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Edge and fog computing

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1. Introduction

Edge and fog computing are directly related with IoT (*Internet of things*), a large number of smart devices, such as TV's, cameras, fridges, sensors, that are connected to the network generating a lot of data.

This data is often sent to the cloud, where big data centers collect and process the generated data, see image 1.

Image 1 - IoT

The amount of data generated by IoT can be quite overwhelming for data centers to process and store, needing something to reduce this workload.

Here comes edge and fog computing, two different architectures that have their own goals and interests, but in the end reduce the amount of work in data centers.

2. Edge computing

What is edge computing?

Edge computing is about processing and storing data closer to where it's being generated, reducing or even eliminating the communication between data centers and devices or applications.

This can be achieved by using local servers or by having the devices that collect the data do the calculations themselves.

Why do we need edge computing?

There are some devices and applications that need or would be better if they act instantly when new data is collected. Doing calculations at the edge gives devices reduced latency and increased bandwidth.

There are some IoT devices that collect data at remote sites, edge computing makes it easier to process this data where internet connectivity is poor or unavailable.

There are also other IoT devices that gather data that requires privacy and security. Edge computing provides more privacy and security because there's no necessity to send the collected data to the cloud.

Benefits

1. **Latency reduction:** The closer the calculations are made, the faster the response time, allowing real-time reactions in some cases.

2. **Heightened security and privacy:** There's no need to send and store data in data centers, where the security and privacy of the data can be compromised.

3. **Reduction of workload in data centers:** If the computations are done at the edge of the network, data centers would have less work and, as a consequence, the size of these data centers could be reduced or eliminated.

4. **Reduced bandwidth:** Thanks to data processing at the edge, communications between IoT devices and data centers are being reduced and less data is being sent to the cloud.

Real world examples

1. **Autonomous vehicles:** The reaction times of autonomous vehicles are crucial for the system to work correctly, for that reason they need to do the computations fast, real time AI. They cannot rely on cloud servers, because the response times they provide are too high. Instead, they have to bring all the computations to the edge where the latency is the lowest possible.

2. **Voice assistance technologies such as Google Home, Apple Siri:** These companies are trying to bring these services to the edge in order to reduce the response time of the assistant, to increase the security and privacy of the consumers and to improve the quality of the service they provide.

3. **Space exploration:** NASA has begun adopting edge computing to process data close to where it’s generated in space rather than sending it back to Earth, which can take minutes to days to arrive.

3. Fog computing

What is fog computing?

Fog computing or fog networking, also known as fogging, is an architecture that uses edge devices to carry out a substantial amount of computation (edge computing), storage, and communication locally and routed over the Internet backbone. It serves as an intermediate layer, between the edge layer and the cloud layer, and it appeared from the need to extend cloud computing in order to cope with huge numbers of IoT devices and big data volumes for real-time low-latency applications. Fog computing is intended for distributed computing where numerous "peripheral" devices connect to a cloud. The word "fog" refers to its cloud-like properties, but closer to the "ground".

Why do we need fog computing?

Fog computing serves to make the cloud treat less information, either by discarding non important data, or by treating it itself. Many IOT devices will generate voluminous raw data, and rather than forward all this data to the cloud to be processed, fog computing filters it before sending it to the cloud, so that less processed data is sent instead of all the raw data, helping simplify the cloud computation. Fog computing devices decide what data to send and what data to treat partially based on how fast the data has to be treated, to help reduce latency.

Benefits

1. **Latency reduction:** this is the main benefit of fog computing, although it’s not the only one. Fog computing allows us to treat more critical data closer to the source of it, making it much faster, while leaving the less immediately critical data for the cloud. Since fog computing focuses partially on latency reduction, it’s more efficient in this department than edge computing.

2. **Reduction of workload in data centers:** fog computing allows an extra layer of data processing on top of edge computing before the data gets to the cloud, which further reduces the amount of work cloud servers have to do. Not only is the data filtered, but it’s also preprocessed by the time it reaches the cloud.

3. **Reduced bandwidth:** The reduced amount of data sent to the cloud also helps reduce the bandwidth requirements.

