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INCORPORATION OF EDGE COMPUTING THROUGH CLOUD COMPUTING TECHNOLOGY

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ABSTRACT: Cloud computing — by which remote servers hosted on the Internet store and process data, rather than local servers or personal computers — is ready to move to the next level i.e. 'Edge Computing'. Edge computing enables data to be analysed, processed and transferred at the edge of a network. The idea is to analyse data locally, closer to where it is stored, in real-time without latency, rather than send it far away to a centralised data centre. The basic difference between edge computing and cloud computing lies in the place where the data processing takes place. At the moment, the existing Internet of Things (IoT) systems performs all of their computations in the cloud using data centres. Experts believe the true potential of edge computing will become apparent when 5G networks go main stream in a year from now. Users will be able to enjoy consistent connectivity without even realizing it. Several edge computing technologies originating from different backgrounds to decrease latency, improve SE, and support the massive machine type of communication have been emerging. This paper comprehensively presents a tutorial on three typical edge computing technologies, namely mobile edge computing, cloudlets, and fog computing. From the viewpoint of radio access network, the differences between mobile edge computing and fog computing are highlighted, and the characteristics of fog computing-based radio access network are discussed. Finally, open issues and future research directions are identified as well.

KEYWORD: Mobile edge computing, Cloudlets, Internet of Things (IoT)

1. INTRODUCTION

Edge Computing is a distributed computing paradigm in which processing and computation are performed mainly on classified device nodes known as smart devices or edge devices as opposed to processed in a centralized cloud environment or data centers.

It helps to provide server resources, data analysis, and artificial intelligence to data collection sources and cyber-physical sources like smart sensors and actuators.

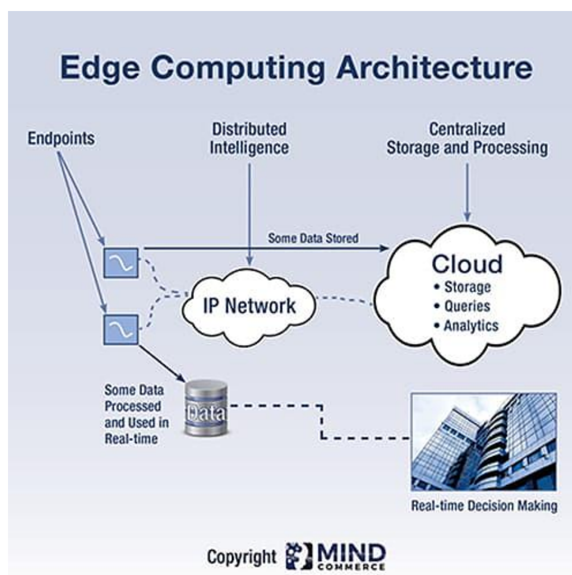

Fig 1: Edge Computing Architecture

- A network of micro data centers that store or process critical data locally and push received data to a centralized data center or repository of cloud storage.
- Typically in IoT use cases, a massive chunk of data goes through the data center, but edge computing processes the data locally results in reduced traffic in the central repository.
- This is done by IoT devices, transferring the data to the local device, which includes storage, compute, and network connectivity.
- After that, data is processed at the edge while another portion is sent to storage repository or central processing in the data center.

Edge computing is a "mesh network of micro data centers that process or store critical data locally and push all received data to a central data center or cloud storage repository, in a footprint of less than 100 square feet," according to research firm IDC.

Edge computing is a method of optimizing cloud computing systems by performing data processing at the edge of the network, near the source of the data. This reduces the communications bandwidth needed between sensors and the central datacenter by performing analytics and knowledge generation at or near the source of the data. This approach requires leveraging resources that may not be continuously connected to a network such as laptops, smartphones, tablets and sensors.

Edge computing covers a wide range of technologies including wireless sensor networks, mobile data acquisition, mobile signature analysis, cooperative distributed peer-to-peer ad hoc networking and processing also classifiable as local cloud/fog computing and grid/mesh computing, dew computing, mobile edge computing, cloudlet, distributed data storage and retrieval, autonomic self-healing networks, remote cloud services, augmented reality, and more.

