Edge Computing

CS5341 - Cloud Technologies and Systems

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17.1 Billion devices connected to the Internet in 2016 (Cisco pointed out in the Global Cloud Index)

50+ Billion terminals and devices connected to the network in 2020 (Internet Data Center (IDC))

10.4 Zettabyte (ZB) data traffic in global data centers in 2019

What is Edge Computing

Due to the massive growth of data volume and various data processing requirements, Cloud-Based data processing has shown many shortcomes.

Following Applications

- The Application which requires Automation
  - Ex: self driving cars
- The Application which can not tolerate latency
  - Ex: Health Care, Finance
- The Application which require significant bandwidth
  - Ex: Smart surveillance system

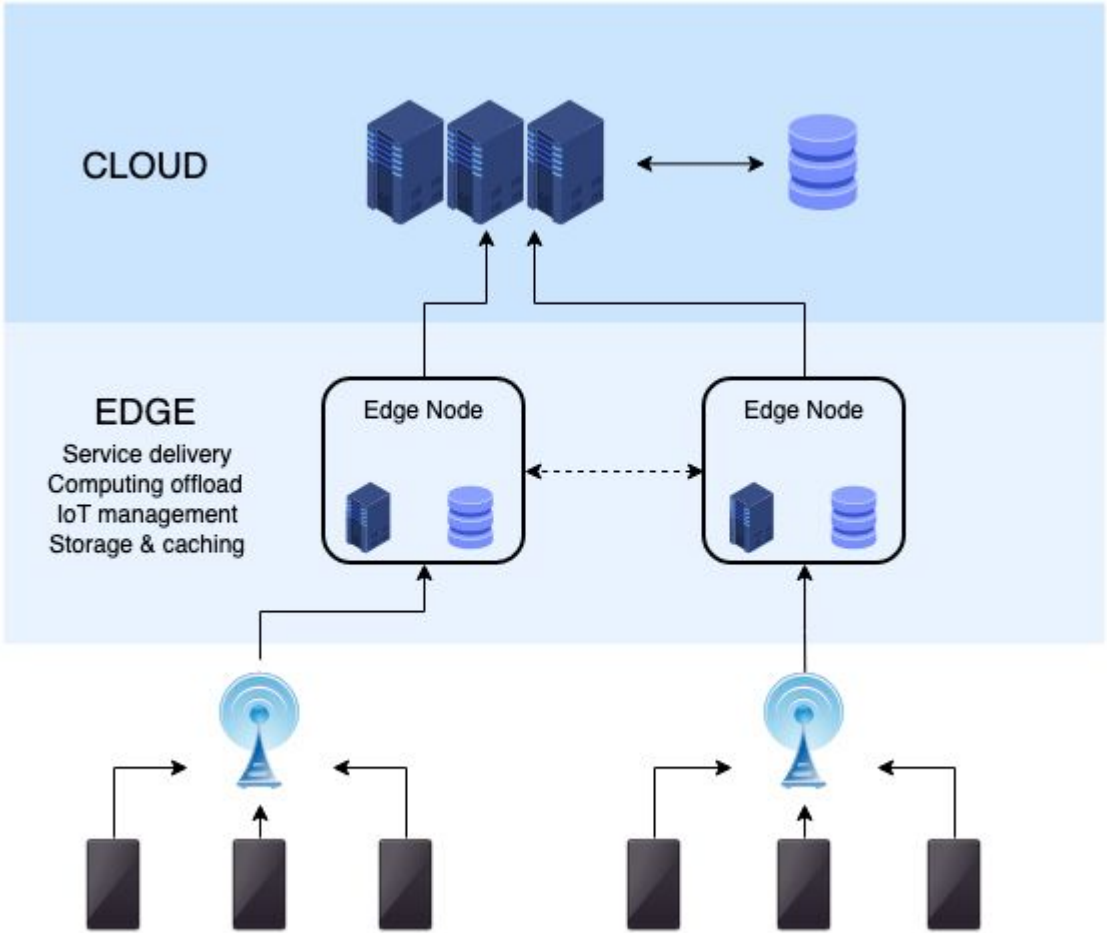
What is Edge Computing

Following aspects can be highlighted considering above applications

- Real-time
- Less risk and privacy
- Energy consumption

Due to the increasing amount of data and increasing requirements for data processing, edge computing has emerged at the historic moment.

