Edge Computing – "An Enabling Technology for Industrial IoT (IIoT) Devices" – Exploring Its Challenges and Security Issues

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Abstract: Internet of Things (IoT) is latest technology these days which generates high volume of data. Efficient use of data analytics techniques on discrete data using Cloud Computing provides significant and precise information. In view of the previously used applications, an application that is IoT enabled such as environmental monitoring, application for navigation and smart healthcare systems being developed with different requirements such as portability, fast and real-time response etc. However, the typical architecture of cloud system cannot fulfill these requirements as the processing of the data being distributed across the world remotely from physical location of installed IoT devices. Hence, the concept of edge computing emerged to perform data storage and processing at the extreme end devices that is nearer to data collection sources than the cloud storage. This makes applications computationally intelligent and location notified. But edge computing suffers from many challenges related to security and privacy when it is been applied to data analytics in association with IoT devices. The literature collected till date still deficient in detail review on the advancements in security and safe data analytics techniques used in edge computing. This paper, first introduce the various concepts and characteristics related to edge computing, and then we try to propose solutions for performing data analytics in a secured and efficient manner, thereafter reviewing the underlying some security attacks in the field of edge computing. Based on our literature survey, we have highlighted current open issues and some future research areas in this field

Keywords: IoT, Edge Computing, Cloud Computing

I. INTRODUCTION

Cloud computing over the past decade has changed our lives. In cloud computing, storage of data and management of network works in a manner which is managed centrally. Due to some latest development of mobile networks, some latest Internet technologies and various IoT based applications, the commonly used cloud computing architecture [2] is facing many challenges.

Mobile or edge devices that are connected to various cloud servers that are remotely located try to use various kind of applications which impose extra work load on the network & results in high latency[1]. This can be a constraint for the applications and services that requires real time response.

Hence, the solution is to overcome the problem to look "Beyond the Clouds" that is towards the edge of the networks[5], we refer to as edge computing or also known as Fog computing or Cloud let Computing.

In the methodology of edge computing, the data which is created by various IoT devices can easily be analyzed and processed at the edge nodes itself rather than sending it to any of the cloud infrastructure[7] for analysis and hence consuming less bandwidth and energy. The advantage of Edge Computing is that it can maximize the efficiency of various services. It provides faster response and better quality of service with regard to Cloud Computing.

Edge Computing can be used in association with IoT, that basically provides a facility or service which is effective on large number of end devices. Edge computing is transferring the various computing resources such as storage, data analysis, various kinds of applications and all other functionality on the edge device instead of providing a centralized infrastructure where everything is done by one central server.

In today's times most of the applications running on cloud uses a data centre that will act as a central server for the processing and computation of data that is produced by various edge devices[4] , for example like tablets , wearable like smart watches ,smart phones etc. This architecture puts greater demand of computational infrastructure with effect on QoS and its response rate. Edge Computing aims at pushing the computational workload towards the edge devices to provide processing capabilities that are presently unexplored and untouched in edge nodes like base stations [6], switches and routers.

II. EDGE COMPUTING REQUIREMENTS

1) Push From Cloud Services:

The efficient way to processing is to place and store all the data and various computational tasks related to it on the cloud, due to the enhanced computing power of the cloud. When compared with the speed of the fast development the processing of data, the network bandwidth becomes a limitation. As the quality and quantity of data generated at edge nodes increases, the speed at which the data being generated becomes a challenge for the cloud based methodology. For instance, any autonomous vehicle generates nearly 1 GB data/sec which basically requires processing in real time manner to make the correct and efficient decisions. Now, if the data is sent to the cloud for its storage and processing, than the execution time will

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be more and thus the performance will be poor.

2) Pull From IoT:

IoT is the collection of all kinds of electrical devices which plays a vital role for data consumers as well as data producers. Various IoT devices like sensors to sense air quality, LED Bars, Sensor controlled street lights, IoT Enabled Microwave oven etc. Now a days, the various components that are part of Edge network has developed from few to billions of devices in last few years. Hence, the data which is produced by all these devices or components will be very large and un-controllable that makes the traditional Cloud Computing techniques inefficient to handle and manage all this data. So, we can say that all the data generated by various IoT enabled peripherals will not be transferred to the any of the cloud server; instead all this data will be processed at the edge device.

3) Change From Data Consumer to Producer:

In cloud computing methodology, various end components and devices connected at a network works as a data consumer, eg. any user watching any video on YouTube using his phone or laptop. However, in today's scenario, most of the people are generating huge amount of data from their smart devices. The transformation from data consumer to producer of data requires more functions to be performed at the edge. For example, it is so common in life that people takes photos or do video recording. These photos and videos are then shared through any cloud based service such as various social media handles YouTube, Facebook, Twitter etc. The image or the video file is very large enough and will occupy a lot of bandwidth to be got uploaded on the cloud. Thus, in this situation, the image or the video file should be configured to a suitable format at the edge prior to its transfer on to the cloud. The second example, wearing of devices monitoring various health parameters of individuals. As this data collected is private, hence analyzing this data at edge will protect the privacy[8] of the user and secrecy in a better way instead of uploading the unprocessed data on to the cloud platform.

4) On-premise Edge computing:

The most important priority is to increase the availability or accessibility of IT enabled devices and its systems. As per the methodology and technologies used, Cloud Computing is a centralized design in which all the processing and storage is done at a central computer.

