Edge Computing

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by

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Introduction

Edge computing is a networking philosophy focused on bringing computing as close to the source of data as possible in order to reduce latency and bandwidth use. In simpler terms, edge computing means running fewer processes in the cloud and moving those processes to local places, such as on a user's computer, an IoT device, or an edge server. The term edge is derived from the English word for corner: an allusion to the fact that data processing in this approach does not take place centrally in the cloud, but decentrally at the edge of the network. In IT jargon, the "edge" is the edge of the network. However, which network components are assigned to the network edge depends on the situation. In telecommunications, for example, a mobile phone can be the edge of the network; in a system of networked, autonomously driving cars, the individual vehicle. In situations like these, you're talking about an edge device.

Every data generating device at the edge of the network functions as an edge device. Possible data sources are sensors, machines, vehicles or intelligent devices in an IoT environment – like washing machines, fire detectors, light bulbs or radiator thermostats.

Bringing computation to the network's edge minimizes the amount of long-distance communication that has to happen between a client and server.

Edge computing is a "mesh network of micro data centers that process or store critical data locally and push all received data to a central data center or cloud storage repository, in a footprint of less than 100 square feet," according to research firm IDC.

The "edge" is where things and people connect and start to converge with the digital world via communication network. The edge could be a Play Station, a Smartphone, a home wireless router, an Apple TV, a Surface Pro, a local cellular tower, or even a connected car.

Consider a building secured with dozens of high-definition IoT video cameras. These are 'dumb' cameras that simply output a raw video signal and continuously stream that signal to a cloud server. On the cloud server, the video output from all the cameras is put through a motion-detection application to ensure that only clips featuring activity are saved to the server's database. This means there is a constant and significant strain on the building's Internet infrastructure, as significant bandwidth gets consumed by the high volume of video footage being transferred. Additionally, there is very heavy load on the cloud server that has to process the video footage from all the cameras simultaneously.

Now imagine that the motion sensor computation is moved to the network edge. What if each camera used its own internal computer to run the motion-detecting application and then sent footage to the cloud server as needed? This would result in a significant reduction in bandwidth use, because much of the camera footage will never have to travel to the cloud server. Additionally, the cloud server would now only be responsible for storing the important footage, meaning that the server could communicate with a higher number of cameras without getting overloaded. This is what edge computing looks like.

Five Key Edge Use Cases:

1. Field and Industrial IoT — Various sensors and other field devices across verticals like Manufacturing, Transportation, Power are a prime candidate for Edge computing. These devices can be HVAC systems, Energy Meters, Aircraft engines, Oil rigs, Scanners in Retail, Wind turbines, Connected cars, RFIDs in Supply chain, Robotics, AR, and much more. These are often characterized by applications that collect data from edge devices and analyze it for different business use cases — security management, predictive maintenance, performance or usage tracking, demand forecasting, etc.
2. Smart Cities and Architecture — Many cities across the globe are vying for the tag of a Smart City. IoT devices will make living in such cities easier for citizens. The use cases here range from municipalities providing faster urban services (repair of equipment), traffic management (to reduce gridlock), public safety and green energy provisioning
3. Customer Experience in Retail and Hospitality — Customer sentiment data and social media data is collected and analyzed to improve customer experience. Data here is being captured by a kiosk or a Point of Sale (POS) system or Terminal.
4. Connected Vehicles — For example, telematics data used for navigation, or to influence dynamic pricing for auto insurance, predict required maintenance, and so on.
5. Facial and image recognition — as a way of identifying customers and reducing fraud in verticals such as Retail, Banking, and Entertainment.

Blockchain is the technology that powers the Bitcoin cryptocurrency. It is a decentralized and distributed ledger, cryptographically secured from tampering of data. The ledger is maintained through consensus between the peers in the decentralized network. The ledger can be integrated with a system for smart contracts and other assistive technologies. These can be used to build a new generation of transactional applications that establishes trust, accountability and transparency at their core, while streamlining business processes and legal constraints. The decentralization of the ledger enables the removal of hitherto indispensable intermediaries like banks for the transfer of assets and value.

Essentially blockchains are databases wherein transactions are bundled together into blocks for storage. A block is the current part of the blockchain which records some or all of the recent transactions. On the completion of block, it goes into the blockchain as a permanent database. The blocks are added to the blockchain through cryptography, ensuring that they remain meddle-proof.

