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Fog computing as Internet of Things (IoT) enabler

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ABSTRACT

Traditional Centralized paradigm of cloud computing experienced many problems with Internet of Things Technology accelerated growth including high latency, low bandwidth and network failure. Fog computing takes the cloud closer to IoT devices to address those problems. Fog offers local IoT data care and storage on IoT devices and not cloud transmission. In comparison to cloud, fog provides faster responses and higher quality services. Consequently, Fog computing can be regarded as the best way to allow IoT to provide many IoT users with secure, reliable services. We addressed how fog is a viable tool for applications and services for IoT.

Keywords: Fog Computing, Internet of Things (IoT)

Introduction

Internet of Things (IoT) is an innovation which offers unlimited benefits to our world. The Internet of Things evolves on the way towards entering a world in which many of our devices link to the internet to communicate without involving people [1]. This opens up the key to technologies that render modern connections between objects and people to make the development of quality of life for intelligent communities, infrastructure systems and services [2]. IoT originally intended to minimize efforts to access human data and to use the various sensors for the collection and automated storage of environmental data, as the IoT is characterized by a reduced process power and storage computations, and is subject to several problems including speed, protection, privacy, and confidentiality[1], so that the data can be stored and processed automatically.

IoT's Cloud Integration provides a range of benefits for multiple IoT applications. Although it is challenging to create new IoT applications as a consequence of the numerous heterogeneous platforms of IoT devices. It is due to the large quantities of sensors and other tools that IoT applications produce data. These massive numbers of the data are then evaluated to determine the options of various acts. All of this information is transmitted to the cloud with a high network bandwidth [1]. For local saving and preliminary data

analysis it is proposed to use edge computing capabilities near IoT sensors to answer these challenges and resolve these problems. It will also reduce network congestion, speed up research, and then take decisions [2].

Cisco has developed the term 'fog computing' [1],[3],[4]. Fog computing is a geographically scattered, resource pool architecture that comprises one or more all-present (including) edge devices at a network edge that are jointly supplied by elastic computing, storage and networking, and not merely seamlessly supported by cloud infrastructure. In this paper, the factors which make fog an effective platform for the internet of application and services were discussed.

II Related Work

Fog Computing expands the concept of cloud computing to a broad variety of applications and utilities. Fog's related characteristics include: (a) low latency and location response; (b) high spatial diffusion; (c) mobility; (d) large node spectrum; (e) prevalent wireless networking capabilities; (f) fast streaming and real-time applications; and (g) heterogeneous. Within this article, we argue that Fog is an appropriate medium for many main IoT (including the connected car), Smart grid, Smart Cities and the wireless sensor and actuator (wireless) network [8] within general, as well as a

number of core Internet services and applications.

With the growth of the IoT Internet and the advent of rich cloud infrastructure, the new computing paradigm, edge computing, has emerged which calls for the treatment of network thresholds. For edge computing it can be minimized the constraints on battery power, bandwidth efficiency and objectively protection and privacy. To order to understand the idea of edge computing, we integrate the definition of field computing encountered across a variety of situations, from cloud transactions to intelligent homes and society. Sooner or later, we have other machine problems and blessings at the edge [9].

While cloud usage is on the rise, Problems such as low latency, lack of mobile assistance and details on position tend to remain unresolved. Fog networking, which is sometimes called Edge Computing, can overcome these issues by supplying end-users with open infrastructure and operation on the front of the network while cloud computing delivers centralized services more carefully across the central networking network. This study examines the definition of fog computing and related principles and discusses other examples of the challenges encountered by fog computing systems. This also shows potential possibilities and challenges for the correct approaches to be used in the

sense of nebula computation as guidance for possible future work [10].

Modern central cloud machines are facing significant challenges, including high latency, poor spectral effectiveness (SE) and non-adaptive network processing, with a increasing number of mobile internet and Internet applications. The new technology drives a movement to address these challenges by transferring complexities of centralized cloud computing to network periphery applications. Different revolutionary computing technology from various backgrounds has emerged that reduces latency, increases SE and supports the massive form of communication between machines. This article offers a detailed guidance on three new, conventional computing technologies, mobile technology, cloudlets and fog. These three technologies are in particular illustrated and contrasting with approaches, principles, architectures and implementations for standardization. Through a radio access network point of view, distinguishes between the computation of mobile edges and fog computing are seen and features in fog computing networks are discussed. Finally, as are the possible directions for study [11], open problems are also mentioned.