Edge computing overcome this limitation of cloud computing and transformed cloud computing to a advanced analysis that is Cloud Engineering. The most important point in this type of methodology is that in case of any disturbance, the non availability of the resources is restricted to the affected node or the edge device only, and the whole system will be in operation without any problem. A DDoS (i.e. Distributed Denial of Service) problem or power failure would be a limitation to edge computing devices and its applications related to that particular device, rather than all application executing on a centralized cloud server. For the institutions that are using cloud computing in off-premise mode are more capable of utilizing the concept of edge computing for the sake of expanded redundancy and accessibility of resources. Whereas, the on-premise edge computing servers will play an important role during the outages and failures. Hence, these servers of edge computing within the premise of any organization can also be considered as extension or advancement of cloud computing concept where the processing and storage of any sensitive information and data for a public cloud.

III. EDGE CLOUD INFRASTRUCTURE

Mentioned below is the Generic Architecture which provides accessibility to various IT services, as well as cloud services to mobile users. The main task is to minimize the latency; this can be done by transferring the storage and computation over the edge network instead of cloud. Edge computing is also defined as "Mobile Edge computing is a technique or model for enabling business oriented platform of Cloud Computing with the concept of Radio Access Network that serves different mobile users for delay sensitivity". Versatile edge computing provides the facility of performing calculations and other kind of administrative tasks on various edge devices that minimizes the system idleness and transfer speed.

There are three important vital parts in the architecture of edge computing.

1) Edge devices includes all kind of electronic devices (such as mobile phones and other IoT enabled devices) incorporated with the system.
2) Edge cloud is miniature version of cloud computing which is transmitted to each base station.

Edge Computing is also responsible for customary system movement control, and allowing various applications to process on edge that are portable.

Open cloud is the type of methodology of cloud computing which is facilitated through the Internet.

A. Brief Review Of Architecture In Edge Computing

Architecture view and functional elements of edge computing. With various data gathering techniques and analytical abilities, enterprises can clearly analyze their operations. The architecture should depict: Functional building blocks and methods to join sensors and various end point devices to cloud. Using this architecture the various companies can;

1) Host containers that are private on the edge device.
2) Hosting of gateway proxies on the cloud
3) Secure on-board peripheral with minimum human interference.
4) Execute implementation on diverse edge configurations

The edge architecture should use the following characteristics:

1) **Data Acquisition and device control:** The structural design should allow acquisition of data from different data sources. Data from various sources are then entered to the different controlling entities with the help different protocols [3]

2) **Features for Data Security between sensors gateways and the cloud:** Edge Computing architecture should provide various security features for the protection of data. The security features should also allow various devices to classify data as private or public.
3) **Edge Data Collection, Storage and Analysis:** Platforms should have offline capabilities for the storage, collection and analysis of data. Various IoT enabled edge devices must be domain specific and have the capability to collect real time events, actions and process execution at the edge.

The architecture must provide various techniques for real time business intelligence, optimized decision support, autonomous decision making and interaction across all devices.

4) **Edge Platform Flexibility and Scalability:** The platform should support various edge gateway configurations that is Systems having minimum compute capabilities to those devices having high computing processors. The solutions may be deployed on the cloud, either within the organizational premise or mix of both and should support cloud to cloud and cloud to premise integration.

The data which is produced at the users-end often requires to be transferred to a centralized cloud for carrying out important analysis which has, as discussed latency and energy implications. Computing resources at the edge of the network can be used for various computational tasks. Computation of data is done in a distributed manner. For example, a typical application pipeline can have an Initial phase where initially the raw data generated on an edge device is filtered. This phase is followed by Intermediate phase in which data-analytics is performed on the edge nodes .In the Final phase this data is transmitted to the cloud for more detailed analysis. Alternatively, we can also make the data centers to transfer the computations that require limited resources on to edge nodes/devices. Edge nodes can also do computations nearer to the source of the data and can include various methods and techniques for enhancing and improving the efficiency of front-end devices.

Moreover ,the need of deploying application workloads on edge nodes requires careful analysis and good strategies . These can be called Deployment strategies .These strategies involve solving the issues like workload-distribution, choice of edge nodes and how to handle the heterogeneity of nodes. For attaining such a framework, we need to address the above challenges at the various layers like hardware, middleware and software layer.

Analyzing the edge network requires discovery of edge nodes which can utilize cloud environment in a diffused manner. This mechanism cannot be managed manually and this method of identifying the edge node should be swift for assessing the capability of the resources i.e Edge nodes. This mechanism should ensure smooth aggregation and disaggregation of various devices in the computing work flow at many different echelons without causing any increase latencies in and compromising the user experience. Real-time addressal of faults at the nodes and restoring the faulty nodes should also be factored in. the methods which are used in the cloud are not effective in dealing with such issues.

IV. CONCLUSION

In the present scenario many services are being transferred from Cloud System to Edge devices, because the different processes to be executed on the edge, can provide minimum time latency and hence increase in reliability. If data can be analyzed on the edge device than network bandwidth is also utilized optimally and efficiently. It would be efficient if we could analyze the data at edge of the network. In this paper we came up with the paradigm of edge computing and gave a brief review of edge computing architecture and its concepts. Edge computing is here to stay and we need to work on it. Edge computing is an emerging technology and is still in its early stage that has the potential to become more efficient and optimized distributed computing technology. In this paper we have highlighted the significance of computing at the edge of the network.

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