Edge computing is a optimization of cloud. It makes computing closer to the source of the data. It stores and processes data at the edge of the network


CLOUD
EDGE
Service delivery
Computing offload
IoT management
Storage & caching
Edge Node
Edge Node

Cloud computing Vs Edge computing

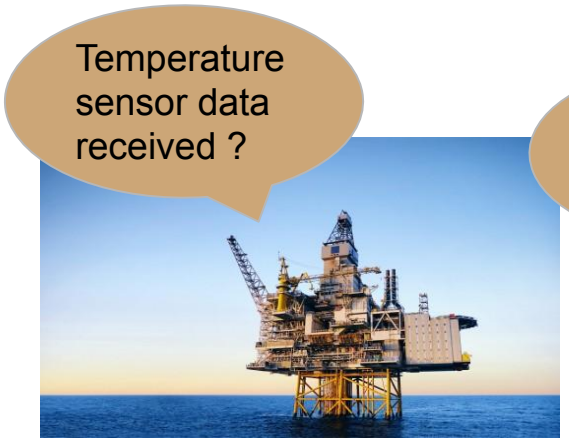
Cloud Computing	**Edge Computing**
Process data that is not time-driven	Process time-sensitive data
Large scale centralized processing	Small scale distributed processing
High network bandwidth require	Low Network Bandwidth require
Globally applicable	In locally applicable
centralized storage	Local storage need

Edge computing vs. cloud computing, we noticed that both the platforms are different and can't replace each other.

Challenges of Edge Deployments

Maintenance Criticality

Post Deployment, Monitoring and managing edge environment is complicated due to remotely located, open to environment, no redundancy, cost etc.



Edge Computing Vs Fog Computing

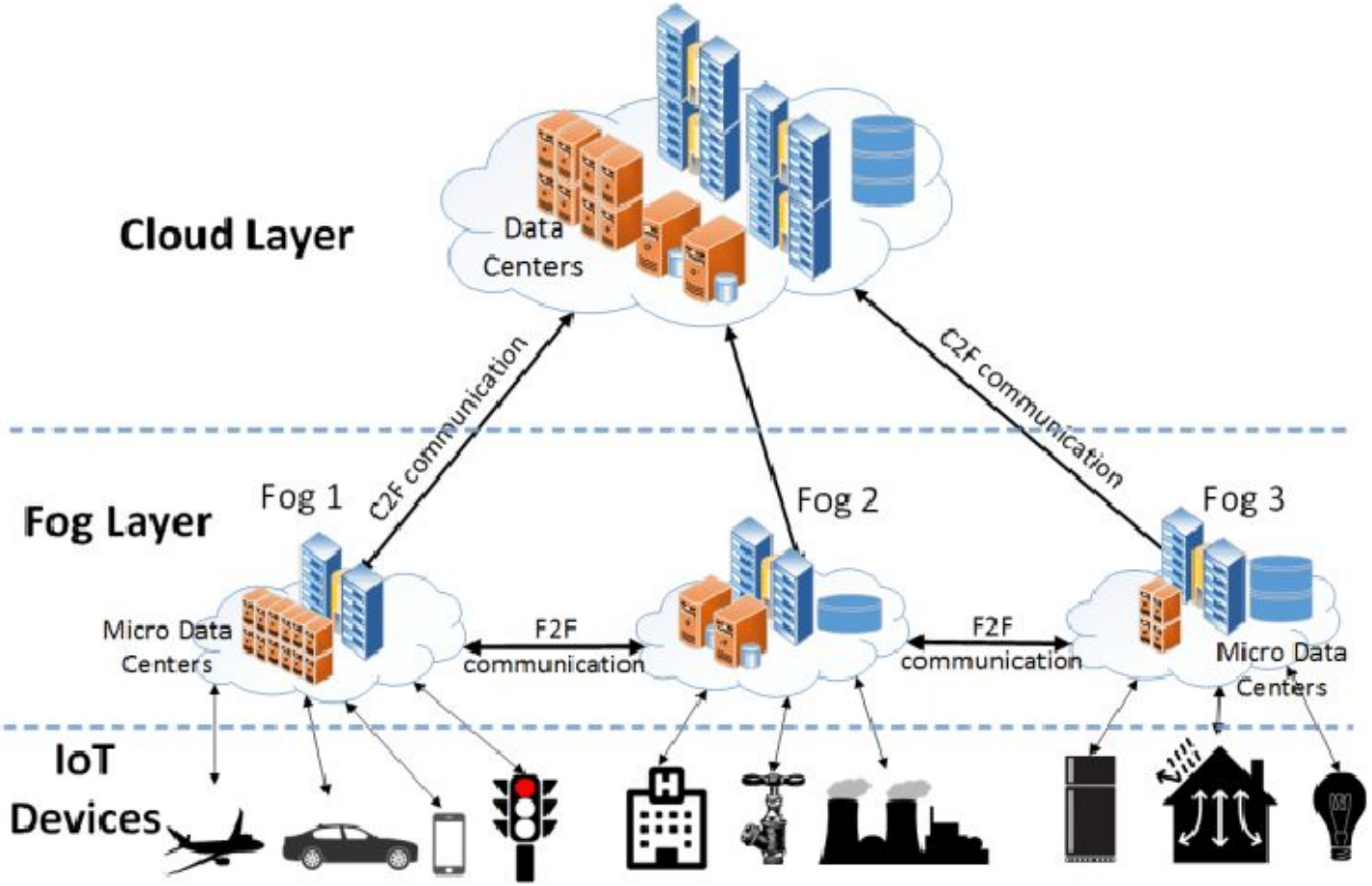
In a nutshell, fog computing acts as a mediator between the edge and the cloud for various purposes, such as data filtering. In the end, fog computing can’t replace edge computing, while edge computing can live without fog computing in many applications.

