International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-9, Issue-6, November 2021
https://doi.org/10.55524/ijircst.2021.9.6.37
Article ID IRPS12047, Pages 163-167
www.ijircst.org

A Systematic Review of Challenges in Fog Computing

Swapnil Raj[1], and Mrinal Paliwal[2]

[1,2]SOEIT, Sanskriti University, Mathura, Uttar Pradesh, India
Correspondence should be addressed to Swapnil Raj; swapnil.cse@sanskriti.edu.in

ABSTRACT- The number of Internet of Things (IoT) applications is rapidly increasing. Current cloud-centric IoT designs, on the other hand, are unable to meet the mobility and dormancy necessities of duration precarious IoT practices. In certain industries, the practices have hampered the expansion of IoT. The computation in the Fog model is investigated in the present study as an option for IoT applications. Fog computing problems or obstacles for IoT applications must be thoroughly reviewed and synthesized. This study uses a well-known and commonly used method of systematic literature review (SLR) technique to address this critical research requirement. From an initial collection of 439 publications, 17 relevant studies were selected and examined by means of the SLR method and specific searching conditions generated from the study topic. In addition, four papers were hand-selected based on the significance to the topic. The collected information from the review was divided into a set of primary difficulty groups. The verdicts of the presented study may assist practitioners and scholars in better understanding fog computing problems, as well as providing a variety of valuable acumens for upcoming research. Range or scope of the study mainly is restricted to collection of the resources that have been evaluated from the database.

KEYWORDS- Architecture, Computing in Cloud, Fog Computing, Internet of Things (IoT), Operational Process.

I. INTRODUCTION

Internet of Things (IoT) is gaining popularity and popularity, with different types of opportunities available and new usage perspectives and applications developing in areas such as intensive healthcare, intelligent or smart homes, industrial developments, and smart agriculture [1]. IoT has piqued the interest of both industry and academics. However, the way of properly handling varied ecosystems including huge data volumes created by billions of smart devices is a perennial subject of concern. Failure to respond appropriately in real time has a negative impact on the professional occupations viability of duration precarious IoT practices. Furthermore, IoT applications are hampered by the system tailback generated by transferring the collected set of informations to the servers in the cloud. The discussed computation architype, first announced by Cisco almost a decade back, is an emergent, promising and upcoming modal or architecture that claims to address IoT cloud computation shortcomings by bringing such services related to computations closer to the users and data sources rather than relying on consolidated computing servers capable of performing computations on the cloud [2].

Fog is cloud computing that occurs close to a customer's network. To accelerate fog adoption, the OpenFog Consortium (OpenFog) was founded by Intel, ARM, Princeton University, Dell, Cisco, and Microsoft. It defined fog as a "system-level horizontal architecture that distributes computing, storage, control, and networking resources and services anywhere along the continuum from Cloud to Things". The demand for fog computing stems from an increasing understanding that centralized topologies are unable to handle the huge volume, variety, and velocity of data created by the Internet of Things. According to recent projections, over 40% of the world's IoT produced data i.e., the set of informations will be gathered, warehoused, administered, analyzed, and managed at devices used by the end users [3]. Fog computing's key qualities are the mobility of "things," wide spread topographical distribution, lesser dormancy, and bandwidth needs. With just a few real-world use cases for fog, it's critical that everyone must comprehend the diminuendos of spreading storage, communication, and computing over the spectrum of cloud technologies [4]. It will be impossible to reap the benefits and potential of fog without first comprehending its complicated ecosystem, which includes numerous heterogeneous hardware, software components, and processes. As a result, this article emphases on below discussed major research question (RQ), with a particular emphasis on fog application functional characteristics: Is the problems of the fog computation architype known?

To obtain reactions to the above discussed RQ from various peoples, this article use a systematic literature review (SLR) technique. Fog enabled IoT networks face four major problems, according to this study. The conclusions or the verdicts of the presented study may definitely assist experienced experts and new researchers in better understanding the entire functional perspective of computation in fog environment along with IoT applications, as well as give a variety of helpful discernments for impending or ongoing researches. The remainder of this work is organized in the following manner. The research technique is discussed in Section 2. Before finishing the article in section 4, section 3 discusses the research findings in depth.

