IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 24, Issue 4, Ser. II (Jul. –Aug. 2022), PP 23-26
www.iosrjournals.org

Fog Computing and IOT

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Abstract:
Fog computing or fog networking, also known as fogging, is an architecture that uses edge devices to carry out a substantial amount of computation, storage, communication locally and routed over the internet backbone.
Fog computing *is a term created by Cisco that refers to extending cloud* computing *to the edge of an enterprise's network. Also known as Edge* Computing *or fogging,* fog computing *facilitates the operation of compute, storage and networking services between end devices and cloud* computing *data centers.*
Fog computing (FC) is an emerging distributed computing platform aimed at bringingComputation close to its data sources, which can reduce the latency and cost of delivering data to a remote cloud. This feature and related advantages are desirable for many Internet-of-Things applications, especially latency sensitive and mission intensive services. With comparisons to other computing technologies, the definition and architecture of FC are presented in this paper. The framework of resource allocation for latency reduction combined with reliability, fault tolerance, privacy, and underlying optimization problems are also discussed. We then investigate an application scenario and conduct resource optimization by formulating the optimization problem and solving it via a genetic algorithm. The resulting analysis generates some important in sights on the scalability of the FC systems
Key Words*: Fog computing, Cloud Computing, mobile computing Internet of Things, optimization*

Date of Submission: 02-08-2022 Date of Acceptance: 15-08-2022

I. The Role of Cloud Computing and Fog Computing in IoT

Cloud Computing and IoT:At a basic level, cloud computing is a way for businesses to use the internet to connect to off-premise storage and compute infrastructure. In the context of the Internet of Things, the cloud provides a scalable way for companies to manage all aspects of an IoT deployment including device location and management, billing, security protocols, data analysis and more.
Cloud services also allow developers to leverage powerful tools to create IoT applications and deliver services quickly. On-demand scalability is key here given the grand vision of IoT; a world saturated with smart, connected objects.Many major technology players have brought cloud-as-a-service offerings to market for IoT. Microsoft has its Azure suite, Amazon Web Services, a giant in cloud services, has an IoT-specific play, IBM offers access to the Watson platform via its Bluemix cloud, and the list goes on and on.
Regardless of the specific product, the commonality is the ability to access flexible IT resources without having to make big investments into hardware and software and the management that comes with it.
However, for services and applications that require very low latency or have a limited "pipe" through which to pipe data, there are some downsides to the cloud that are better addressed at the edge.
Fog Computing and IoT: The OpenFog Consortium was organized to develop a cross-industry approach to enabling end-to-end IoT deployments by creating a reference architecture to drive interoperability in connecting the edge and the cloud. The group has identified numerous IoT use cases that require edge computing including smart buildings, drone-based delivery services, real-
If you want to dive deeper into how open source initiatives like the Edge X Foundry are impacting the internet of things, you can check out our primer, "Open Source and the IoT: Innovation through Collaboration.
Challenges in IOT, The IoT promises to bring the connectivity to an earthly level, permeating every home, vehicle, and workplace with smart, Internet-connected devices. But as dependence on our newly connected devices increases along with the benefits and uses of a maturing technology, the reliability of the gateways that make the IoT a functional reality must increase and make uptime a near guarantee. As every appliance, light, door, piece of clothing, and every other object in your home and office become potentially Internet-enabled; The Internet of Things is poised to apply major stresses to the current internet and data center infrastructure. Gartner predicts that the IoT may include 26 billion connected units by 2020.
The popular current approach is to centralize cloud data processing in a single site, resulting in lower costs and strong application security. But with the sheer amount of input data that will be received from globally distributed sources, this central processing structure will require backup. Also most enterprise data are pushed

up to the cloud, stored and analyzed, after which a decision is made and action taken. But this system isn't efficient, to make it efficient, there is a need to process some data or some big data in IoT case in a smart way, especially if it's sensitive data and need quick action.

To illustrate the need for smart processing of some kind of data, IDC estimates that the amount of data analyzed on devices that are physically close to the Internet of Things is approaching 40 percent, which supports the urgent need for a different approach to this need.

To deal with this challenge, Fog Computing is the champion.Fog computing allows computing, decision-making and action-taking to happen via IoT devices and only pushes relevant data to the cloud, Cisco coined the term "Fog computing "and gave a brilliant definition for Fog Computing: "The fog extends the cloud to be closer to the things that produce and act on IoT data. These devices, called fog nodes, can be deployed anywhere with a network connection: on a factory floor, on top of a power pole, alongside a railway track, in a vehicle, or on an oil rig. Any device with computing, storage, and network connectivity can be a fog node. Examples include industrial controllers, switches, routers, embedded servers, and video surveillance cameras."