Edge computing pushes applications, data and computing power (services) away from centralized points to the logical extremes of a network. Edge computing replicates fragments of information across distributed networks of web servers, which may spread over a vast area. As a technological paradigm, edge computing is also referred to as mesh computing, peer-to-peer computing, autonomic (self-healing) computing, grid computing, and by other names implying non-centralized, nodeless availability.

To ensure acceptable performance of widely dispersed distributed services, large organizations typically implement edge computing by deploying Web server farms with clustering. Previously available only to very large corporate and government organizations, edge computing has utilized technology advances and cost reductions for large-scale implementations have made the technology available to small and medium-sized businesses.

The target end-user is any Internet client making use of commercial Internet application services.Edge computing imposes certain limitations on the choices of technology platforms, applications or services, all of which need to be specifically developed or configured for edge computing.

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2. LITERATURE SURVEY

Internet of Things (IoT) was first introduced to the community in 1999 for supply chain management, and then the concept of "making a computer sense information without the aid of human intervention" was widely adapted to other fields such as healthcare, home, environment, and transports. Now with IoT, we will arrive in the post-cloud era, where there will be a large quality of data generated by things that are immersed in our daily life, and a lot of applications will also be deployed at the edge to consume these data. By 2019, data produced by people, machines, and things will reach 500 zettabytes, as estimated by Cisco Global Cloud Index, however, the global data center IP traffic will only reach 10.4 zettabytes by that time. By 2019, 45% of IoT-created data will be stored, processed, analyzed, and acted upon close to, or at the edge of, the network. There willbe 50 billion things connected to the Internet by 2020, as predicted by Cisco Internet Business Solutions Group. Some IoT applications might require very short response time, some might involve private data, and some might produce a large quantity of data which could be a heavy load for networks. Cloud computing is not efficient enough to support these applications. With the push from cloud services and pull from IoT, we envision that the edge of the network is changing from data consumer to data producer as well as data consumer. In this paper, we attempt to contribute the concept of edge computing. We start from the analysis of why we need edge computing, then we give our definition and vision of edge computing.

According to IDC (data announced in its November 1, 2017, worldwide IoT forecasts webcast) by 2020, the IT spend on edge infrastructure will reach up to 18% of the total spend on IoT infrastructure. That spend is driven by the deployment of converged IT and OT systems which reduces the time to value of data collected from their connected devices IDC adds. It's what we explained and illustrated in a nutshell.

According to a November 1, 2017, announcement regarding research of the edge computing market across hardware, platforms, solutions and applications (smart city, augmented reality, analytics etc.) the global edge computing market is expected to reach USD 6.72 billion by 2022 at a compound annual growth rate of a whopping 35.4 percent.

The major trends responsible for the growth of the market in North America are all too familiar: a growing number of devices and dependency on IoT devices, the need for faster processing, the increase in cloud adoption, and the increase in pressure on networks.

In an October 2018 blog post, Gartner's Rob van der Meulen said that currently, around 10% of enterprise-generated data is created and processed outside a traditional centralized data center or cloud. By 2022, Gartner predicts this figure will reach 50 percent.

Gartner's definition of edge computing: "Gartner defines edge computing as solutions that facilitate data processing at or near the source of data generation. For example, in the context of the Internet of Things (IoT), the sources of data generation are usually things with sensors or embedded devices. Edge computing serves as the decentralized extension of the campus networks, cellular networks, data center networks or the cloud."

3. METHODOLOGIES

CLOUDLET

Cloudlet, initiated by Carnegie Mellon University, is envisioned as small clusters with certain computation and storage capabilities deployed near the mobile devices such as buildings and shopping centers for assisted processing, offloading, caching, etc. Cloudlet usually utilizes virtualization management technologies to better support mobile applications. And an important target of cloudlet is to bring the cloud advances to mobile users, achieving more low-latency and resourceful processing. Micro data centers (MDCs) , initiated by Microsoft that are similar to the concept of cloudlet, are a small-scaled version of data centers to extend the hyperspace cloud data centers.