Real world examples

1. **Connected trains:** some trains, train tracks and stations use sensors to communicate with each other. However, trains are fast, which means that a stable connection is difficult, but at the same time, a low latency is required. The solution is fog computing, allowing these elements to quickly communicate and react to each other.

2. **Pipelines:** in order to maintain oil and gas pipelines, a lot of data is constantly generated and analyzed along the kilometers of pipe. Instead of sending all that data constantly to a central server, fog computing nodes along the pipes can help reduce the amount of data the main computer receives, and can also help manage some of the most urgent issues, letting the main computer focus on the big picture.

3. **Video surveillance:** once again, we have an example of an activity that generates a lot of data, and that may require quick responses of the program. Fog computing helps treat the video data quickly, and filter the video that is not needed, saving a lot of storage space.

4. Main differences

1. Fog computing can't live without edge devices: Fog nodes can't collect data while edge nodes can.
2. Fog computing can be seen as a subdivision of cloud computing, while edge computing can be viewed as a subdivision of fog computing.
3. The number of edge nodes is higher than the number of fog nodes.
4. Edge nodes handle less data compared to fog nodes. Fog nodes process data generated by multiple edge nodes, while edge nodes process data only from the devices that are connected to the node.
5. Edge computing is closer to the devices and sometimes the devices and edge nodes are the same.

To better see the differences, here is the structure of iot using fog and edge computing:

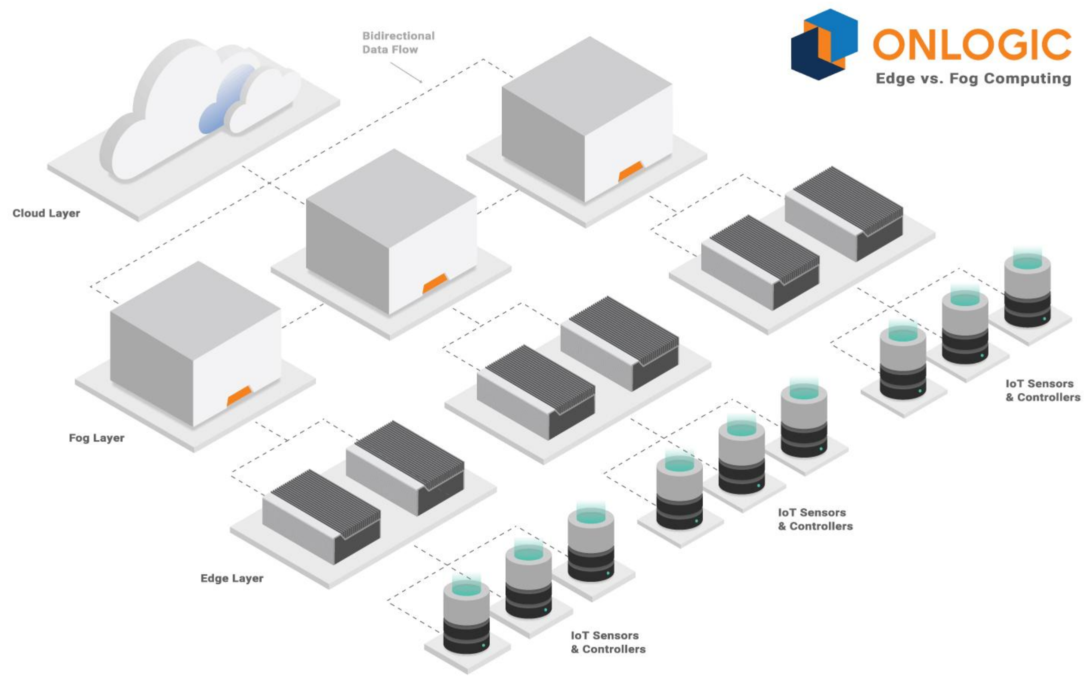

Image 2 - IoT structure with fog and edge computing

5. Conclusions

The world is today more interconnected than it’s ever been, to the point where even household objects are starting to connect among each other. Nowadays we also have more data than we’ve ever had, and speed is an important factor to our society. Edge and fog computing were created to help with these issues, and thanks to them, we can have a very fast and efficient interconnectivity, helping us communicate with each other, and making the world more comfortable for us.

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