

IoT Cloud Framework

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Abstract

Internet of things is more than intelligent objects. It is new area which converts analog into digital world for better decisions makers and improving human being life. For this dream become reality, infrastructure behind is needed to support high demand of connected sensor network, to process and analyse data and them give back an answer with accuracy and precision for user in an acceptable time. Cloud computing address in a good shape Internet of Things needs. It reflects enthusiastic scenario of opportunities for new brands and revolutionary the industry.

The main proposal of this research is to evaluate the state of the art of Internet of Things cloud framework in order to support a better understanding which characteristics are important to build better IoT solutions on cloud. This work focused on three most popular IoT cloud providers(AWS, Azure and Google) as well re-evaluate the cloud services characteristics presented by Mushed [13] highlighting the new features and present benchmark results about performance for Google Core Internet of Things.

Keywords: IoT, cloud, internet of things, cloud computing

1. Introduction

Internet of things is one of the driving forces which generates data all the time from household appliances, cars, and other physical devices without requiring human-to-human or human-to-computer interactions.

The computer scientist Mark David Weiser created in 1988 ubiquitous computing term and vision, but in 1999 Market Ashton introduced Internet of Things(IoT) paradigm, which converted the ubiquitous computing concept in applicable by the embedded short range of sensors in the network-enabled objects or devices with Radio Frequency Identification(RFID) to integrate communication between people and devices [4]. IoT technology transforms all raw material in a pipeline of capturing, processing

and transform to make a decision with high precision to facilitate human in life simpler.

Based on Help net security portal [3] 41.6 billion IoT devices will be generating 79.4 zettabytes of data in 2025 from devices on the ground. The existence of marketing and assistance of IoT is inevitable. This scenario demands a particular infrastructure to play this critical role of making efficient and reliable supporting high demand to process data, in closer or real-time efficient communication to fit user and system feedbacks.

In the same direction, cloud technology provides parallel and distributed computing infrastructure environment which can be offered in different levels of services like platform as service(PaaS), Software as a Service(SaaS), infrastructure as a service(IaaS) [15] enabling the flexible and scalable environment with low financial cost to supply for different channels like web and mobile applications.

The development of IoT demands high efficient storage, high-speed and computing power, which cloud computing is an advantage and combines IoT needs [9], for collects, organizes data and information by using wireless sensor identification, then transmits it to the application layer if the cloud computing platform [16].

According to Mukesh among the current available Cloud IoT solutions in the market, there are three Cloud with the most notable services for IoT Computing [7, 13], based on market share at 2018 (Figure1).

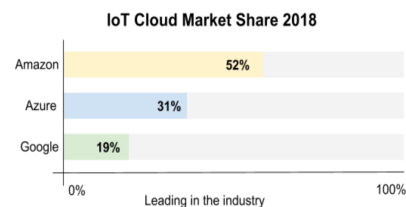


Figure 1. Cloud IoT market share in 2018.

This market share list address the following cloud providers: Amazon Web Services IoT, Azure IoT Hub e Google Cloud Core IoT.

Guth et al. [5] present open-source platforms and cloud for IoT like FIWARE, OpenMTC, SiteWhere, Webinos and proprietary solutions IBM’s Watson IoT Platform, Samsung’s SmartThings and Salesforce.

The structure of this article contemplates 4 sections. The next presents methods and procedures to presents the process to collect the data. Section 3 represents the related word represents the research finding and section 4 conclusion.

2. Methods and Procedures

The methodology apply a protocol based on systematic mapping of Peterson et al.(2015). It consist three steps: planning, conducting and present the results.

In order to support the planning step becomes important to defined research question(RQ) to support better conducting and final results, the following primary research questions (RQ1 and RQ2) and the secondary ones (a, b, c) for each RQ were defined:

RQ1) Questions to answer concerning IoT cloud characteristics between the three most popular cloud IoT :

- a) Which cloud services?
- b) Supported protocols?
- c) Process, analytic?

RQ2) Questions to answer about benchmark concerning specific for Google Cloud Core IoT:

- a) What are the important items to test in the benchmark for IoT?
- b) Performance

To discover the state of cloud IoT framework were elaborated a search string (Figure 2) to apply against a database with filters on IEEE explorer¹ and google scholar² database.

