A SURVEY ON EDGE COMPUTING FOR IOT AND EDGE ACCELERATED WEB PLATFORM

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Abstract

Cloud has been a significant trend in the past decade. However, as the explosion of connected lightweight devices starts the era of the Internet-of-Things (IoT), cloud computing is facing increasing difficulty to meet the data computing and intelligent service demands of IoT devices and applications. Moving the data computation and service supply from the cloud to the more closer source of data, called Edge enables the possibility of meeting application delay requirements, improves the scalability and energy efficiency of lightweight IoT devices, provides contextual information processing, and mitigates the traffic burdens of the backbone network. An efficient frame work and operating system for Edge computing can make the services better. Edge does not replace cloud, it simply complements the cloud. As an example in 2014 "edge accelerated Web platform (EAWP)" was developed; it enables Web applications to run on edge severs. EAWP is a Web application execution framework that takes full advantage of the features of the edge computing. Edge-centric Computing is a novel paradigm that moves the locus of control of Cloud Computing applications and services to the edges of the network.

Index Terms: Edge accelerated Web platform (EAWP),Edge Computing, Fog Computing, Internet of Things(IoT)

I. INTRODUCTION

A study by IDC estimated that by 2020 10% of the world's data will be produced by edge devices. This will further drive the need for more efficient fog computing technologies that provide low latency and holistic intelligence simultaneously. "Computing at the edge of the network is, of course, not new — we've been doing it for years to solve the same issue with other kinds of computing." Many in industry use the terms fog computing and edge computing (or edge processing) interchangeably. Fog computing, a concept introduced by CISCO in 2012, is an extension of cloud computing paradigm from the core to the edge of the network. It enables computing at the edge of the network, closer to IoT and/or the end-user devices [1].

Both fog computing and edge computing involve pushing intelligence and processing capabilities down closer to where the data originates from pumps, motors, sensors, relays, etc. The key difference between the two architectures is exactly where that intelligence and computing power is placed:

- Fog computing pushes intelligence down to the local area network level of network architecture, processing data in a fog node or IoT gateway.
- Edge computing pushes the intelligence, processing power and communication capabilities of an edge gateway or appliance directly into devices like programmable automation controllers (PACs) [2].

A. The problem with the cloud

As the internet of things proliferates, businesses face a growing need to analyze data from sources at the edge of a network, whether they are mobile phones, gateways or IoT sensors. Cloud computing has a disadvantage here: It can't process data quickly enough for modern business applications.

IoT owes its explosive growth to the connection of physical things and operational technologies to analytics and machine learning applications, which can help glean insights from device-generated data and enable devices to make "smart" decisions without human intervention. Currently, such resources are mostly being provided by cloud service providers, where the computation and storage capacity exists.

However, despite its power, the cloud model is not applicable to environments where operations are time-critical or internet connectivity is poor. This is especially true in scenarios such as telemedicine and patient care, where milliseconds can have fatal consequences. The same can be said about vehicle-to-vehicle communications, where the prevention of collisions and accidents can't afford the latency caused by the roundtrip to the cloud server.

"The cloud paradigm is like having your brain command your limbs from miles away — it won't help you where you need quick reflexes."

Moreover, having every device connected to the cloud and sending raw data over the internet can have privacy, security and legal implications, especially when dealing with sensitive data that is subject to separate regulations in different countries.

IoT nodes are closer to the action, but for the moment they do not have the computing and storage resources to perform analytics and machine learning tasks. Cloud servers, on the other hand, have the horsepower, but are too far away to process data and respond in time.

The fog/edge layer is the perfect junction where there are enough compute, storage and networking resources to mimic cloud capabilities at the edge and support the local ingestion of data and the quick turnaround of results.

B. The Openfog consortium and Edgex foundry

The OpenFog Consortium was founded on the premise based on open architectures and standards that are essential for the success of a ubiquitous fog computing ecosystem. The collaboration among tech giants such as ARM, Cisco, Dell, GE, Intel, Microsoft and Schneider Electric defining an open, interoperable fog computing architecture was without any doubt good news for a vibrant supplier ecosystem.

EdgeX Foundry is a vendor-neutral open source project hosted by the Linux Foundation building a common open framework for IoT edge computing. At the heart of the project is an interoperability framework hosted within a full hardware- and OS-agnostic reference software platform to enable an ecosystem of plug-and-play components that unifies the marketplace and accelerates the deployment of IoT solutions[3]

II. ARCHITECTURE FOR EDGE COMPUTING

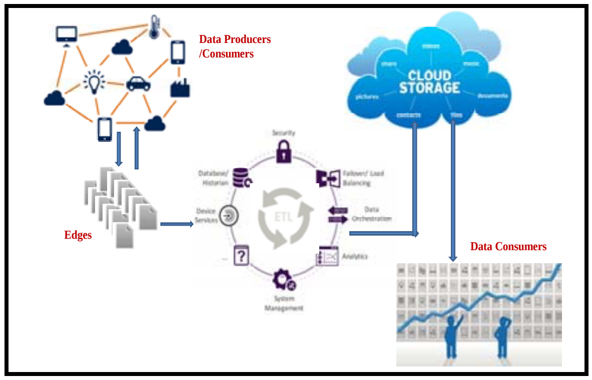

Fig 1: Architecture of Edge Computing and IoT Devices

The architecture in fig 1 shows the architecture of Edge Computing and IoT devices and that the data producers can also be data consumers for which edge computing is the best solution as sometimes the data may not be needed to be uploaded or processed on cloud. Edges are closer to the data producers thus making an efficient transfer of data. Edges can handle storage and data processing as well.

