Review of Fog Computing: Architectures, Applications With Cloud Challenge

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Abstract— Latency and sporadic connectivity difficulties plague cloud services for smart objects. Fog devices reside in the middle between the cloud and smart devices. Real-time applications and location-based services, as well as mobility support, are enabled by their high-speed Internet connection to the cloud and physical closeness to users. In the fields of smart grid, connected vehicles, and wireless sensor and actuator networks, Cisco supported the fog computing concept. This survey article applies this notion to decentralised smart building control, recognises cloudlets as a subset of fog computing, and connects it to SDN scenarios. A small number of articles are found in our literature review. Demand response management in macro station and micro-grid based smart grids, as well as cooperative data scheduling and adaptive traffic light challenges in SDN based vehicular networks, are examined. Security, privacy, and trust issues, as well as control information overhead and network control regulations, appear to have received little attention in the fog computing concept.

Keyword: Fog Computing, Cloud Computing

I. INTRODUCTION

The introduction of computer networks in the 1970s led to the development of distributed systems (Andrews, 1999). A distributed system is a group of separate computers that seem to the user as a single computer and give a single system view (Tanenbaum & Steen, 2006).computing. Up to this time, a few technologies emerged in the distributed systems. One of The coordinated aggregation of these distributed computers allows access to a large amount of the most common distributed systems is the peer-to-peer (P2P) network. The distributed computing system, on the other hand, is an important class of distributed systems that is used for high-performance computing activities (Tanenbaum & Steen, 2006). Cluster computing has grown in popularity as a re (Hajibaba, A Review on Modern Distributed, CIT 22, 2014, 2, 69–84)sult of low-cost and more powerful personal computers, as well as high-speed networks. Other well-known distributed computing paradigms, such as Grid computing and Cloud computing, emerged in the mid-1990s and 2007, respectively, with the expansion of the Internet. Within a few years, cloud computing has become the most popular technology (Qian, Luo, Du, & Guo, 2009). However, according to Gartner's Hype Cycle for Emerging Technologies, Cloud computing has passed the "peak of inflated expectations" and is now in the "trough of disillusionment," with two to five years to go before reaching maturity. Gartner, Inc. (Gartner, Inc., 2013). As a result, in distributed systems, the tendency is shifting toward the usage of novel computing paradigms. Jungle computing emerged as a new paradigm for improving performance by combining disparate and extremely non-uniform distributed computing systems (Seinstra, et al., 2011; Kahanwal & Singh, 2012). In 2012, Fog computing expanded the Cloud computing paradigm to the network's edge, allowing for new types of applications and services (Bonomi, Milito, Zhu, & Addepalli, 2012). A taxonomy of distributed computing paradigms is shown in Figure 1.

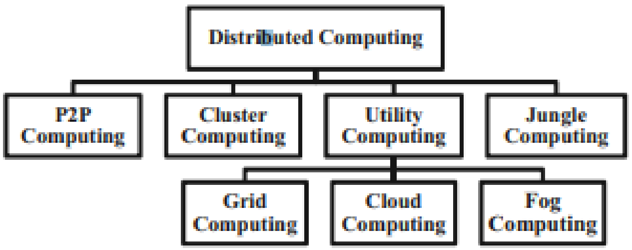

Figure 1. Taxonomy of distributed computing.

These two new distributed computing paradigms, Jungle computing and Fog computing, are discussed, as well as Cloud computing, which is linked to both. These three paradigms are known as modern distributed computing paradigms. A review of these models and their properties might help you better grasp the similarities and differences between modern distributed computing concepts. (Gorgin, 2014).

II. LITERATURE REVIEW

QINGLIN Q et.al. (2019) "A Smart Manufacturing Service System Based on Edge Computing, Fog Computing, and Cloud Computing" Smart manufacturing system involves multiple levels. The underlying layer is the smart devices, which are the sources of data and provide edge computing. The data transmission network is the middle layer, which is where fog computing happens. Big data is stored and analysed in the cloud, which is the top layer. Through the computing, storage, and networking capabilities in the near-end nodes, edge computing and fog computing reduce the data sent to cloud, and the probabilities of service downtime, ensuring the robustness of smart manufacturing system. Edge computing, fog computing and cloud computing cooperate with each other, better meeting the requirements of smart manufacturing applications [1].

Vishal Kumar et .al. (2019) "Comparison of Fog Computing & Cloud Computing" The This comparison of fog and cloud computing will assist in understanding the differences between the two researchers. Cloud computing technology has advanced to the point where several development tools for designing and implementing cloud architecture are now available. Fog computing is currently in its early stages of development, with prototype models and development tools still under development, but we believe it represents the future of modern computing technology, evolving quickly and utilising the edge of devices for computational resources.The Tables given in paper provides details of

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advantages which provide of Fog computing over cloud computing. Fog will promising business model for service providers in the future [2].