II. DISCUSSION

This paper used the SLR criteria for scientifically and methodically finding, selecting, evaluating, and combining the fog computation problems from pertinent educational and commercial papers, as discussed in Kitchenham and Charters. The papers in this study were chosen from five well-known internet databases and were authored in English, as listed in Table 2. Additionally, important fog computation work from the networking company Cisco (S1), the Manufacturing Association (S4), and comparable research (S2, S6) were all encompassed. Main purpose of the author's work is to examine and synthesize gaps in the literature that influence fog computing. It also looks into existing methods for reducing the negative effects of the highlighted fog problems.

A search string was created based on our study goal utilizing the Boolean "OR" and "AND" operators from the google's logical search tool: ("fog computing" OR "Fog Computing") AND (Problems OR concerns OR challenges OR issues). A variation of the aforementioned string was created for the AIS electronic library database to guarantee that relevant research were not overlooked. Other researchers from different educational institutes were also invited as peer referees and critics to recognize and address any difficulties to enhance the complete feature of the work, in order to minimize or eliminate any researcher bias. The basic search of the initial level yielded an aggregate of "339 results" from six databases, with 300 of them being unique. Fig 1 depicts the enhanced way of multi-stage selection method for a document, which includes identification, filtering, and selection. This method was used to guarantee that only those research papers were considered that were pertinent to the above discussed RQ and the same were chosen. Table 1 displays the percolation norms utilized, such as title keyword search, abstract keyword search, and content exploration.

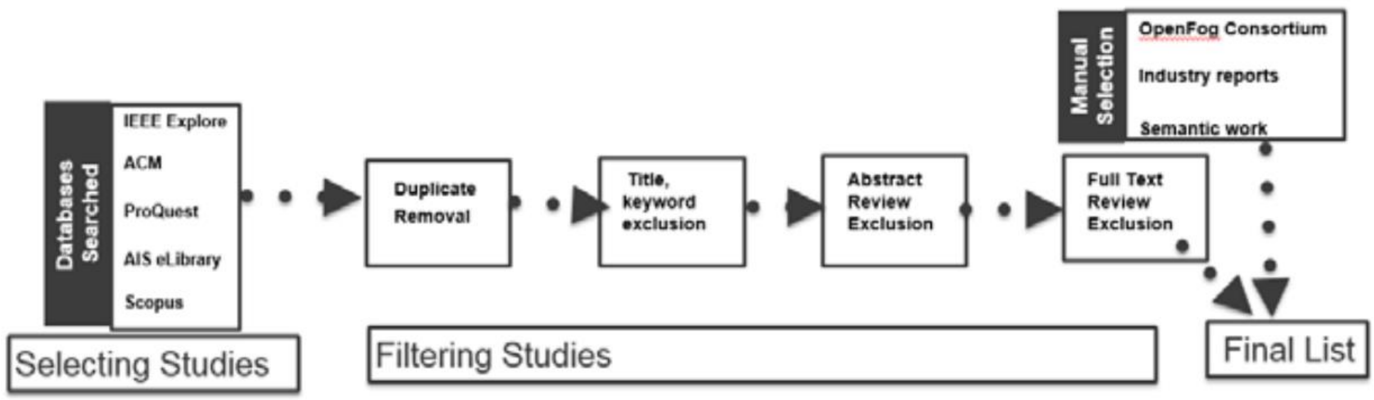


Figure 1: Multi-stage selection process

Table 1: Topic related research paper selection norms

Filtration	Method	Assessment Criteria
Stage 1	Identify relevant studies from data sources	Keyword search Published after 2013 Exclude dissertations Remove Duplicates
Stage 2	Exclude studies based on titles	Title matches "fog" search term
Stage 3	Exclude studies based on Abstract review	Abstract matches RQ on fog
Final	Exclude studies based on full-text review	The article addresses the RQ

Table 2 shows the results of database or website explicit searches.

Table 2: Illustrates the detailed list of database or website specific search results

Database	1st Filtration	2nd Filtration	3rd Filtration	Final Count
IEEE	179	32	13	7
ACM	44	21	10	2
Scopus	150	95	10	4
AISeL	4	1	1	1
Proquest	62	19	17	2
Others				4
Total	439	228	51	21

In addition to the 17 studies listed above, a manual and little time consuming searching method (S1,S2,S4,S6) turned up four other publications (labeled "Others"). This brings the total number of final articles selected for this research to 21.