IEEE	
Articles	1.270
Search String	(cloud OR cloud computing) AND (internet of things OR iot) AND framework
Link	https://bit.ly/2luXzdn
Google Scholar	
Articles	651
Search String	"cloud" AND "internet of things" AND "framework"
Link	https://bit.ly/2MOJQdw

¹ <http://IEEExplore.ieee.org>

² <https://scholar.google.com.br>

2.1. Data Gathering and criteria

1. Research on search engine IEEE and Google scholar
2. Filter IEEE explore articles manually applying exclude rules provided by own engines, as cited below:
 - (a) Discarded articles before 2017
 - (b) Discarded articles out of scope for cloud IoT topic
3. Filter Google scholar articles manually applying exclude rule
 - (a) Discarded articles before 2017
 - (b) Discarded articles out of scope for cloud IoT
4. Import BibTeX from step 3 into StArt tool program1
5. Filter articles manually multiple from step 4 and 5
6. Result in 30 relevant articles for this research

Inclusion and Exclusion criteria: The Inclusion and exclusion criteria is to ensure only relevant works aligned objective of this article will be selected and in parallel to facilitate the filtering process. The follow inclusion criteria(IC) enabled the section of appropriated works:

- IC1: The result must be in the defined languages;
- IC2: The result must be available in full and be available free of charge;
- IC3: The result must contain in the title, keywords, or in the abstract some relation with the theme of this work; The result will be from the area of engineering or computer science;
- IC4: Works that address cloud issues for IoT in a general way.

The follow exclusion criteria(EC) enabled the section of appropriated works:

- EC1: The result is not related to the work theme
- EC2: Articles with languages other than English and Portuguese In the case of similar or duplicate studies, only the most recent was considered.
- EC3: Works that address cloud issues for IoT in a general way.

3. Related Work

The major cloud provides specialized services for data collection from IoT devices, support popular protocols like Message Queue Telemetry Transport(MQTT), Advanced Message Queuing Protocol (AMQP), CUPUS pub/sub, Extensible Messaging and Presence Protocol (XMPP), Representational State Transfer (REST) over Hypertext Transfer Protocol (HTTP). However applications for industrial area

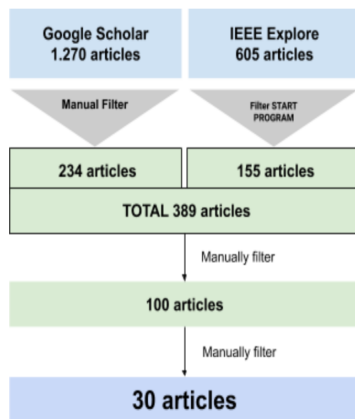


Figure 2. Step by step to filter articles

works around close to real-time, cases like industrial machines are controlled by applications running in the cloud or use the cloud as a central instance for data exchange. By another hand, Daniel Happ et al. [8] describes the limitations of publishing and subscribe architecture for constrained devices, high latency, low-bandwidth, unreliable links used in protocols MQTT, AMQP. The first drawback is a side-effect of the decoupling properties and space. In pub/sub systems, the subscriber does not know if there are any publishers publishing on a given topic, how many of them there might be or who the publisher of a given message might be. Likewise, the publisher does not know if there are any subscribers actually interested in messages on a certain topic.

The platforms come in various shapes and sizes and there are not standard for IoT [17], although the effort to become homogeneous exists [17]. At some level, most of all platform landscape allows: to connecting different devices, accessing and processing their data and using the knowledge gained through this ecosystem to create automated control [5]. The particularity of the platforms are competitive because they are differential between them, however, it places a heavy burden on the user who will choose which tool to start their application, demanding as a result of well-defined and clear documentation to get the answer immediately. The most platforms and architecture found about cloud IoT does not provide an easy way to compare in high granularity, but Gut et al. [10] extends this work by a refinement of the description, the extension of the analysis to eight IoT platforms, and a more extensive survey on related work.