Mohammed Al Yami et.al. (2019) “Fog Computing as a Complementary Approach to Cloud Computing” In industry and government, fog computing plays a critical role in enabling big data applications. It is an essential component of cutting-edge products and services including as smart cars, smart manufacturing facilities, digital healthcare systems, and smart transportation systems that are proliferating around the world. Nonetheless, despite its several benefits, Cloud Computing environments are subject to many challenges including information safety and latency of services, network congestions, and reduced communication and bandwidth concerns. Integrating Cloud and Fog Computing, on the other hand, can assist firms in realising new potential in information-driven industries while also resolving existing issues. In a variety of ways, integration assists businesses in realising existing opportunities. These include the implementation of effective disaster recovery systems, increased company agility, loss prevention, enhanced data security, and the creation of new revenue sources. As a result, fog and cloud computing are critical for many businesses, and they should be deployed more frequently to boost revenues and data security[3].

Sourav Kunal et.al. (2019) “An overview of cloud-fog computing: Architectures, applications with security challenges” In the context of fog devices, there are several designs with application domains such as Energy Lattices, MediFog, UXFog, Connected Parking System, etc., as well as security concerns at each level of the architecture to prevent unwanted access or change of the data. We've also talked about authentication, integrity, secure storage, key management, and intrusion detection systems (IDS) in fog devices and cloud computing. Overall, we've created a secure and dependable framework that can be used to various elements of human life to acquire related data securely and quickly whenever it's needed [4].

Amandeep Singh Sohal et.al. (5) “A Cybersecurity Framework to Identify Malicious Edge Device in Fog Computing and Cloud-of-Things Environments” Edge device attacks will become the bottle neck in the successful implementation of the fog computing environment [55]–[57]. In this research, we show how to use our proposed cybersecurity framework to identify malicious edge devices in a distributed fog computing environment. For early detection of malicious and legitimate edge devices, the suggested cybersecurity architecture employs a two-stage Markov model. Experiment results reveal that our system is effective and efficient, with test results to back it up. One of the important features of the proposed framework is the ability to revert the genuine edge device from the VHD, which could happen by accident. In addition, IDS, adaptive in nature, and a false alarm controller have been introduced and thoroughly tested [5].

Tian Wang et.al. (2018) “Coupling resource management based on fog computing in smart city systems” The smart city system, which integrates CPS with cloud computing, has steadily grown in popularity as a research centre. A technique based on fog computing is designed to overcome the problem of coupling resource management. The system ensures near-optimal resource management. The fog computing layer is a tier that sits between the cloud and CPS upper and lower layers, respectively. In addition, the EHGB adds a buffer queue to the fog computing layer to reduce computational coupling. When there are malicious nodes in the system and user requests, the fog layer can cache the conflicting node's data, preventing system conflicts. Theoretical analysis and experimental findings suggest that this strategy can effectively solve the coupling resource management problem, resulting in a sustainable smart city system [6]

Shanhe Yi et.al. (2015) “A Survey of Fog Computing: Concepts, Applications and Issues” This survey compares and contrasts fog computing definitions with related ideas, presents representative fog computing applications, and covers many aspects of challenges we may face when designing and implementing fog computing systems. In addition, topics such as QoS, interface, resource management, security, and privacy are examined, as well as new opportunities and difficulties in fog computing for related methodologies. With the rapid development of underlying IoT, edge devices, radio access techniques, SDN, NFV, VM, and Mobile cloud, fog computing will evolve. We believe fog computing has promise, but it will take a concerted effort from underlying approaches to reach “fog computing” status [7].

Ivan Stojmenovic et.al. (2014) “Fog computing: A cloud to the ground support for smart things and machine-to-machine networks” Latency and sporadic connectivity difficulties plague cloud services for smart objects. Fog devices reside in the middle between the cloud and smart devices. Real-time applications and location-based services, as well as mobility support, are enabled by their high-speed Internet connection to the cloud and physical closeness to users. In the fields of smart grid, connected vehicles, and wireless sensor and actuator networks, Cisco supported the fog computing concept. This survey article applies this notion to decentralised smart building control, recognises cloudlets as a subset of fog computing, and connects it to SDN scenarios. A small number of articles are identified in our literature review. Demand response management in macro station and micro-grid based smart grids, as well as cooperative data scheduling and adaptive traffic light challenges in SDN based vehicular networks, are examined. The fog computing concept does not appear to have explored security, privacy, and trust concerns, control information overhead, or network control policies[8].

III. METHODOLOGY

A systematic methodology, which is summarized in Fig. 2. The first phase aimed at finding the set of relevant publications. This was difficult because I fog computing articles are dispersed throughout a wide range of journals and conferences, and (ii) there is no standard nomenclature for fog computing that would allow for a straightforward keyword search. We used a combination of three different search strategies for these reasons:

• Manual search. We identified five conferences that deal specifically with fog computing. We manually checked each paper that was published in these conferences for its relevance to our work (see below for inclusion and exclusion criteria). The conferences are: –

Since 2016, the IEEE International Conference on Fog and Mobile Edge Computing (FMEC) has been held annually.

