International Journal of Fog Computing
Volume 3 • Issue 1 • January-June 2020

A Review of Quality of Service in Fog Computing for the Internet of Things

William Tichaona Vambe, University of Fort Hare, Alice, South Africa
https://orcid.org/0000-0003-0516-1260

Chii Chang, University of Melbourne, Melbourne, Australia

Khulumani Sibanda, University of Fort Hare, Alice, South Africa

ABSTRACT

With the advent of the paradigm of the Internet of Things, many computing elements need many modifications to promote Quality of Service (QoS). Quality of Service is a pillar that promotes real-time reaction to time-critical tasks. Any impediments to QoS should be resolved and handled. In 2012, fog computing was implemented to enhance QoS in current systems in a bid to tackle QoS problems encountered by using cloud computing alone. Currently, the primary focus in fog computing is now on enhancing QoS. The primary goal of this study is, therefore, to critically review and evaluate the literature on the work done to improve elements of QoS in fog computing. This study begins by examining the roots of history, characteristics, and advantages of fog computing. Secondly, it discusses the important elements of QoS parameters. Finally, open problems that still affect fog computing are identified and discussed in order to achieve enhanced QoS.

KEYWORDS

Cloud Computing, Edge Computing, Fog Computing, Internet of Things, Latency, Quality of Experience, Quality of Service, Quality of Service Aspects

INTRODUCTION

The Internet of Things (IoT) is defined as a vibrant worldwide data network composed of internet-connected objects such as radio-frequency identifiers, sensors, and actuators, as well as other devices and smart devices that are becoming an essential part of the Internet (Perera, Liu, Jayawardena, & Chen, 2014). The word IoT can be traced back to the early 1990s when Kelvin Ashton introduced it (S. Albishi, Soh, Ullah, & Algarni, 2017). Over the years, IoT has received considerable attention due to the capacity to interact and execute some tasks together or react to incidents without specific instructions (Perera, Zaslavsky, Christen, & Georgakopoulos, 2014). Intelligence, Connectivity, Dynamic Scale, Enormous Nature, Sensing, Heterogeneity, and Security are the key fundamental characteristics which drive IoT (Ericsson, 2011). The above-mentioned features have contributed considerably to the successful adoption plus the use of IoT in current information systems and applications, creating value and support for human operations (Perera, Liu, et al., 2014). Collected works demonstrate that IoT has been implemented in various fields, leading to the development of smart cities, intelligent energy, and electrical grids, intelligent homes, smart buildings and infrastructure, intelligent health just to mention a few (Saad et al., 2017). This “smart world” has changed the manner in which people

DOI: 10.4018/IJFC.2020010102

live and work by saving time and organizational resources whilst bringing new opportunities for knowledge formation, innovation, and development (Capossele, Cervo, Petrioli, & Spenza, 2016).

After the realization that the "things" that make up the IoT ecosystem have limited processing power and storage, cloud computing was introduced and integrated into IoT to provide scalable storage and processing services to meet IoT demands (Atlam, Walters, & Wills, 2018). In spite of cloud computing advantages in terms of storage and processing services, it still suffers mostly in providing low latency (Satria, Park, & Jo, 2017). This is because of its geographical location to the devices it wants to offer services. High latency compromise QoS which cause communication delays due to unstable and intermittent network connectivity. Explicitly, the unprecedented amount of data produced by IoT devices (Dastjerdi & Buyya, 2016) burden the network resulting in network transmission delays. Additionally, sending such huge data to and from the cloud requires exceptionally high network bandwidth (Atlam et al., 2018).

With the anticipated 50 billion intelligent interconnected device deployments serving various vertical markets by 2020, QoS is probable to be compromised which in turn affect time-sensitive functions which have been backed by cloud computing. As such, this has triggered a concerted effort to come with adaptive and decentralized computational paradigms that complement the centralized cloud computing model serving IoT networks. To fill this technological gap, new concepts and technologies have been developed to manage this growing fleet of IoT devices. Specifically, fog computing which was introduced by Cisco has gained much attention (Bonomi, Milito, Zhu, & Addepalli, 2012). OpenFog Consortium (the IEEE standard) defined fog computing as "a horizontal, system-level architecture that distributes computing, storage, control, and networking functions closer to the users along a cloud-to-thing continuum" (OpenFog Consortium Architecture Working Group, 2017). Fog computing architecture consists of fog (physical or virtual), residing between smart end-devices and centralized (cloud) services which facilitates minimization of the request-response time from-to supported applications, and provides, for the end-devices, local computing resources and, when needed, network connectivity to centralized services (Iorga, Martin, & Feldman, 2018). These are achieved through fog computing ability to support: i) Low latency and location awareness; ii) Extensive geographical dispersal; iii) Mobility; iv) Very large number of nodes, v) Predominant role of wireless access, vi) Strong presence of streaming and real-time applications, vii) Heterogeneity, thus supporting critical IoT services and applications to have improved QoS (Atlam et al., 2018).

Since its inception in 2012, fog computing has gained much attention in both academic and industrial space because of its advantages in supporting the Internet of Things technologies and providing improved QoS. Several surveys whose main topics cover fog computing key features(Vaquero & Rodero-Merino, 2014), platform and paradigm(Xu & Helal, 2014), architecture design (Simonet, Lebre, & Orgerie, 2016), security, and privacy (Osanaiye et al., 2017) has been done and in-depth. However, to the best of our knowledge, there are no existing related survey papers of fog computing whose main perspective is on QoS. The primary purpose of this study is, therefore, to review and critically evaluate current literature on the work that has been done to tackle difficulties and enhance QoS elements in fog computing. Conclusively, open researches areas and future re-scopes for QoS of fog computing will be underscored.

BACKGROUND

Providing satisfactory QoS is a fundamental goal in networking, cloud services or in general information systems. Depending on the perspective, QoS can have several definitions. From a networking perspective, QoS refers to any technology that manages data traffic to reduce packet loss, latency and jitter on the network (Cisco, 2014). In general information systems, Quality of Service is the capacity to prioritize distinct applications, customers or information flows or to ensure a certain level of information stream efficiency. In cloud computing, QoS is "non-functional properties of cloud services, which describe how well a service is performed, such as compliance, availability, reliability,

Related Content

Artefact Consistency Management in DevOps Practice: A Survey

Dulani Meedeniya, Iresha Rubasingheand Indika Perera (2020). *Tools and Techniques for Software Development in Large Organizations: Emerging Research and Opportunities (pp. 98-129).*