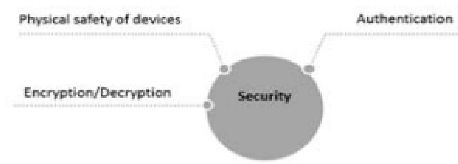
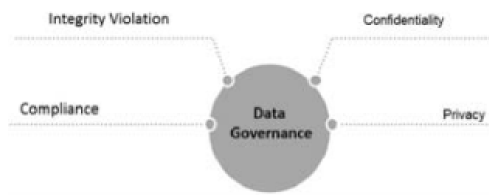
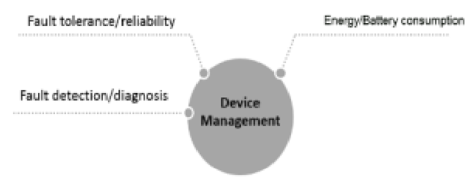
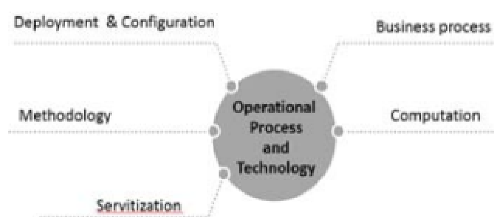
Table 3 contains all of the datasets collected from the identified research papers listed in a tabular format. The used technique aided in the knowing of fundamental Fog issue or concern categories, apart from best practices or dogmas to address such difficulties.

A. *Findings/Outcomes of the Work*

In final step of the work, 19 publications along with the details were examined grounded on the research method's criteria regarding wether to choose the publication or not. In the appendix section, you'll find a list of papers. SLR results are summarized and evaluated in this part to give helpful insights on fog computing issues. The primary issue areas as highlighted in Table 3 are:

- Data governance
- Security
- Device management
- Operational technology and procedure.

Table 3: Outcomes –computation in fog and related challenge groupings

<table>
<tr><th>Category</th><th>Papers</th><th>Count</th><th>Percentage</th><th>SubCategories</th></tr>
<tr><td>Security</td><td>S1-8, S10, S13-14, S16, S18-21</td><td>16</td><td>76</td><td>
</td></tr>
<tr><td>Data Governance</td><td>S1-8, S10, S13, S19-21</td><td>13</td><td>62</td><td>
</td></tr>
<tr><td>Device management</td><td>S4-5, S16, S10-11</td><td>5</td><td>24</td><td>
</td></tr>
<tr><td>Operational technology and process</td><td>S4, S9, S12, S16-17</td><td>5</td><td>24</td><td>
</td></tr>
</table>

1) *Security*

A lot of studies (76 percent) have highlighted the absence of security in fog devices, implying that fog inherits some of the problems associated with cloud computing [5-8]. Devices are placed up in public locations depending on the use case and are vulnerable to manipulation owing to a lack of supervision. Moving computing functionality to the network's edge, on hardware from third-party vendors, is likewise a possible danger. As a potential solution to this challenge, Dastjerdi and Buyya recommended employing public-key substructures under fog [9,10]. Others, though, contended that using substructures in every case might not be enough. Several writers pin pointed regarding a decentralized fog system that the system is not only susceptible to attack, but also to assaults like session riding, Code injection, and session hijacking. Because of the large processing power required, they decided that utilizing cryptographic technique to all of the layers was insufficient.

2) *Data Governance*

Many of the fog applications need data to be stored locally rather than on the cloud. This is especially true when dealing with financial and medical organizations. The addition of a fog provider complicates things even more, because gaining access to the fog network from the outside world is a time-consuming procedure. People, objects, and processes are anticipated to create 44 zettabytes of data by 2020, according to an IDC estimate. As a result, a compelling requisite is must so as to recognize and close the previous gaps so that data owners may properly monitor and govern their data. Thus, from a regulatory compliance perspective, authoring data involves confidential needs to be recognized with proper SLA structure involving each and every point of communication within a procedure in the area of fog computation.

3) Heterogeneously Managing the Devices

The setup of billions of different "objects" in fog must be done decentralized. As noted out in the paper, maintaining record of information relating to hardware failure as well as delivering patch updates of all software is uncharted territory. To build a error free and failure condition detection framework, Open Fog suggests utilizing machine learning approaches. Considering an instance, in systems that contains life-essential usages such as medical care, this is vital and must be solved in order for fog to become a practicable way out for widespread adoption.