Three level of Architecture with Fog Computing

First level:
- unmodified cloud infrastructure

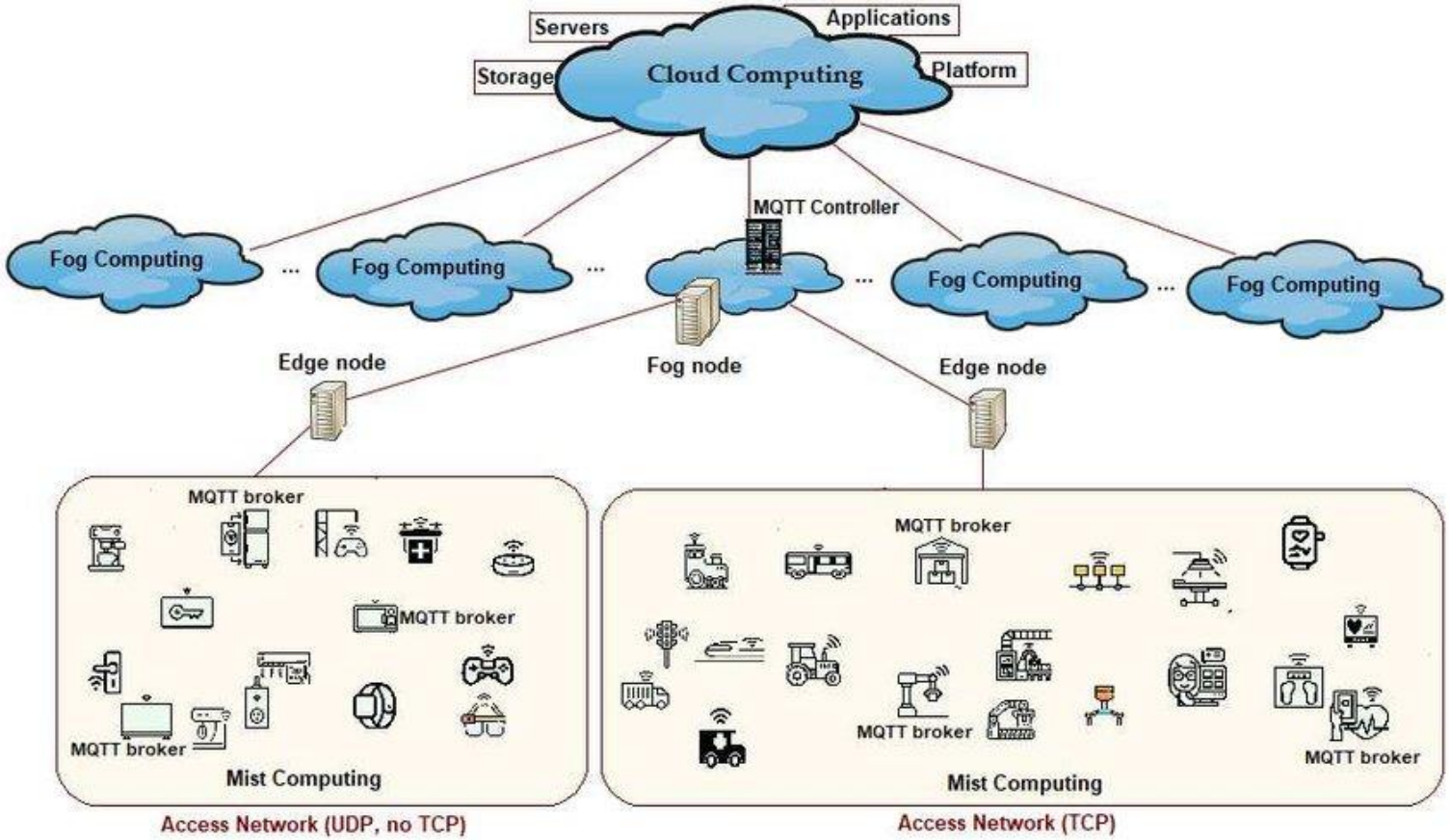
Second level:
- dispersed elements called cloudlets with state cached from the first level

