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RESEARCH ARTICLE

EDGE COMPUTING: MOTIVATION & CHALLENGES

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ABSTRACT

In this paper we have listed the importance of edge computing and what are the challenges to adapt edge computing. Edge Computing is one of the growing technologies these days. Internet of Things is the concept of Edge Computing where we connect daily used devices to the internet so that we can operate these devices from remote locations.

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INTRODUCTION

Edge Computing works at the edge of the network i.e. more close to or even work at the data. It optimizes the use of cloud computing as it lies closely to data hence results in reducing time to response. Cloud Computing has its own data centres and requires devices to act as clients, these client devices need to request the server resources and wait for the response. This procedure is not very much useful for the devices that requires real time responses. The solution here is Edge Technology to provide computing power at the edge of the network that improves the real time responses. Figure 1 illustrate the example of cloud computing and edge computing.

Elements of edge Computing

Following are the essential elements of edge computing:

Accessibility: As we discussed earlier processing power in edge computing lies at the data end that is more close to user and device so accessibility of data is much more and easier as compared to Cloud Computing.

1.Intelligence: Edge Computing supports autonomous decision making as edge devices and sensors has become more powerful with increasing computing capacity.

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2.Trust: Everyone is much concerned about their sensitive data. Edge provides the security of the data as it is residing at the data end.
3.Control: Edge machines also provides the management and the coordination between the applications to assign computation to an edge node and provide synchronization between these nodes.
4.Humans-centric design: Edge Computing provides the control of information to the users itself hence providing human centric approach. Users can link their networks and devices to work on a shared project accordingly.

Why Edge Computing

Cloud Computing relies on their own data centres. The storage and processing resources are hosted within these centres in a centralized paradigm. The Operating Cost and response time is very high as the devices requiring to access these data centres must request the servers for process. The processing control lies at the data centres end. On the other hand, edge centric computer systems are user centric where the control lies at the user end.

Motivation

The edge computing has the following properties that tempted a user to adopt this technology:

Low Latency and Decentralised Cloud: Cloud Computing is not a best idea for the regions that are geographically distributed. To improve the delivered service and response

time, computing must be done at or closer to the source. Computing on the edge nodes that are closer to user end provides the better real experience to the user. Because real time applications do not provide good results when computing it at a distant cloud. Also real time decision making becomes hard. The use of current Cloud Computing Technology creates a great issue of response latency especially in real time applications such as visual guiding like google maps. So, a technology is required that can overcome this problem of response latency and edge computing is a good solution as it provides computing closer to user. Figure illustrate the response time computing time required by edge computing and cloud computing.

Energy Consumptions by data centres: Data centres consumes very high energy for computation and this energy requirement is increasing rapidly. It is predicted that these data centres will consumes three times as much energy as they are consuming today. So, there is a need to use energy efficient resources to minimize such a huge consumption of energy. Computing data on edge nodes can be a solution to this problem as no need to overload data centres by uploading data for computation.

Network Traffic and Data Explosion: The usage of edge devices is increasing day by day. With increase in number of edge devices the volume of data production is increasing at very high speed which will lead to network traffic. This is will

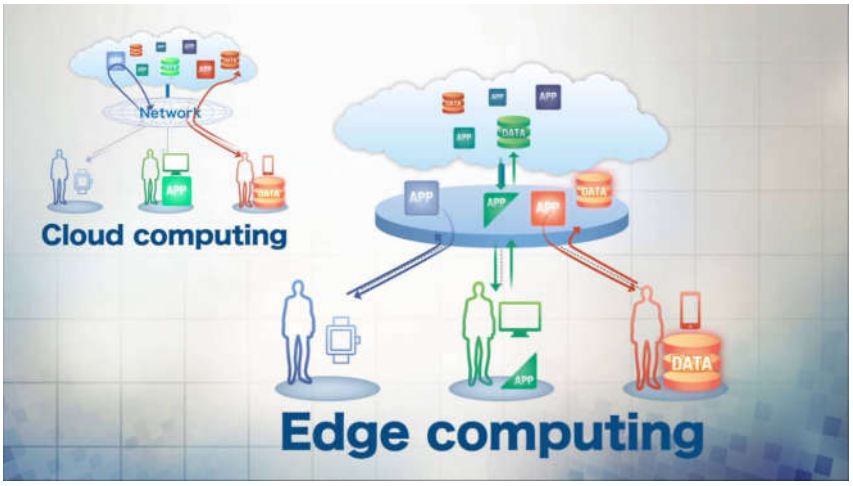

Fig. 1.

