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Edge Computing:Vision and Challenges

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Abstract

The proliferation of Internet of Things and the success of rich cloud services have pushed the horizon of a new computing paradigm, Edge computing, which calls for processing the data at the edge of the network. Edge computing refers to a process where the open platform that converges the core capabilities of networks, computing, storage, and applications provides intelligent services at the network edge near the source of the objects or data to meet the critical requirements for agile connection, real-time services, data optimization, application intelligence, security and privacy protection of industry digitization.Edge computing has the potential to address the concerns of response time requirement, battery life constraint, bandwidth cost saving, as well as data safety and privacy. In this paper, we introduce the definition of Edge computing, followed by several case studies, ranging from cloud offloading to smart home and city, as well as collaborative Edge to materialize the concept of Edge computing. Finally, we present several challenges and opportunities in the field of Edge computing, and hope this paper will gain attention from the community and inspire more research in this direction.

Index Terms*—Edge computing, Internet of Things (IoT), smart, home and city*

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1.Introduction

Edge computing allows data produced by internet of things (IoT) devices to be processed closer to where it is created instead of sending it across long routes to data centers or clouds. Doing this computing closer to the edge of the network lets organizations analyze important data in near real-time – a need of organizations across many industries, including manufacturing, health care, telecommunications and finance."In most scenarios, the presumption that everything will be in the cloud with a strong and stable fat pipe between the cloud and the edge device – that's just not realistic," says Helder Antunes, senior director of corporate strategic innovation at Cisco. 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.

It is typically referred to in IoT use cases, where edge devices would collect data – sometimes massive amounts of it – and send it all to a data center or cloud for processing. Edge computing triages the data locally so some of it is processed locally, reducing the backhaul traffic to the central repository.

Typically, this is done by the IoT devices transferring the data to a local device that includes compute, storage and network connectivity in a small form factor. Data is processed at the edge, and all or a portion of it is sent to the central processing or storage repository in a corporate data center, co-location facility or IaaS cloud.

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. Several case studies like cloud offloading, smart home and city as well as collaborative edge are introduced to further explain edge computing in a detailed manner, followed by some challenges and opportunities in programmability, naming, data abstraction, service management, privacy and security, as well as optimization metrics that are worth future research and study.

2.What is Edge Computing?

Data is increasingly produced at the edge of the network, therefore, it would be more efficient to also process the data at the edge of the network. Edge computing is the practice of processing data near the edge of your network, where the data is being generated, instead of in a centralised data-processing warehouse. Edge computing is a distributed, open IT architecture that features decentralised processing power, enabling mobile computing and Internet Of Things technologies. In edge computing, data is processed by the device itself or by a local computer or server, rather than being transmitted to a data centre.

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3.Why does Edge computing matter?

Edge computing deployments are ideal in a variety of circumstances. One is when IoT devices have poor connectivity and it’s not efficient for IoT devices to be constantly connected to a central cloud.

Other use cases have to do with latency-sensitive processing of information. Edge computing reduces latency because data does not have to traverse over a network to a data center or cloud for processing. This is ideal for situations where latencies of milliseconds can be untenable, such as in financial services or manufacturing.

Here’s an example of an edge computing deployment: An oil rig in the ocean that has thousands of sensors producing large amounts of data, most of which could be inconsequential; perhaps it is data that confirms systems are working properly.

That data doesn’t necessarily need to be sent over a network as soon as its produced, so instead the local edge computing system compiles the data and sends daily reports to a central data center or cloud for long-term storage. By only sending important data over the network, the edge computing system reduces the data traversing the network.

Another use case for edge computing has been the build out of next-gen 5G cellular networks by telecommunication companies. Kelly Quinn, research manager at IDC who studies edge computing, predicts that as telecom providers build 5G into their wireless networks they will increasingly add micro-data centers that are either integrated into or located adjacent to 5G towers. Business customers would be able to own or rent

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space in these micro-data centers to do edge computing, then have direct access to a gateway into the telecom provider's broader network, which could connect to a public IaaS cloud provider.

4.Edge Computing Benefits

In edge computing we want to put the computing at the proximity of data sources. This have several benefits compared to traditional cloud-based computing paradigm. Here we use several early results from the community to demonstrate the potential benefits. Researchers built a proof-of-concept platform to run face recognition application in , and the response time is reduced from 900 to 169 ms by moving computation from cloud to the edge. Ha et al. used cloudlets to offload computing tasks for wearable cognitive assistance,and the result shows that the improvement of response time is between 80 and 200ms. Moreover, the energy consumption could also be reduced by 30%–40% by cloudlet offloading. clonecloud in combine partitioning, migration with merging, and on-demand instantiation of partitioning between mobile and the cloud, and their prototype could reduce 20×running time and energy for tested applications.