Third level:
- Mobile-device or IoT device


Cloud Layer
Data Centers
C2F communication
C2F communication
Fog Layer
Fog 1
Fog 2
Fog 3
Micro Data Centers
F2F communication
F2F communication
Micro Data Centers
IoT Devices

Mist computing

- Mist computing is utilized at the extreme edge of a network which consists of microcontrollers and sensors
- Mist computing infrastructure uses microcontrollers and microcomputers to transfer data to fog computing nodes and eventually to the cloud
- Mist computing can enable local decision-making with the help of micro-controllers and sensors.
- Can ensure the data privacy at lower level by utilizing control access mechanisms


Servers
Applications
Storage
Cloud Computing
Platform
MQTT Controller
Fog Computing
Fog Computing
Fog Computing
Fog Computing
Edge node
Fog node
Edge node
MQTT broker
MQTT broker
MQTT broker
Mist Computing
MQTT broker
MQTT broker
MQTT broker
Mist Computing
Access Network (UDP, no TCP)
Access Network (TCP)

Advantages of Edge Computing

Response Time and Latency: processing data closer to the source of information, considerably lowers the distance it must travel. As a result, the overall service's speed, quality, and responsiveness have improved.

Less Risk: Risk can be avoided since edge computing only sends the appropriate data to the cloud. In addition, edge computing does not always need the use of a network connection. Therefore, even if hackers gain access to the cloud, not all users' information is at risk. However, this does not guarantee that edge computing is risk-free. Nevertheless, when compared to the cloud, this provides a possibly reduced risk profile.

Lesser Transmission Costs: edge computing can also result in significant cost reductions due to lower bandwidth. Because so much data is now processed and stored in localized servers and devices, there is no need for most data to go to data centers. As a result, edge computing requires less bandwidth. The Data centers can save bandwidth capacity and prevent costly improvements to existing cloud storage features by storing fewer data in the cloud and processing more locally.

Scalability and Versatility: Modifying or expanding this data center can be expensive at times. On the other hand, the edge may be utilized to scale your own IoT network without having to worry about storage. Furthermore, IoT devices can be placed here with just one implantation.

Disadvantages of Edge computing

Security: Although edge computing improves security by reducing the quantity of data that has to be protected in data centers, it also raises security concerns at each localized point of the edge network. In addition, some data is more vulnerable to breaches because not every edge device has the same built-in authentication and security capabilities.

Infrastructure costs:. While investing in a more robust edge network saves money on data center bandwidth, the strategy comes with its own set of costs to launch and manage edge devices. Edge devices may require more hardware and software for optimal performance and local storage needs, and costs can quickly escalate when they're spread across multiple local geographies.

Data Loss : It can be tedious to sift through all of the data in a cloud data center, but the data's central storage gives you the peace of mind that it will be there when you need it. While edge computing processes save space and money for storage, critical data could be misconstrued and destroyed by an edge device by accident.

What are some of the characteristics of edge hardware?

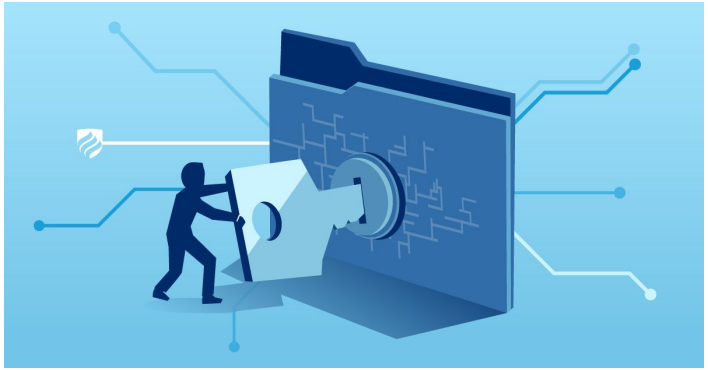
- **Fanless and ventless**.
- **Temperature resistant**.
- **Impervious to sudden movements**.
- **Small form factor**.
- **Equipped with ample storage**.
- **Compatible with new and legacy equipment**.
- **Built with multiple connectivity options**.
- **Able to support several types of power inputs**.
- **Protected from cyber attacks**.
- **Tamper resistant**.