III. BENEFITS OF FOG/EDGE COMPUTING

A. Frees up network capacity

Fog computing uses much less bandwidth, which means it doesn't cause bottlenecks and other similar occupancies. Less data movement on the network frees up network capacity, which then can be used for other things.

B. *It is truly real time*

Fog computing has much higher expedience than any other cloud computing architecture we know today. Since all data analysis is being done at the spot, it represents a true real-time concept, which means it is a perfect match for the needs of internet of things concepts.

C. *Boosts data security*

Collected data is more secure when it doesn't travel. It also makes data storing much simpler because it stays in its country of origin. Sending data abroad might violate certain laws.

IV. DISADVANTAGES OF FOG/EDGE COMPUTING

A. Analytics is done locally

The fog computing concept enables developers to access the most important IoT data from other locations, but it still keeps piles of less important information in local storages.

B. Some companies don't like their data being out of their premise

With fog computing, lots of data is stored on the devices themselves (which are often located outside of company offices), this is perceived as a risk by parts of some developers' communities.

C. *Whole system sounds a little bit confusing*

Concept that includes huge numbers of devices that store, analyze and send their own data and are located all around the world sounds utterly confusing.

V. EDGE ACCELERATED WEB PLATFORM

Nippon Telegraph and Telephone revealed the "Edge computing" concept which can reduce the cloud application response time by factor of 100 at most, and demonstrated its first research outcome, the "Edge accelerated Web platform" prototype. The research and development effort leading up to the announcement has been carried out as a part of the company's strategic plan, "Accelerating Innovation and Collaboration for the Next Stage", and is expected to open up a new era of applications for "Smart Life and Smart Work". Although cloud services and their use by devices such as smart phones has become quite the norm today, they are increasingly and inevitably facing the problems of poor scalability and slow response time due to their dependence on sole remote servers that may be located far away, possibly across an ocean and on the other side of the planet. Because of the finite speed of light, it takes several hundred milliseconds to interact over the Pacific Ocean, for example. These problems hinder the most promising applications to be widely deployed, such as intelligent transport control systems (ITS) and games that necessitate real-time response time, and the M2M services that will impose huge data traffic loads on the data center.

The edge computing platform solves the problems by the simple idea of locating small servers called edges servers in the vicinity of the users and devices and passing to the servers some of the load of center servers and/or user's devices.

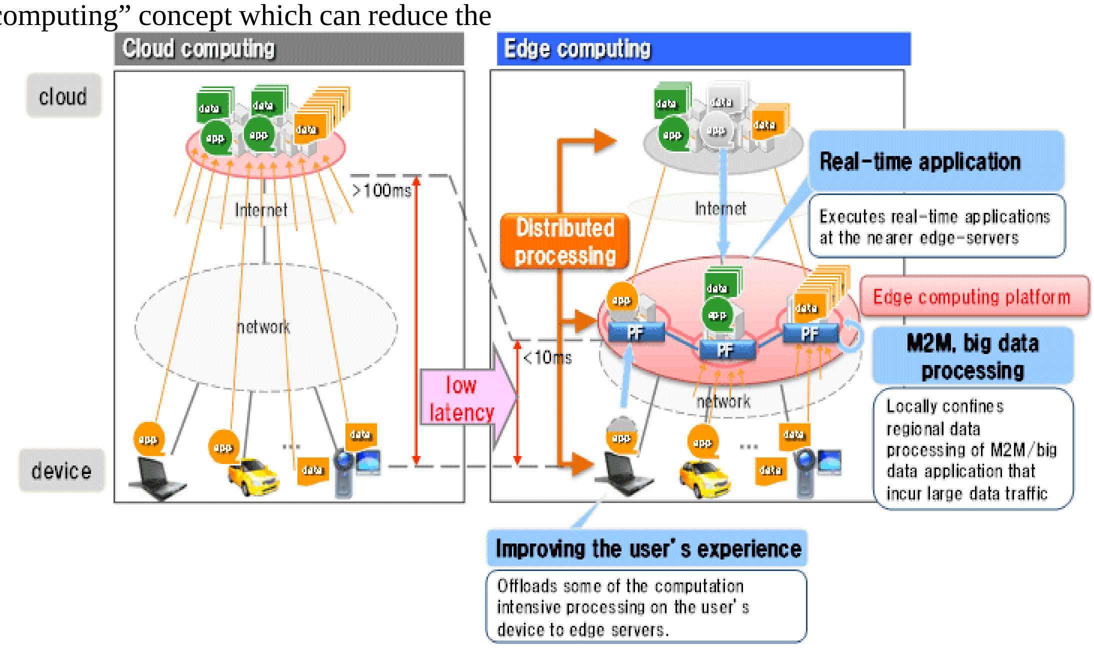

Fig 2. Edge computing platform

Fig 2 demonstrate Edge Computing Platform that executes real-time applications that require high-speed response at the nearer edge-servers which will satisfy the severe real-time requirement. The communication delay is shortened to a few milliseconds, not a several hundred milliseconds. Locally confines regional data processing of M2M/big data applications that incur large data traffic to edge-servers, and reduces network bandwidth. Offloads some of the computation intensive processing on the user's device to edge servers and makes application processing less dependent on the device's capability. It is possible to run applications faster and improve the user's experience.