4) Functional Process

There is a dearth of clear processes, methods, and implements to assist the creation of IoT applications employing fog computing. Several research on concepts and application areas have been conducted in this context. However, there hasn't been much research into fog-enabled IoT implementation approaches. Giang N. K. has created a non-centralized dataflow model for designing and developing IoT application in fog in this respect. The authors of another study presented a prototype solution to address the implementation problem. Authors gave an outline of the model relating to the process of business in fog-to-cloud gamut in one of the studies concentrating on the healthcare industry. The Openfog Reference Architecture has similar issues.

5) Recomendation

Fog computing is a broad topic that encompasses a variety of overlapping technologies. Table 3 shows four key areas of fog computing issues based on the RQ. These issues must be thoroughly investigated in order to build reliable modals and elucidations for IoT applications that are also fog-enabled. The most often mentioned difficulty in the publications evaluated for this study was security (76 percent). The high proportion shows that there is a compelling need to address this critical problem among stakeholders. Another issue that 62 percent of the research addressed was data governance, which includes privacy, confidentiality, compliance, and integrity. Regulators demand that IoT service providers follow certain standards and policies. The hazards connected with the realms of privacy and security are acknowledged in reports from government agencies such as the EU and the US Federal Trade Commission (FTC). Concerns about operational processes and technology, as well as device management, were also important topics (24 percent each). Fog is a complex ecosystem made up of a variety of technology, people, and processes. Few studies have emphasized the importance of process optimization and service oriented approaches in enhancing maintainability. Most of the times such concerns were not highlighted, even though it does not mean that they are unimportant. This, on the other hand, implies that further research and development in this area is required. The presented study and its scope is basically confined to the review or research topics at hand and the papers chosen for SLR exploration. Furthermore, some relevant research may have been excluded owing to type of the searching method created and papers picked. To mitigate this risk, we created a search string, followed a systematic research selection approach (Table 1, Figure 1), and used analytic tools from a very famous model. Despite its flaws, this article gives some helpful information regarding difficulties of fog computation in IoT senarios. It also highlights the necessity for further research into elements of fog computation, such as monetary and human resource considerations.

III. CONCLUSION

Fog computation is a hot issue in the IoT world. Fog enabled IoT i.e., IOT embedded in fog environment appears to be a significant facilitator for IoT applications across a variety of industries, according to both researchers and industry practitioners. Fog, like many other technological advancements, presents both possibilities and difficulties. Fog for IoT adoption demands a thorough grasp of its issues and potential solutions in order to be successful and informed. As a result, this research identified four key fog computing difficulty categories, including securily maintaining and authorizing the data and issues related to same. The research may be used as a fog literature knowledge base for scholars and practitioners. We plan to undertake a more comprehensive investigation in authorization of fog data and process optimization approaches to enhance maintainability of fog-embedded IoT applications based on the findings of this study.

REFERENCES

[1]. Bader A, Ghazzai H, Kadri A, Alouini MS. Front-end intelligence for large-scale application-oriented internet-of-things. IEEE Access. 2016;

[2]. Bonomi F, Milito R, Natarajan P, Zhu J. Fog computing: A platform for internet of things and analytics. Stud Comput Intell. 2014;

[3]. Lee J, Lee J. Hierarchical Mobile Edge Computing architecture based on context awareness. Appl Sci. 2018;

[4]. Perera C, Qin Y, Estrella JC, Reiff-Marganiec S, Vasilakos A V. Fog computing for sustainable smart cities: A survey. ACM Comput Surv. 2017;

[5]. Yi S, Li C, Li Q. A Survey of Fog Computing. In 2015.

[6]. Yi S, Li C, Li Q. A survey of fog computing: Concepts, applications and issues. In: Proceedings of the International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc). 2015.

[7]. Hu P, Dhelim S, Ning H, Qiu T. Survey on fog computing: architecture, key technologies, applications and open issues. Journal of Network and Computer Applications. 2017.

[8]. Naha RK, Garg S, Georgakopoulos D, Jayaraman PP,

Gao L, Xiang Y, et al. Fog computing: Survey of trends, architectures, requirements, and research directions. IEEE Access. 2018;

[9]. Dastjerdi AV, Buyya R. Fog Computing: Helping the Internet of Things Realize Its Potential. Computer (Long Beach Calif). 2016;

[10]. Mukherjee M, Matam R, Shu L, Maglaras L, Ferrag MA, Choudhury N, et al. Security and Privacy in Fog Computing: Challenges. IEEE Access. 2017;