MOBILE EDGE COMPUTING

The paradigm of mobile edge computing was first standardized by European Telecommunications Standards Institute (ETSI), which aims to provide sufficient computing capacities within the radio access network (RAN). Since base stations are the important access gate for numerous IoT devices, mobile edge computing could provide direct service to the end devices through only one hop, bringing great convenience for IoT data processing.

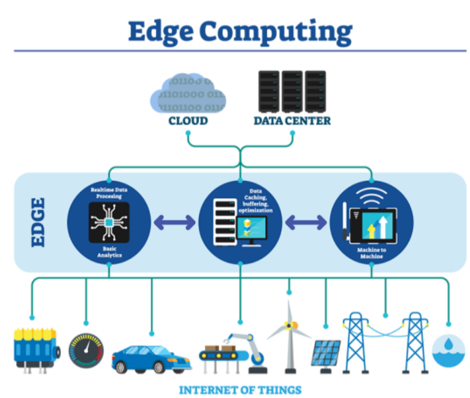

Fig.2: Working of Edge Computing

LOW LATENCY

Since edge devices are placed closer to end devices, which are usually both the data source and the transmission target of processing results, the transmission latency can be largely reduced compared to the cloud computing scenario.

ENERGY SAVING

Restricted by the size and usage scenarios, IoT devices usually have quite limited energy supply, but they are also expected to perform very complex tasks that are usually power consuming. It is challenging to design a cost-efficient solution to well power the numerous distributed IoT devices given that frequent battery charging/discharging is impractical in not possible.

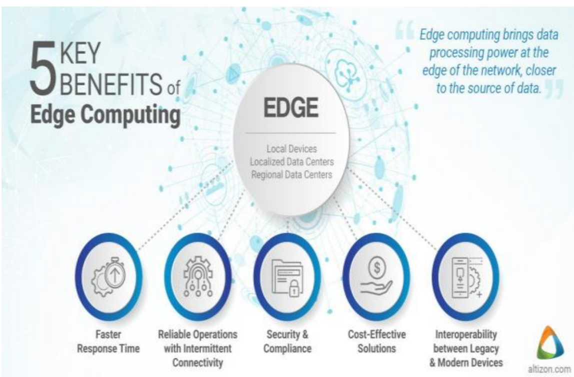

Fig.3: Benefits Of Edge Computing

Benefits of Enabling Edge Computing

- Lesser Network Load
- Zero Latency
- Reduced Data Exposure
- Computational Efficient
- Costs and Autonomous Operation
- Security and Privacy

D-ReP ALGORITHM.

1: for all {k ∈ K} do

2: for all {n ∈ N | (n, k) < KRLh} do

3: if num_requestsknh · latencynh · λ

> unit_pricen · epoch then

4: O ← O ∪ {duplicate k to n}

5: break

6: end if

7: if (num_reqsknh −

Í

i∈N

i,n

num_reqskih) · latencynh · λ

> (unit_pricen − unit_priceh) · epoch then

8: O ← O ∪ {migrate k to n}

9: break

10: end if

11: else

12: if Í

i∈N num_requestskih

< original_num_requestsh ∗ f ade_rate

then

13: O ← O ∪ {remove k}

14: end if

15: end for

16: end for

Advantages of Enabling Edge Computing

- Speed is increased.
- Reliability is increased.
- The random issue is reduced.
- The compliance issue is reduced.
- Hacking issues are reduced.
- Random issues are reduced.

7. CONCLUSION

Nowadays, more and more services are pushed from the cloud to the edge of the network because processing data at the edge can ensure shorter response time and better reliability. Moreover, bandwidth could also be saved if a larger portion of data could be handled at the edge rather than uploaded to the cloud. The burgeoning of IoT and the universalized mobile devices changed the role of edge in the computing paradigm from data consumer to data producer/consumer. In this work, we tackle the problem of latency-aware and cost-efficient placement of data replicas at the edge of the network based on magnitude and location of user demand as well as storage pricing in attempt to reduce data access latency. We present fully decentralized dynamic replica placement algorithm, D-ReP that is based on FLP and requires only local topology information. The algorithm is complemented with a replica discovery method where concerned nodes are notified of nearby replicas.

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