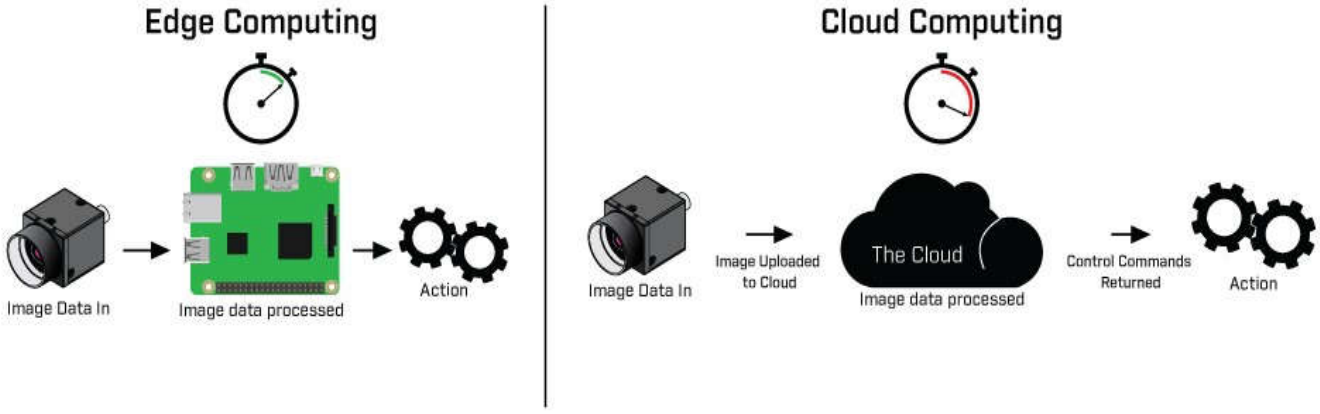

Fig 2.

Resource limitation: Data centres are very huge and have pretty much resources as compared to user front end devices such as smart phones. To use the server facilities these end devices must capture the data and transfer that data to the server because user end devices cannot match the complex computation speed of the servers. Also sometimes the computation at cloud causes battery draining at very high speed. There must be an alternate technology to overcome this problem of forwarding data to the servers for computation.

to expand the data centres to do analytical work and monitoring of this data production. Expansion of these data centres will again lead to the problem of energy consumption. So, there is a need to perform computing work on edge devices, but there is a challenge to do so because of resource limitation. Also parallel computation is a great challenge for real time analytics. So, instead of centralized approach distributed technique is required to share the load of computing or analytical work.

Challenges

To implement edge computing we first need to focus on the problem areas that causes challenges for this technology. In this section we have lightened those areas as following:

Programmability: While using Cloud Computing users write their code and upload to cloud for compilation and execution. Server decide the location of the program where it will get compiled and executed. This counts as a benefit of Cloud Computing as because programs may be written in one language and compiled on any targeted platform whereas in case of Edge Computing the computation work is offloaded from the cloud and the edge nodes may be heterogeneous platforms. So, it is difficult to write an application as it may be deployed on heterogeneous edge devices so the runtime of these devices differs from each other. Here comes the concept of computing stream which describe the series of functions to be performed along with the path of propagation of data on which these function has be computed on. The functions could also be sub functions of an application and the computation can be done anywhere depending upon the path specified.A software called computing stream defines the flow of computing so that data can be computed efficiently in a distributed manner and the focus is that the data should be computing as close to the data source as possible.Also collaboration/Synchronization of devices must be addressed effectively.

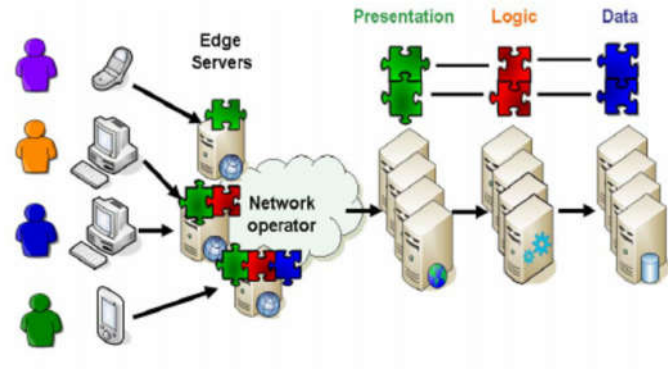

Fig. 3.

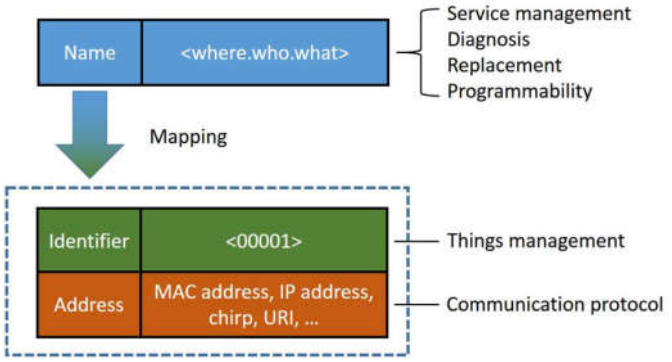

Fig. 4.