Since 2017, the IEEE International Conference on Fog and Edge Computing (ICFEC) has been held 100 times.

The IEEE International Conference on Edge Computing is a gathering of experts in the field of edge computing (EDGE, since 2017) –

Edge Computing Symposium (ACM/IEEE) (SEC, since 2016)–

The IEEE Fog World Congress is held every two years (FWC, since 2017)

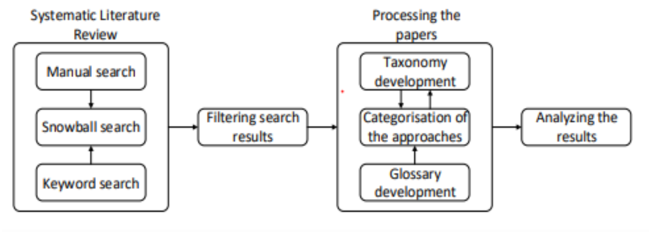

Figure 2: Overview of the used survey methodology

• Look up a keyword. We constructed a search string based on the identified relevant documents. We started with [5]'s simple search string and iterated until it matched at least 85 percent of the 105 documents manually found (the original search string matched only about 20 percent). ((TITLE-ABS-KEY("edge computing" OR "fog computing" OR cloudlet)) OR (TITLE-ABS-KEY(offload*) AND TITLE-ABS-KEY(cloud)) AND (TITLE-ABS-KEY(optim* OR minimise OR maximise OR "objective function")) AND (TITLE-ABS-KEY(optim* OR minimise OR maximise OR "objective function"))) AND (

• Searching with a snowball We checked the papers cited by or citing each found paper to locate another 110 relevant papers. The search was conducted with a November 1st, 2018 deadline. The combined search approach yielded a list of possibly relevant papers, which we then filtered further using the following criteria:

• Only articles that deal specifically with optimization challenges in fog computing were considered. This meant that articles that were not about fog computing (for example, papers in which tasks are offloaded from end devices to 115 cloud services rather than fog nodes) and papers in which no specific optimization problem was specified were eliminated (e.g., papers about technology and architecture issues in fog computing).

• We also excluded non-English papers as well as short papers (less than 4 pages in double-column format) that do not contain sufficient information to assess them. During manual search, 285 papers were considered, 9 of which were selected as relevant for this work. Starting 120 from these 9 papers, 40 further papers were found through snowball search. These 49 papers were used to define the search string. On our cutoff date the keyword search yielded about 1,700 papers, of which more than 1,420 were irrelevant. (In particular, many papers had to be discarded that contain these keywords but do not describe an optimization problem.) Overall, we identified 280 relevant publications. After that, we examined these publications and collected crucial information about the optimization challenges they addressed. We created a taxonomy of the primary optimization difficulties identified based on the 125 collected data. At the same time, we classified each paper using the taxonomy. This was an iterative process: we started with open code and worked our way up to a taxonomy. As the number of publications classified grew, so did the need for adjustments to the taxonomy (also resulting in a re-categorization of already processed papers). In addition to the taxonomy of optimization problem variants, we also developed a glossary of the different metrics used in the 130 papers, and we also used this glossary for tagging the papers.

In the final step, The analyzed the elaborated categorization of the papers to derive insights on the focal points of the existing research

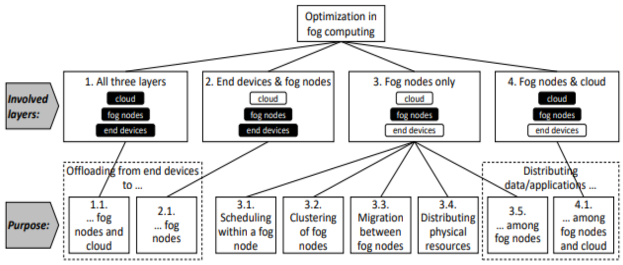

Figure 3: Taxonomy of optimization problems in fog computing

IV. CONCLUSION

Fog computing is a new technology that has thrived in overcoming Big Data IoT application execution challenges at the edge by processing continuously generated data. This computing paradigm is a high-potential computing model that is fast gaining traction, although it is still in its infancy, as many concerns need to be thoroughly examined. This work evaluated and presented different existing Fog computing architectures in order to identify research concerns connected to the execution of Big Data applications using the Fog paradigm. We presented a high-level Fog computing design, addressed a variety of additional Fog computing architectures, and highlighted the benefits of a variety of proposed architectures.We also discussed key limitations of the cloud to execute Big Data applications, especially in the IoT environment. Following the limitations of cloud, some challenges to execute Big Data application on Fog were presented. Also, some recent research works that specifically addressed Big Data application executions on Fog were investigated. Consequently, the characteristics of some currently available commercial Fog related platforms and devices were discussed. Finally, several open research issues were presented. Hopefully, these will pave future research directions among industry experts and academia.

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