Fog Computing is designed for filling the gap between IoT and distant data centers. Fog is an efficient platform for a wide

range of IoT systems and provides a host of benefits including improved security, lower bandwidth and decreased latency. Nevertheless, fog devices have clearly other security and safety threats (located on the internet edge). Of course. Authors deal here with security and privacy issues and suggest a system to fog in order to facilitate the dissemination of certificate cancellation details among IoT devices [12].

The Fifth Generation (5 G) cellular network is built to provide sub millisecond latency and 1 gigabit per second bandwidth to its users. Nonetheless, this service quality (quality of service) (QoS) guarantee, which leads to a significant increase in the number of cordless network hops from the 5 G basis stations to the cloud, cannot easily be abused. The bandwidth is depleted and congested by moving all system generation data directly into the cloud. This is also important for the processing of data close to devices, in order to make it possible to use 5 G high speed communication and for processing and filtering the data in the cloud. This push towards the network's edge by uploading the transmission, storage and networking resources opens several new research areas to apply Fog calculation to cellular network architecture. The advantages of extending Cloud Infrastructure to include use circumstances

that 5 G network fog computing would realize [13] are mentioned in this book.

The today's industrial automation systems are still arranged in accordance with the automation ladder, in which the lower pyramids are centered on process control and the higher levels on software requirements. Nonetheless, this automation pyramid will not be ideal for future development due to its restricted knowledge flow between the tiers. Consequently, industry is implementing technologies from the Internet of Things (IoT). That will break the very tight pyramid structure of the infrastructure and make it possible and access knowledge both at and outside a manufacturing center. The subsequent Internet of Things Technological (IIoT). In This paper offers fog machines for the architectural purposes of the city and explores two fog-enabled technologies: virtualization and deterministic communication [14].

An evolving fog computing platform is the cloud and network edge technology. Fog provides end-users such as Cloud with information, computing, storage, and device services. In the essay, we draw on Fog Computing's concept and advantages and explore its use in a range of practical scenarios, including intelligent networks, intelligent light in-cars and software-defined networks. We deal with Fog computation and associated research in the same way. Under the latest Fog computing

paradigm, protection and privacy concerns are still exposed [15].

III Fog Platform and its support for IoT devices

Research distribution

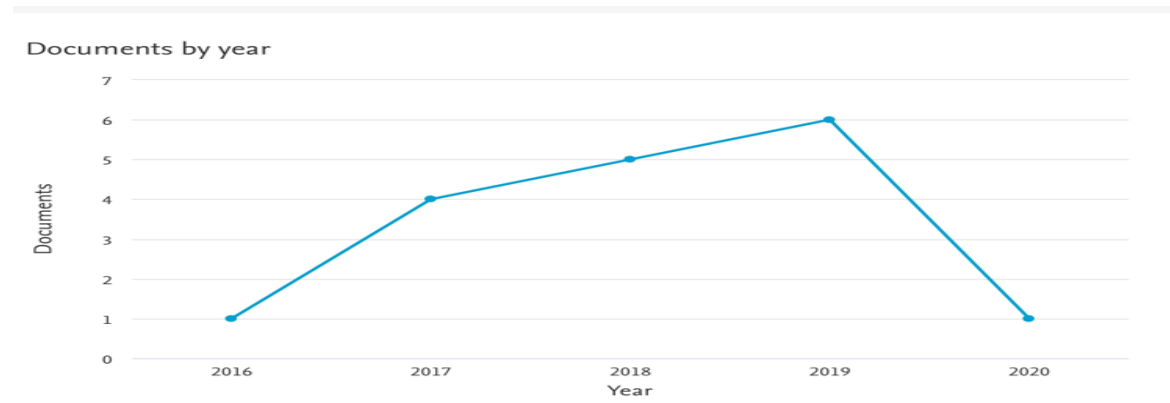


Figure 1 documents by year

The above figure shows the number of the reviewed articles by year with 2019 having the highest frequency of the articles.

Research distribution by type

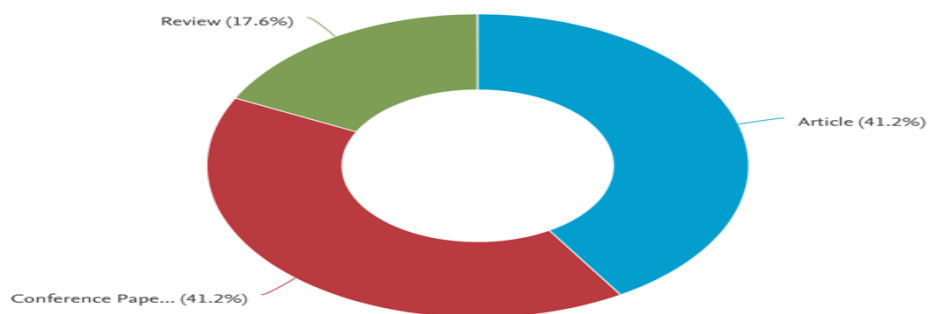


Figure 2: Documents by Type

The above figure shows the distribution of the research documents by type.