To understand Fog computing concept, the following actions define fog computing:

- Analyzes the most time-sensitive data at the network edge, close to where it is generated instead of sending vast amounts of IoT data to the cloud.
- Acts on IoT data in milliseconds, based on policy.
- Sends selected data to the cloud for historical analysis and longer-term storage.

BENEFITS OF USING FOG COMPUTING

- Minimize latency
- Conserve network bandwidth
- Address security concerns at all level of the network
- Operate reliably with quick decisions
- Collect and secure wide range of data
- Move data to the best place for processing
- Lower expenses of using high computing power only when needed and less bandwidth
- Better analysis and insights of local data

fog computing is not a replacement of cloud computing by any measure, it works in conjunction with cloud computing, optimizing the use of available resources. But it was the product of a need to address two challenges, real-time process and action of incoming data, and limitation of resources like bandwidth and computing power, another factor helping fog computing is the fact that it takes advantage of the distributed nature of today's virtualized IT resources. This improvement to the data-path hierarchy is enabled by the increased compute functionality that manufacturers are building into their edge routers and switches.

REAL-LIFE EXAMPLE:

A traffic light system in a major city is equipped with smart sensors. It is the day after the local team won a championship game and it's the morning of the day of the big parade. A surge of traffic into the city is expected as revelers come to celebrate their team's win. As the traffic builds, data are collected from individual traffic lights. The application developed by the city to adjust light patterns and timing is running on each edge device. The app automatically makes adjustments to light patterns in real time, at the edge, working around traffic impediments as they arise and diminish. Traffic delays are kept to a minimum, and fans spend less time in their cars and have more time to enjoy their big day.After the parade is over, all the data collected from the traffic light system would be sent up to the cloud and analyzed, supporting predictive analysis and allowing the city to adjust and improve its traffic application's response to future traffic anomalies. There is little value in sending a live steady stream of everyday traffic sensor data to the cloud for storage and analysis. The civic engineers have a good handle on normal traffic patterns. The relevant data is sensor information that diverges from the norm, such as the data from parade day

II. Fog Computing Architecture

Fog computing is the system-level architecture that brings computing, storage, control, and networking functions closer to the data-producing sources along the cloud-to-thing continuum. The OpenFog Reference Architecture is a high-level framework that will lead to industry standards for fog computingFog Computing Architecture comprises, physical and logical elements of the network, including the hardware and softwareThis establishes a large number of interconnecting devices. Fog Computing Architecture contains multiple layers. These layers consist of many networking devices such as routers, set- top boxes, proxy servers, base stations, etc. These levels are assigned various tasks to be conducted on the given data. Fog Computing Architecture is implemented in two predominant models the Hierarchical Architecture Model and the Layered Architecture Model. Let us learn more about these modelsThis model of cloud computing uses the fundamental three-layer structure in a hierarchical form of architecture. The three layers comprise of:

