. [3] introduce the IoT architecture of version 4.0 and discuss how to integrate firmware such as Fog into different industry scenarios in this architecture.

Srini et al. [5] present a complete set of topology control (TC) techniques in two phases of construction and maintenance to create and manage a network with Fog computing for the smart city, which in the construction phase of the Hungarian algorithm based on the construction algorithm (HTC) And use the Locator Identification Algorithm (CLI) to create a set of optimal locations to the gateways with the number of resources required, and in the maintenance phase of the holiday-based resource allocation algorithm and dynamic resource allocation (VRA)) Optimize the misuse of resources in the system.

Table 2: The similarities of edge computing and fog computing [18].

	Edge computing	Fog computing
Architecture	Hierarchical, decentralized, distributed	Hierarchical, decentralized, distributed
Proximity to end devices	Located in end devices	Near (single network hop or few network hops)
Latency	Low	Low
Bandwidth costs	Low	Low
Resource	More limited	Limited
Computation and storage capabilities	More limited	Limited
Mobility	Supported	Supported
Scalability	High	High
Service	Virtualization	Virtualization

Table 3: The difference between edge computing and fog computing [18].

	Edge computing	Fog computing
Location of data collection, processing, storage	Network edge, edge devices	Near-edge and core networking, network edge devices and core networking devices
Handling multiple IoT applications	Unsupported	Supported
Resource contention	Serious	Slight
Focus	Things level	Infrastructures level

Ranesh Kumar et al. [10] Overview of Fog computing Research trends and technical differences between Fog and the cloud. Then, in the Fog computing architecture, the components of these structures are examined in detail. Finally, they presented a classification of Fog computing according to the requirements of the Fog computing model.

Ola Salman et al. [11] have introduced the use of SDNs and Fog computing as an evolution of the IoT to achieve an IoT architecture to meet the challenges of the Internet of Things.

PeiYun Zhang et al. [12] discuss and analyze the structures of Fog computing and the issue of security, and discuss various challenges in this area.

Geetanjali Rathee1 et al. [13] proposed a secure transmission mechanism to prevent an attack by examining the degree of trust and degree of each Fog node. A trust manager is created between the Fog layer and the IoT layer that can destroy node Fog and And Fog node services are provided through a trusted route.

Weidong Fang et al. [14] propose a Gaussian Distributed Comprehensive Trust Management System (GDTMS) for F - IWSN called TMSRS and also make the gray decision to achieve a secure routing plan with a balance between security (trust value), energy ((Residual energy) and transfer (transfer performance).

Zahmatkesh et al. [15] review the applications of Fog computing for smart cities in IoT environments. They also review airborne control (UAVs) and machine learning (ML) techniques in FOG computing IoT systems that present opportunities and challenges. They also check the available ones.

Alhaidari et al. [16] provide a comprehensive review of the security of the Fog and CoAP protocols and the classification of review articles to better understand existing techniques. In fact, in this review, Fog's main security mechanism proposed to ensure the CoAP protocol is architecture, Security, and performance evaluation have been reviewed.

S. Prabavathy et al. [17] have proposed an intelligent intrusion detection method based on Fog computing using a sequential extreme learning machine called OSELM. By distributing cloud intelligence to local Fog nodes, it can detect IoT attacks faster.

Yousefpour, A. et al.[19] provide a training program on what fog computing is and how it relates to other computational paradigms such as cloudlets, MECs, and edge computing. Then, they provide a classification of research topics in fog calculation.

Mukherjee, M. et al.[20] provide an overview of the various architectures of fog computing and its challenges.

Iorga, M. et al.[21] show the conceptual model of fog computing and how it relates to cloud-based computing models for the Internet of Things.

Mutlag, A. A. et al.[22] provide a comprehensive overview of fog computing and provide examples that are classified into four classes: fog computing methods in healthcare applications, system development in fog computing in healthcare applications, and review and survey of fog computing in healthcare applications. They also examine the weaknesses of current methods, systems, and frameworks

Tange, K. et al.[23] conducted a systematic review of IIoT security, reflecting how a relatively new Fog computing model can be used to address these needs and improve security.

Mahmud, R. et al. [24] examine the application management strategies in fog computing from the perspective of application architecture, placement, and maintenance, and also propose separate classifications for each aspect of application management.

Lei, K. et al.[26] propose a scalable general structure of two chains suitable for cloud computing from IoT services, and this scheme can defend against attacks such as double-spend and selfish mining.

Bellendorf, J et.al. [27] Provide an overview of optimization problems in fog calculations and have developed a classification of optimization problems in fog calculations shown in Figure.5.