Documents by subject area

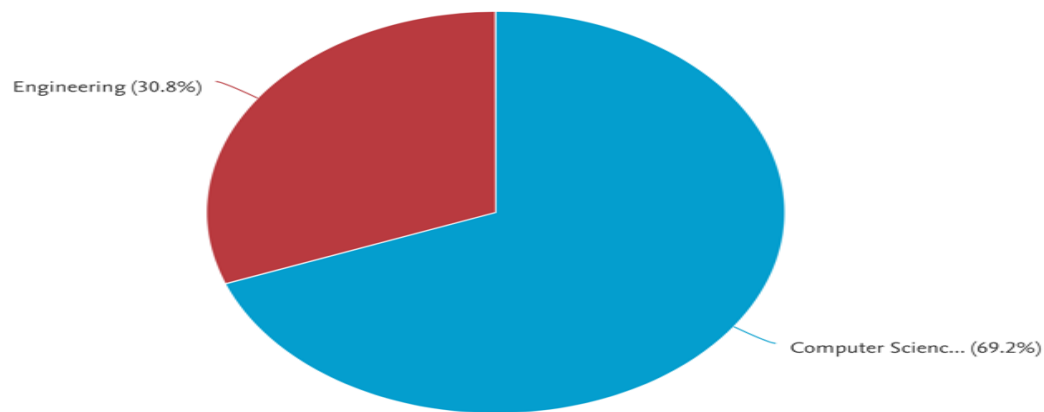


Figure 3 Distribution by subject area

The above figure show the distribution of the research by subject area with computer science having the highest percentage of 69.2% followed by Engineering with 30.8%.

Fog Platform and its support for IoT devices

The management of IoT data from sensors and actuators is one of the main challenges, to incorporate an IoT system that solves these problems. fog come to salvage the situation.

Fog Computing is a means of delivering data and storage facilities to physical computers in a business called Cloud Edge faster and closer. The Fog Computing is a way to provide access faster and can also be understood to bypass the wider Internet, the speed of which depends largely on bandwidth and transportation systems. Fog is a system-level horizontal architecture, according to the Open Fog Consortium,

which distributes processing, storage, management and the network functionality with a cloud-to-things system similar to users [16]. Fog computing is an all-embracing model for all-embracing access to a common computer network. The model makes the implementation of latency-conscious distributed applications and services consisting of fog nodes⁸ (physical or virtual) residing in a centralized (cloud) smart end-user array. The purpose and architecture of the fog calculations is to maintain data and computation close to the edge of the device and to build a new class of low latency, high bandwidth and context-sensitive applications and end-user services. The term "fog computing" is widely used [18] and generally is closer to humans than to clouds. Cloud and Fog

provide end users with data, encoding, storage and device services. Nevertheless, Fog can differentiate itself from Cloud [15] because of its proximity to end-users, compact geography delivery and connectivity assistance.

Fog Computing is responsible for correspondence, storage, and processing on computers near to users. This may be the big benefit in contrast with other forms of computing. Some popular properties and advantages of fog computing concerning the internet of things are mention below:

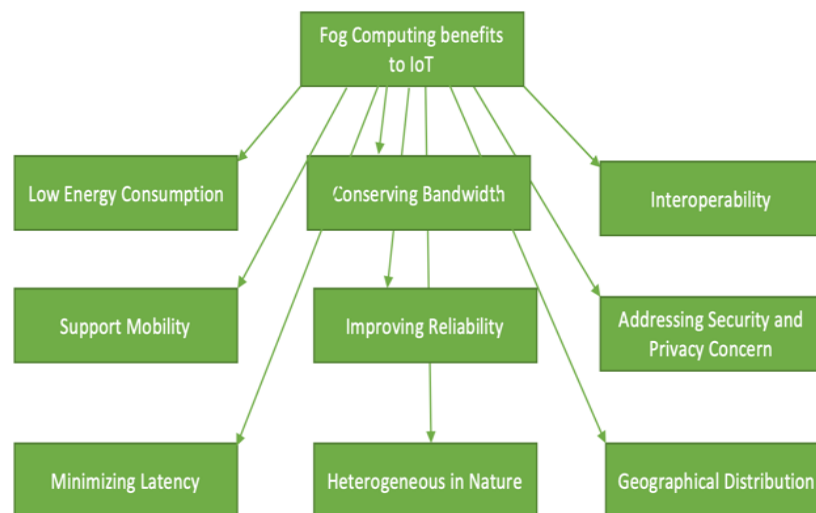


Figure 4: Fog benefits to IoT Systems

Minimizing Latency: Increased internet use Unable to support longevity as a central cloud storage provider as cloud infrastructure enables users to view, access and store data on remote servers. Encrypted access to data is accessible on cloud computers. A central cloud service system may stop working as users that contribute to highly accessible latencies are typically not closer to it, so the recommended approach is to switch to an area such as Fog Computing, which is also known as edge computing. Cloud architecture has increased in importance of data mining and highly efficient computing services. Although the

bandwidth does not increase, there are difficulties where a large network bottleneck occurs. Cloud service costs, for instance in order to conserve vast volumes of service and storage expenses such as data transfer, require time and are costly and scarce, are among the drawbacks of cloud computing. Sarkar and Misra showed the complexity of latency when they indicated that Fog was less than cloud computing using the theoretical concept of Fog Computing [16].

Supporting Mobility: Different individuals, appliances (vehicles, wearable equipment, cameras, autonomous systems, etc.) and organizations, using their Fog infrastructures, can communicate with one another. Applications such as mobile

devices on or close to a network's edges process the existing Big Data paradigm generated every day and the powerful Input IoT and permit access to local data. Various mobile apps can directly interact. Data is not expected to be sent to the cloud or even to the base station [16].

Improving Reliability: IoT's vision calls for the use of data from public surveillance systems or critical infrastructure. While most business cloud providers provide highly secure datacenters with good network access, saving capability and computing capacity, it can be easily breakable in some situations. It is really useful to be able to at least use some local processing as a reversal tool or solely using local processing [3].

Addressing Privacy Concerns: Any IoT data cannot be stored outside specific regional borders or legally allowed. Although the cloud service services are generally recognized as private, the user has no say over when and how the data are kept. The possibility that third parties can have unwanted access to sensitive data due to glitches cannot be completely omitted. In the other hand, since they are managed by the local operators, it is possible to trust local gates or other edge nodes. Naturally, this means there are no health flaws in local networks [3].

Conserving Bandwidth: The IoT Gateways, such as DSL or 3 G, are typically highly limited in uplink

bandwidth. It is not always possible to transfer vast volumes of data from edge computers to the cloud. If data processing is carried out locally and filtered data is only sent into the cloud, the bandwidth needed for the uplink is significantly reduced so that cloud connected IoT systems are deployed via restricted or sporadic connections [3].

Heterogeneity in nature: For low latency and flexible requirements at various stages of network hierarchy, fog nodes are extremely diverse and heterogeneous. The field of Fog Computation is applied in numerous forms, both digitally and physically. Fog Computing systems, including edge routers, access points and gateways, have networking and storage capacities that run on multiple OSs and execute user applications at various locations. In comparison, Fog Computing is highly virtualized as "dicentric computer nodes and clustered network nodes," known as heterogeneous Fog nodes. The Fog-Computing network architecture is heterogeneous and not only provides high-speed data center networking, but also Edge-connects (e.g. wireless Internet service, Wi-Fi, 3G, 4G, ZigBee).

Geographical distribution: Fog computation consists of several nodes spread uniformly. We should also track and improve system locations to safeguard mobility. The use of fog computing resources and activities has since been

widely distributed. Fog Computing's favorite aspect is that end-user data and knowledge can be decentralized. Its characteristics contribute to improved localization, better real-time decision-making and accelerated revision of large data[6].

Interoperability: Fog computing is versatile and heterogeneous in nature. Different vendors based in a different area include end machines and fog nodes and fog nodes are used in multiple scenarios. Fog knots must also be linked, cooperated and integrated with a broad variety of suppliers to ensure the availability and maintenance of a wide spectrum of services. One example is the fog-backed subscription service, which requires the coordination of multiple networks, and which services ultimately are spread through numerous locations and areas. Only imagine the situation of the intelligent fog-related transport network. In this sense, it is important to rapidly examine the actual data between smart cars, fog nodes and apps, traffic lights and signals. Therefore, in the context of a legislative resource management framework, a partnership and collaboration between the various fog computing resources have been suggested to ensure efficient partnership and interoperability [6].