5.Applications Of Edge Computing

5.1-Grid Edge Control and Analytics

Smart Grids, as we now know them, essentially work by establishing two-way communication channels between power distribution infrastructure, the recipient consumers (residential households, commercial buildings, etc.) and the utility head-end. This is done by using the tried and proven wide-area network (WAN) internet protocols.

The incredible growth-rate the internet of things is experiencing has steadily poured over into the industrial side (IIoT), bringing with it numerous technologies that can seamlessly monitor, manage and control the various functions within the electric grid's distribution infrastructure.

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5.2-Oil and Gas Remote Monitoring

Real-time Safety monitoring is of the utmost importance for critical infrastructure and utilities like oil and gas. With this safety and reliability in mind, many cutting edge IoT monitoring devices are still being developed in order to safeguard critical machinery and systems against disaster.

Modern advanced machinery uses Internet of Things sensory devices for temperature, humidity, pressure, sound, moisture and radiation. Together with the broad vision capabilities of internet protocol enabled cameras (IP cameras) and other technologies, this produces an enormous and continuous amount of data that is then combined and analyzed to provide key insights that can reliably evaluate the health of any running system.

Computing resources at the edge allow data to be analyzed, processed and delivered to end-users in real-time. Enabling control centers with access to the data as it occurs, foreseeing and preventing malfunctions in the most optimized timely manner.

This is the most practical solution, as time is of the essence in these critical systems. This rings most true when dealing with critical infrastructure such as oil, gas and other energy services, any failures within certain tend to be catastrophic in nature and should always be maintained with utmost precaution and safety procedures.

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5.3-Edge Video Orchestration

Edge video orchestration uses edge computing resources to implement a highly optimized delivery method for the widely used yet bandwidth-heavy resource– video. Instead of delivering video from a centralized core network through all the network hops, it intelligently orchestrates, caches and distributes video files as close to the the device as possible. Think o fit as a highly efficient and specialized instance of a content download network (CDN) just for video, right at the edge for end-users.

MEC-powered video orchestration is most useful for large public venues. Sports stadiums, Concerts and other localized events rely heavily on live video streaming and analytics to create and increase revenue streams.

Freshly created video clips and live streams can quickly be served to paying customers in venues through rich media processing applications running on mobile edge servers and hotspots. This lowers the service costs and avoids many quality issues arising from bottleneck situations with terabytes of heavy video traffic hitting the mobile networks.

This is something 5G edge computing is designed to solve in the coming years. Currently, network operator EE is investigating the potential for these types of services in collaboration with Wembley Stadium, the national soccer stadium of the UK.

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5.4-Traffic Management

Due to the computationally expensive complexities of traffic management efficiency (Read: Traveling salesman problem), one of the best ways to optimize traffic management systems is by improving real-time data. Intelligent transportation systems make extensive use of edge computing technologies, especially for traffic management processes.

The influx of IoT devices and massive amounts of live data necessitate preprocessing and filtering closer to the devices, before these thousands of data streams can hit the core/cloud networks.

Using edge computing the gigabytes of sensory and special data is analyzed, filtered and compressed before being transmitted on IoT edge Gateways to several systems for further use. This edge processing saves on network expenses, storage and operating costs for traffic management solutions.

5.5-Autonomous Vehicles

While autonomous vehicles are not yet ready for the mainstream, without edge computing techniques their viability would be many more years in the future. With the slowdown of moore's law and overall advance computational power the onboard computers will now form a sizeable expense of autonomous vehicles.

The myriad of complex sensory technologies involved in autonomous vehicles require massive bandwidth and real-time parallel computing capabilities. Edge and distributed computing techniques increase safety, spatial awareness and interoperability with current-generation hardware.

With mobile edge computing, vehicles can exchange real-time sensory data, corroborate and improve decisions with less onboard-resources lowering the growing expense of autonomous AI systems.

6. 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. It would be more efficient to process or massage data at the edge of the network. In this paper, we came up with our understanding

of edge computing, with the rationale that computing should happen at the proximity of data sources. Then we list several cases whereby edge computing could flourish from cloud offloading to a smart environment such as home and city. We

also introduce collaborative edge, since edge can connect end user and cloud both physically and logically so not only is the conventional cloud computing paradigm still supported, but also it can connect long distance networks together for data

sharing and collaboration because of the closeness of data. At last, we put forward the challenges and opportunities that are worth working on, including programmability, naming, data abstraction, service management, privacy and security, as well as optimization metrics. edge computing is here, and we hope this paper will bring this to the attention of the community.

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