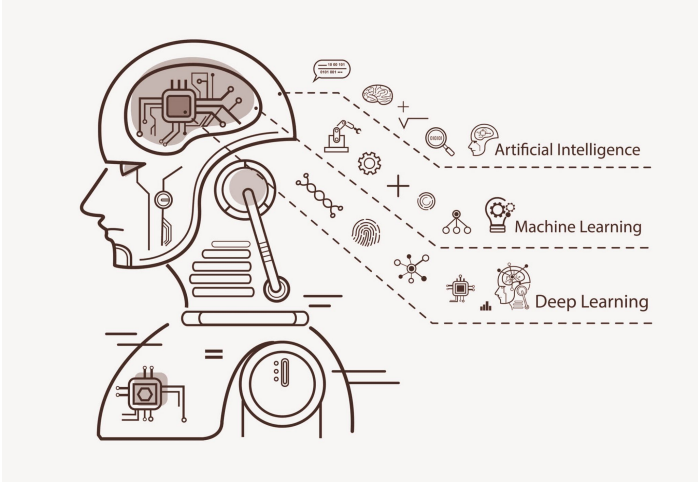
Edge computing use cases and examples

- Branch office managements.
- Farming industry
- Retail industry
- Healthcare industry
- Autonomous vehicles industry
- Manufacturing industry.
- Energy management

Edge computing services

- Run AI, analytics, and other business capabilities on IoT devices.
- consolidate edge data at scale and eliminate data silos.
- Deploy, manage and help secure edge workloads remotely.
- Optimise the costs of running edge solutions.
- Enable devices to react faster to local changes.
- Ensure that devices operate reliably after extended offline periods.





Edge computing on AZURE

Azure IoT Edge: Extend cloud intelligence and analytics to edge devices

Azure Stack Edge: Bring Azure compute, storage, and intelligence to the edge with Azure-managed devices

Azure FXT Edge Filer: Support HPC workloads with a hybrid storage optimisation solution

Azure SQL Edge: Get real-time data insights for IoT servers, gateways, and devices

Azure Percept: Accelerate edge intelligence from silicon to service

Azure Data Box: Quickly and cost-effectively move stored or in-flight data to Azure and edge compute

Edge computing on AZURE Cont..

Azure Network Function Manager: Deploy and manage 5G and SD-WAN network functions on edge devices

Windows for IoT: Build intelligent edge solutions with enterprise-grade developer tools, support, and security

Avere vFXT for Azure: Run high-performance, file-based workloads in the cloud

Azure Front Door: Get fast, reliable, and more secure cloud content delivery with intelligent threat protection

Azure confidential ledger: Store unstructured metadata in a blockchain using a REST API managed service

Azure Sphere: Securely connect MCU-powered devices from the silicon to the cloud

Future of Edge Computing: **Gartner prediction**

- By 2025, more than 50% of enterprise-managed data will be created and processed outside the data center or cloud.
- Through 2025, 80% of edge devices using 5G cellular as the primary connectivity option, Additionally, by 2025, bandwidth cost will be the primary driver for new edge computing deployments, versus latency in 2021
- By 2027, machine learning (ML) in the form of deep learning (DL) will be included in over 65% of edge use cases, up from less than 10% in 2021.

Future of Edge Computing

- Edge computing is a trending topic in cloud computing industry.
- Edge computing has promoted the rapid development of the Internet of Things.
- The upcoming commercialization of the fifth generation mobile communication network (5G network) provides new opportunities for the development of edge computing.
- Large cloud companies such as Google, Amazon and Microsoft are focusing on providing/initiating edge solutions to attract customers for edge computing.

Ref:
https://www.allerin.com/blog/fog-vs-edge-vs-mist-computing-which-one-is-the-most-suitable-for-your-business
Keyan Cao, Yefan Liu, Gongjie Meng, And Qimeng Sun “An Overview on Edge Computing Research KEYAN”

Thank you..!!