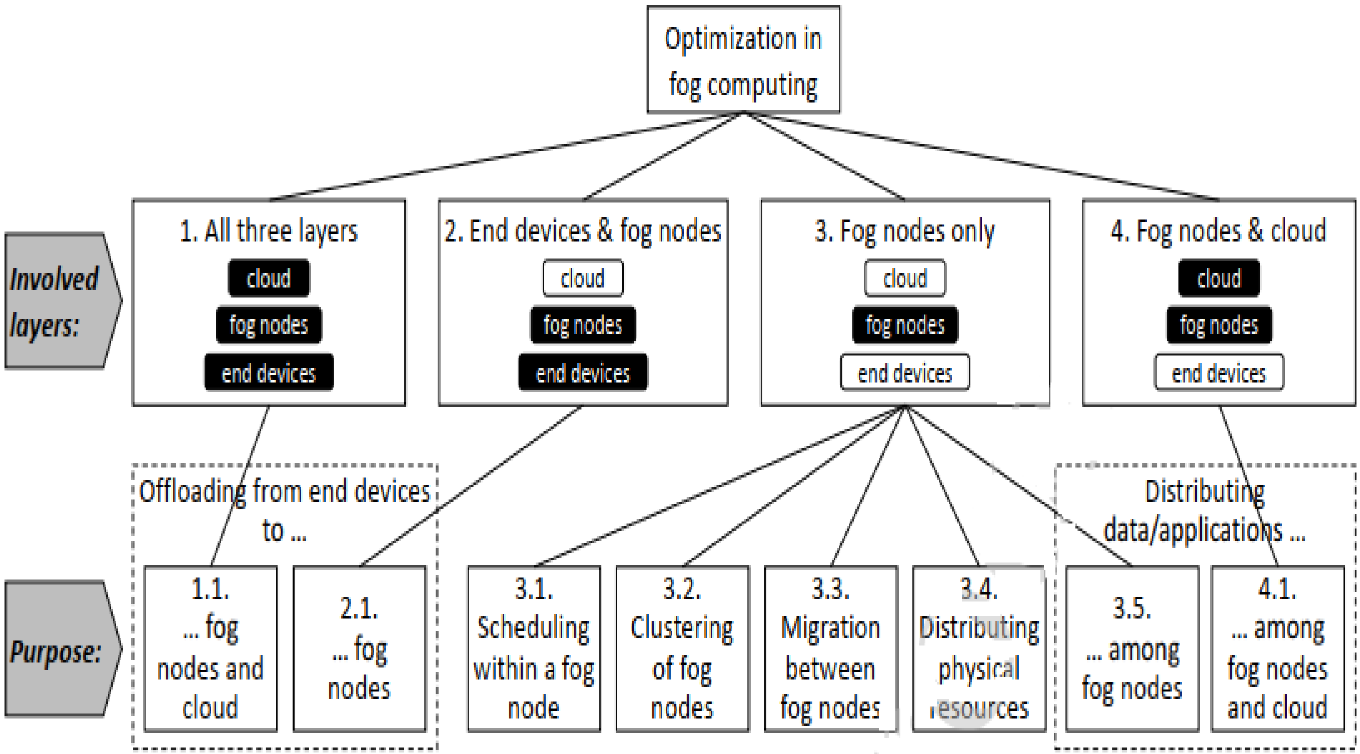

Fig.5. Taxonomy of optimization problems in fog computing [27].

Mutlag, A. A. et al.[28] have proposed a multi - factor model for managing critical health functions in fog computing , which is the main role of a multi - factor mapping system between the three decision tables to optimize the scheduling of important tasks with priority, load in the network and the availability of network resources .

Chen, C. M et al. [29] first showed that the Jia et al protocol, which is designed to fog computing, is vulnerable to a hidden leak attack. Then, they proposed a new approved key swap protocol for fog computing.

Bouachir, O. [30] discussed the creation of a blockchain and fog computing-based ecosystem in the IIoT that can manage and enhance IIoT QoS, data storage, and computing and security requirements.

IV. Conclusion

In Fog computing is a model that provides users with demand-based access to a repository of shared computing resources on a network platform. It can be defined as a distributed computing paradigm that essentially brings cloud-based services to the edge of the network. In fact, it is a bridge between end devices and cloud computing, and because of its proximity to end devices, it has the potential to provide low-latency services. It should be noted that fog computing is complementary to cloud computing, not a substitute because real-time computing is done by fog, while intense computing is processed in the cloud. In this article, we review fog computing and its features and review the latest related research.

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