HIERARCHICAL ARCHITECTURE MODEL

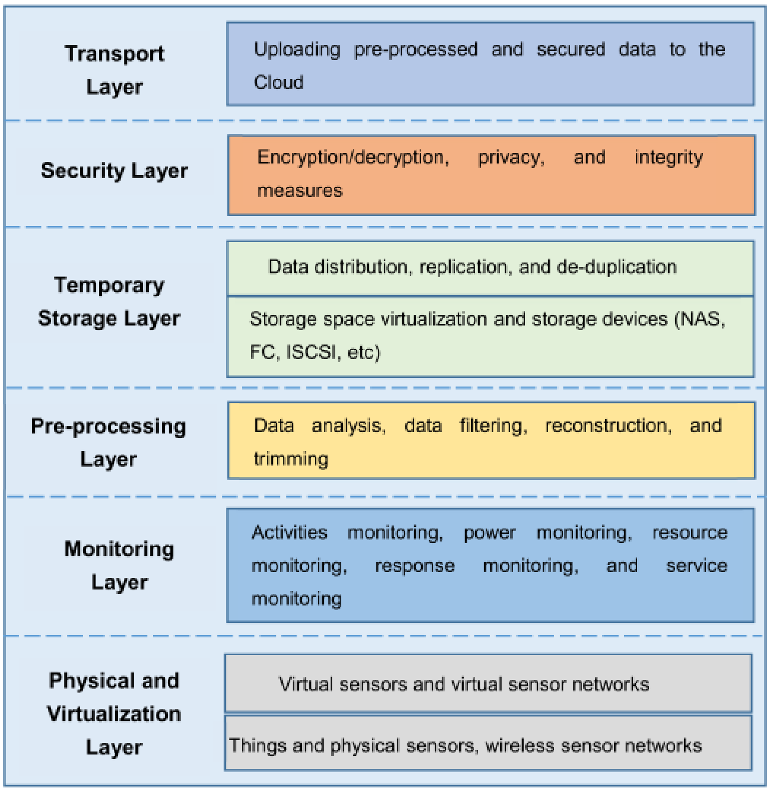
Terminal Layer: The terminal layer is the fundamental layer in the fog design, which comprises devices such as cell phones, cameras, smart cars, readers, smart cards, etc.The sensors in this layer can detect and collect data that is present in the network. Devices are distributed widely away from each other over a range of locations.The layer deals more with sensing and collecting data. In this segment, devices from various platforms and various architectures are primarily found.Applications have the potential to run in a heterogeneous environment, with other devices utilizing distinct technologies and different communication modes.

Fog Layer: The Fog layer contains equipment called Fog nodes, such as routers, gateways, entry points, base stations, individual fog servers, etc.

The fog nodes are placed at the edge of a network. An edge may be a hop away from the end of the unit. These nodes are located between Cloud Data Centers and End Devices.Fog nodes can be static, such as those in a bus terminal or coffee shop, or they can be shifted, such as those inside a moving car.These nodes supply the end devices with facilities. It can also temporarily compute, transmit and store the data.

Cloud Layer: This layer consists of computers that can provide high performance with massive storage and machines (servers).The cloud layer conducts the study of computations and permanently saves data for backup and remains persistent user control, It has a high capacity for storage and efficient computation. A cloud layer is created by enormous data centers with high processing ability. These data centers provide customers with all the fundamental features of cloud computing. The data centers are both flexible and have on-demand computing services.

LAYERED ARCHITECTURE MODEL



The physical and virtualization layer involves different types of nodes such as physical nodes, virtual nodes and virtual sensor networks. These nodes are managed and maintained according to their types and service demands. Different types of sensors are distributed geographically to sense the surroundings and send the collected data to upper layers via gateways for further processing and filtering. While at the monitoring layer, resource utilization, the availability of sensors and fog nodes and network elements are monitored. All tasks performed by nodes are monitored in this layer, monitoring which node is performing what task, at what time and what will be required from it next. The performance and status of all applications and services deployed on the infrastructure are monitored. In addition, the energy consumption of fog nodes is monitored; since fog computing uses many devices with different levels of power consumption, energy management measures can be both timely and effective. The pre-processing layer performs data management tasks. Collected data are analyzed and data filtering and trimming are carried out in this layer to extract meaningful information.

The pre-processed data are then stored temporarily in the temporary storage layer. When the data are transmitted to Big Data, they no longer need to be stored locally and may be removed from the temporary storage media. In the security layer, the encryption/decryption of data comes into play. In addition, integrity measures may be applied to thedata to protect them from tampering. Finally, in the transport layer, the pre-processed data are uploaded to the cloud to allow the cloud to extract and create more useful services. For efficient power utilization, only a portion of collected data is uploaded to the cloud. In other words, the gateway device connecting the IoT to the cloud processes the data before sending them to the cloud. This type of gateway is called a smart gateway. Data collected from sensor networks and IoT devices are transferred through smart gateways to the cloud. The data received by the cloud is then stored and used to create services for users. Based on the limited resources of the fog, a communication protocol for fog computing needs to be efficient, lightweight and customizable.

III. Conclusion

Moving the intelligent processing of data to the edge only raises the stakes for maintaining the availability of these smart gateways and their communication path to the cloud. When the IoT provides methods that allow people to manage their daily lives, from locking their homes to checking their schedules to cooking their meals, gateway downtime in the fog computing world becomes a critical issue. Additionally, resilience and failover solutions that safeguard those processes will become even more essential.

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Prof. Sukeshini Satish Gawai. “Fog Computing and IOT.” *IOSR Journal of Computer Engineering (IOSR-JCE),* 24(3), 2022, pp. 23-26.