As a result, the edge computing platform makes it possible to implement new and attractive applications that require real-time responses along with regional M2M/big data transactions.

As the first instance that realizes the edge computing concept, "edge accelerated Web platform (EAWP)" is developed; it enables Web applications to run on edge severs.

Fig 3. Edge accelerated Web platform (EAWP)

EAWP is a Web application execution framework that takes full advantage of the features of the edge computing. This platform relieves the user's device from having to process the entire Web application by distributing processing loads to the edge server close to the users and devices. In consideration of the background that Web applications and their developers are rapidly increasing, development of this platform allows Edge computing developers to use HTML standards to develop high performance applications.

The following are the key features of EAWP (Fig 3).

- The loads of heavy web application processes such as Web content evaluation and rendering are split and distributed among edge-servers and the user's device. This distribution yields high-speed Web applications whose performance is made less dependent on the capability of the user's device.
- The distribution method and data transfer method are optimized according to the user's environment, such as device capability and the networking environment, such as fixed or mobile. For example, the processing of objects, such as images and sounds, are dynamically allocated to devices or edge-servers to suit the user's environment, and resolution and frame rate are controlled to suit the networking environment [4].

Standard web browsers downloads a web page in 7:15 seconds whereas NTT web browsers downloads within 3.24 seconds. This shows that Edge devices provides more processing speed that cloud services.

Though not used Iot sensors and other devices in the above example of web platform, proves that Edge Computing provides efficiency and scalability and it compliments cloud. The scalability of IoT applications refers to the ability to add new devices, services and functions for customers without negatively affecting the quality of existing services [5].

VI. THE FUTURE OF FOG/EDGE COMPUTING

The current trend shows that fog computing will continue to grow in usage and importance as the internet of things expands and conquers new grounds. With inexpensive, low-power processing and storage becoming more available, we can expect computation to move even closer to the edge and become ingrained in the same devices that are generating the data, creating even greater possibilities for inter-device intelligence and interactions. Sensors that only log data might one day become a thing of the past.

Fog/edge computing will be the next big thing in the internet of things — at least in the next couple of years. It seems obvious that while cloud is a perfect match for the internet of things, we have other scenarios and IoT technologies that demand low-latency ingestion and immediate processing of data where fog computing is the answer.

Fog/edge computing improves efficiency and reduces the amount of data that needs to be sent to the cloud for processing. But it's here to complement the cloud, not replace it.

The cloud will continue to have a pertinent role in the IoT cycle. In fact, with fog computing shouldering the burden of short-term analytics at the edge, cloud resources will be freed to take on the heavier tasks, especially where the analysis of historical data and large datasets is concerned. Insights obtained by the cloud can help update and tweak policies and functionality at the fog layer. *"It is the combination of fog and cloud computing that will accelerate the adoption of IoT, especially for the enterprise."*

VII. CONCLUSION

No matter what industry you're in, the Internet of Things (IoT) is top of mind today. Just a cursory look at the numbers shows that IoT will be big. By 2019, Business Insider forecasts that the internet will connect 35 billion "things" – and most will be objects formerly not connected, such as thermostats, watches, vending machines, cars, robots, servers and heavy machinery[6]. By 2020, over 40,000 exabytes of machine-generated data will be generated through sensors built into physical objects connected to the internet [7]. That's over 90 percent of the data being generated today around the world[8]

Hence I conclude here , that using edge devices along with cloud would definitely improve the over all efficiency of IoT devices and Clouds which are actually overloaded, just like the NNT web browser which proved to be faster than a normal browser.

REFERENCES

[1] https://www.cisco.com/c/dam/en_us/solutions/trends/iot/docs/computing-overview.pdf

[2] https://www.automationworld.com/fog-computing-vs-edge-computing-whats-difference

[3] https://www.edgexfoundry.org/

[4] http://www.ntt.co.jp/news2014/1401e/140123a.html

[5] IoT Data Analytics Report 2016 Report Excerpts Based on the Information on 47 IOT Analytics Technologies and Services, Ideya/Camrosh Market Report First Edition, May 2016

[6] Big Data Analytics and the Internet of Things Exploring Enabling Technologies and Industry Opportunities.

[7] http://uk.businessinsider.com/internet-of-everything-2015-bi-2014-12

[8] http://www.sciencedaily.com/releases/2013/05/130522085217.html