Low Energy Consumption: Since fog nodes are spread topographically

throughout the fog computing, there is insufficient heat that may result from concentration elsewhere and thus no additional cooling method is needed. The usage of communication services is often constrained, as many mobile nodes optimally utilize their services and the short-range mode. While helping to minimize energy usage, conserve resources and eliminate prices, fog computation is a green computer platform. Sarkar [6] has demonstrated the theoretical application of the Fog Computing system by fog computing as a greener computing tool. Who indicated the service latency associated with a protocol that incorporates fog computing to a cloud computing was lower? The facial recognition and resolution fog processing was used to achieve similar results. The study showed that the reaction time from the system was substantially reduced as compared to cloud computing [6].

IV Conclusion and future work

After studying the similar researches, we briefly introduced the concept of Fog computing by providing its definitions. The result shows the contributions of a fog computing platform in supporting IoT applications and due to the time constraints we are not able to provide the detailed architecture and protocol of the Fog computing platform. This will provide the future researchers with the background of exploring the Fog Computing architecture

and protocols as well as its challenges for internet of things devices and its potential

future for different IoT applications

Reference:

- [1] H. Atlam, R. Walters, and G. Wills, "Fog Computing and the Internet of Things: A Review," *Big Data Cogn. Comput.*, vol. 2, no. 2, p. 10, 2018, doi: 10.3390/bdcc2020010.
- [2] A. V. Dastjerdi and R. Buyya, "Fog Computing: Helping the Internet of Things Realize Its Potential," *Computer (Long. Beach. Calif.)*, vol. 49, no. 8, pp. 112–116, 2016, doi: 10.1109/MC.2016.245.
- [3] F. G. Becker, *Internet of Things A to Z*. 2018.
- [4] R. K. Naha *et al.*, "Fog computing: Survey of trends, architectures, requirements, and research directions," *IEEE Access*, vol. 6, pp. 47980–48009, 2018, doi: 10.1109/ACCESS.2018.2866491.
- [5] S. Yi, Z. Hao, Z. Qin, and Q. Li, "Fog computing: Platform and applications," *Proc. - 3rd Work. Hot Top. Web Syst. Technol. HotWeb 2015*, pp. 73–78, 2016, doi: 10.1109/HotWeb.2015.22.
- [6] R. Neware and U. Shrawankar, "Fog Computing Architecture, Applications and Security Issues," *Int. J. Fog Comput.*, vol. 3, no. 1, pp. 75–105, 2019, doi: 10.4018/ijfc.2020010105.
- [7] Y. Yang, X. Luo, X. Chu, and M.-T. Zhou, *Fog-Enabled Intelligent IoT Systems*. 2020.
- [8] F. Bonomi, R. Milito, J. Zhu, and S. Addepalli, "Fog computing and its role in the internet of things," *MCC'12 - Proc. 1st ACM Mob. Cloud Comput. Work.*, pp. 13–15, 2012, doi: 10.1145/2342509.2342513.
- [9] N. Mor, "Edge computing," *Queue*, vol. 16, no. 6, 2018, doi: 10.4018/ijfc.2020010104.
- [10] S. Yi, C. Li, and Q. Li, "A survey of fog computing: Concepts, applications and issues," *Proc. Int. Symp. Mob. Ad Hoc Netw. Comput.*, vol. 2015-June, pp. 37–42, 2015, doi: 10.1145/2757384.2757397.
- [11] Y. Ai, M. Peng, and K. Zhang, "Edge computing technologies for Internet of Things: a primer," *Digit. Commun. Networks*, vol. 4, no. 2, pp. 77–86, 2018, doi: 10.1016/j.dcan.2017.07.001.
- [12] A. Alrawais, A. Alhothaily, C. Hu, and X. Cheng, "Fog Computing for the Internet of Things: Security and Privacy Issues," *IEEE Internet Comput.*, vol. 21, no. 2, pp. 34–42, 2017, doi: 10.1109/MIC.2017.37.
- [13] H. G. Gupta, S. C. Chakraborty, S.

- K. G. Ghosh, and R. B. Buyya,
“Fog computing in 5G networks: an
application perspective,” *Cloud Fog
Comput. 5G Mob. Networks Emerg.
Adv. Appl.*, pp. 23–56, 2017, doi:
10.1049/pbte070e_ch2.
- [14] W. Steiner and S. Poledna, “Fog
Computing als Basis für das
Industrielle Internet der Dinge,”
*Elektrotechnik und
Informationstechnik*, vol. 133, no. 7,
pp. 310–314, 2016, doi:
10.1007/s00502-016-0438-2.