Quality of Service (QoS) in the Internet of Things is an important topic because there are multiple IoT applications type and behaviors and in the same range there are different expectations of quality of services, describing them in a more comprehensive manner. Manish et al. [6] mention in three pillars: QoS param for Things, communica-

tion network in IoT ecosystem responsible for transporting in real-time data and computing. The first pillar things there is item mentioned security, which Google Cloud IoT core is addressed. The strong advantage of secure credentials, like proper device registration, identity authorizations. According to Amir Google Core IoT provides reliable and secure ingestion, connection and management of data from an incredible diversity of resource [1, 2].

Metrics provides parameters to track and measuring fundamental results. In this way, IBM, Microsoft, Oracle examining the performance of their products for storing, repairing and analyzing [11, 12, 14]. Benchmarking is another related domain with industry-standard created by groups like SPEC³ and TPC⁴. We could find a benchmark for social graph, cloud services, but there is not a consolidated guide for benchmarking applications for the Internet of things. On the other hand, Martin et al [10] introduced IoTAbench to address this gap of standard for evaluating a big data analytic platforms for IoT.

4. Conclusions

internet of things is gaining increasing attention, turning from vision into reality and showing booming trend by transforming analog data into digital. In the same direction IoT Cloud platform offer scalable, flexible and low cost infrastructure to simplify the "Things" pipeline of capture raw data from sensor, send to cloud to process and analysis for better decision-maker. In order to understand the current scenario of cloud IoT framework the some initial question was made characteristics and benchmark

RQ1) Questions to answer concerning IoT cloud characteristics between the three most popular cloud IoT:

- a) Which cloud services?
- b) Supported protocols?
- c) Process, analytic?

The result of this research presented clearly 3 AWS, Azure and Google as the most popular proprietary cloud based on market share, confirmed Mushed [13] research published in 2018. The leader in market keeps Amazon Service Web and Forbes predicts by 2020 this scenario is still the same. The table⁵ which compare cloud services, protocols, pricing, analytics Google Core IoT enhanced (SDK, support protocols, services and security/Authentication).

RQ2) Questions to answer about benchmark concerning specific for Google Cloud Core IoT:

³ <https://www.spec.org>

⁴ <http://www.tpc.org>

⁵ <https://bit.ly/2IOqVTY>

- a) What are the important items to test in the benchmark for IoT?
- b) Performance

Although many studies on cloud benchmarking in general exist, we could find a research which address clearly standard of metrics for IoT Cloud Framework, but Manush et al. [16] studies in Quality of Service(QoS) area divided the metrics for IoT in three categories:

In this research Google Core IoT is referenced as stronger in IoT Cloud Platform for metrics security in category Things, because of the full-stack security for providing reliable and secure ingestion, connection and management of data from in a heterogeneous range of devices.

In the same direction, IoTABench is toolset fix the gap in terms of computing and communication categories in QoS, but it's not fully operation on production. On the other hand, there are several benchmark framework not specialized for Iot, but valid to test Cloud Platform in general, like PerfKitBenchmark, PerfKitExplorer, Geekbench, UnixBench, Sysbench(cpu), Stream, SPEC CPU2006 Integer, Stream, MAIH, AWSI.

Benchmark: Test performance was executed using the framework PerfKitBenchmark on Google Core IoT the result is present in figure . Cluster created in region europe zone west1. Simulated calls on GCP Engine from PerfKitBenchmark and the second benchmark was device sending data connected in service Core pub/sub.

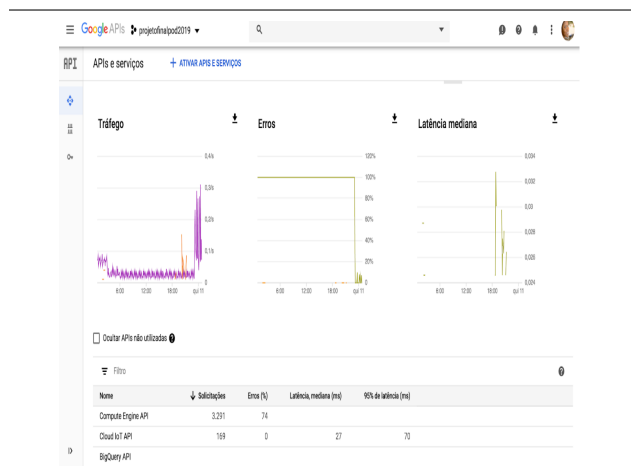


Figure 3. Google Cloud Core IoT

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