Naming: Because of a large number of edge devices there are a huge of number of applications running on these edge nodes and each application has its own structure that may be different from other devices. These devices must follow naming scheme to address or communicate with other devices. Similarly, naming scheme in edge computing plays an important role for addressing, programming and identification of other devices. Edge Computing needs to handles the naming scheme for mobility, protection and security of devices. To implement naming one must have a sound knowledge of communication and network protocols to communicate with heterogeneous devices. Also the naming should be user friendly to identity the devices uniquely. Figure depicts the naming convention in edge computing. Using IP address for naming will be complicated task as to identity devices using IP address will require to run address resolution routine. So, naming devices in edge computing isalso a challenging issue.

Data Abstraction: A large number of applications may be running on the edge devices to consume data or provide services to others by passing signals via air. Data Abstraction has become a challenging issue in edge computing. There would be a large number of data generators in IoT environment, among them many of the devices may produce data that is not even used by any of the user or application or the data generated may be noise. The control of such data may be provided to the gateway so that it sense the data and remove the data not needed. After alternation it send the data to the upper layer. Data filtration must be done in effective manner because there may be cases that the filtered out is required by any of the application.

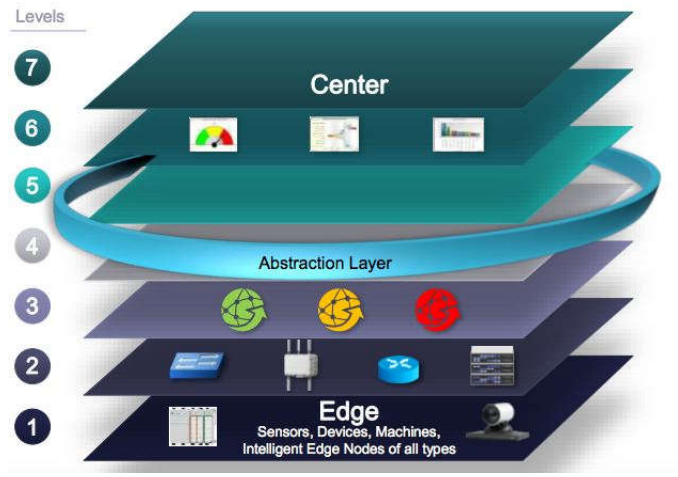

Fig. 5. Data abstraction for edge computing

Challenge with data abstraction is the applicable operationson the things. Collecting data is used to serve the applicationand the application should be allowed to control the required things in order to process certain services that are required by users.Combining the data representation andoperations, the data abstraction layer will serve as an publicinterface for all things connected to edgeOS

Service Management: An edge computing network must be able to support the following features:

1. **Differentiation:** As IoT is developing at very high speed, multiple services are expected to be deployed at the edge of network. The priorities of these services may be different like Health devices alarm should be processed than any ordinary services. Edge devices must be able to differentiate these alarms.
2. **Extensibility:** Edge of network must be able to extend for example if a user buy a new device, it can be added easily to the network and any old or defective device can be removed or replaced easily.

3. **Isolation:** Isolation includes the security of private data of the user from any third party. For example your activity tracking application may track your calling data etc. To protect user data well designed control access mechanism must be provided by the service manager.
4. **Reliability:** An edge of network must be reliable from service point of view as well as system point of view. Network must be able to detect the failure of a particular service as well as maintaining the network topology and able to send status/diagnosis information to the edgeOS.Data sensing in correct manner is also concerned contributes to the reliability.

Privacy and Security: When people are using network then the security of their private data is the height concerned issue. If IoT is deployed at home then the leakage of sensitive data can cause huge damage as any intruder may hack the IoT devices to know whether the home is vacant is or not. So, using IoT without sacrificing privacy and security of data is a big challenge.

Optimization Metrics: Edge computing works in layered manner. So, distributing the workload on these layers is a challenging task. The workload must be distributed evenly on each layer to reduce the response delay. The choice of optimal workload allocation strategy depends upon various factors such as latency, bandwidth, energy and cost.

Conclusion

As data processing at cloud may lead to response delay so more and more applications are adopting edge computing to reduce the response delay. Also Bandwidth can be saved by doing computing work at the edge devices. In this paper we concluded that the computing work must lies with the end near to the data sources for better performance. Also we discussed the points that motivate us to adopt edge computing and also the challenges to be faced while adopting this technology.

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