Each block created, contains the cryptographic hash of the previous block, thereby forming a chain of blocks. This chaining provides blockchains its immutability since if an attacker has to modify a recorded transaction he will have to modify the block in which the transaction was stored. This would lead to a change in the hash of the block, which would not match the hash stored in the following block. Thus the attacker would now have to change successive blocks all the way to the latest block, a change that could be easily detected, and that is computationally infeasible as well. Blockchain has complete information about all the different users addresses and their balances right from the genesis block to the most recently completed block.

Blockchains today are set to rewire the whole structure of the Internet. They enable us to think of an Internet of Value where we use the Internet to transfer value as easily as we so far have shared information. The key difference between an Internet of information and an Internet of Value is that unlike information, value cannot be held by two users at the same time. Blockchain is a distributed open ledger which is shared and maintained by all the nodes in the blockchain network. In retrospect, from the earliest “born for currency”, blockchain has already developed into a “revolutionist” in different industries like credit service, bank, insurance, security etc.
With years of research and build-up in blockchain technology, we believe that blockchain’s value shall definitely not be limited to digital currency in the future.

Issues in Edge Computing

As with any new technology, there are specific problems related to edge computing that are still left to be solved and the solutions approved. Here is my take:

Data tiering. In edge computing networks, the data are separated into many parts and stored across different storage locations, which make it easier to lose data packets or store incorrectly. Thus, it is hard to guarantee data integrity. Besides, data leakage and other privacy issues could occur when the uploaded data involving several edge nodes may be modified or abused by the unauthorized adversaries. Another challenge for storage is ensuring data reliability, since traditional methods to detect and repair corrupted data using erasure codes or network coding result in heavy storage overhead in edge computing systems. While we know that edge-based devices need to store data, and we do so on the cloud tier as well, how do you divide things up? It's really a matter of what needs to return to the data provider in near real time, what can move to the back-end systems, and finally what data should be replicated.

No easy answer for this one and indeed that's the problem. As time progresses it's a matter of planning and deciding which data should exist at the edge tier and which data should exist at the cloud tier. For now though, it's still a case-by-case basis.

Security. While there has been a lot of thought around what edge means and how it's implemented, there is still no standard approach to formal security planning for edge computing.

Core to these issues is one of planning standards that are not just extension of existing security systems on the cloud, or on premises. This means that even with developing industry standards, there is currently no widely-accepted best practice.

The trouble with security and edge-based systems is that they are typically lower-powered computers that can't handle much overhead other than what they currently do as an edge device. Therefore, if the security systems are implemented there, they need to keep a low profile. And that is something that security systems have a hard time doing.

Another important security challenge in edge computing network is to maintain security and privacy in uploading computational tasks to edge computation nodes. Some verifiable computation schemes are introduced, where the computation is outsourced with the computation function or the public key to one or more servers, who return the result of the computation as well as a proof to verify the computation. Thus, it can be seen that security issues such as secure control at the edge, secure data storage, secure computation and secure network may need new ideas to adapt to the decentralization, coordination, heterogeneity and mobility of edge computing, especially the combination of scalability with security in such massive overlays but avoiding the excessive encryption overheads.

Management. While businesses are getting better at managing and monitoring, much like the two issues listed above there is no one-size-fits-all approach or tooling. The specific features of edge computing make “edge-ops” solutions unique to each situation. This will be the case for the near future.

Issues in Blockchain

There are many hurdles to blockchain adoption, despite the above advantages. These concerns that need to be addressed for widespread blockchain deployment are as follows:

Speed / Scalability- One of the biggest problems currently preventing adoption of blockchain systems is their inherent inability to handle large volumes of transactions and system activity. Blockchain implementations are currently in very primitive forms that cannot scale to the requirements of today’s applications.

Privacy- While it is important to expose relevant data to authorized bodies, there is also a need for increasing transaction privacy to enable the routing of even confidential transactions through blockchains.

Implementation- Recent years have seen the proliferation of a number of blockchain implementations each with its own set of protocols and transaction formats. There is a need to establish standard tools and administration interfaces to enable easy adoption of blockchains in businesses.

Interdependency of Blockchain and Edge Computing

Blockchain concerned here pertains to its ability to allow the participant in the network to record the system in a distributed shared ledger. More attention is paid to its consensus protocol, ledger topology, incentive and contract which will be extended in the integration system to fit the different levels of edge computing systems and the combinations. The key points of blockchain are the advantages of security and privacy and the need for scalability improvement.

Edge computing considered here pertains to its capability to perform networking, storing and computing in the distributed network edge. The concentration is the service support and management. The key points of edge computing are the advantages of achieving scalability in a distributed way and the need for efficient control in a secure manner.

Therefore, the integrated frameworks and functionalities of blockchain and edge computing based systems here are aimed at providing secure services to fulfil the application requirement by taking into consideration of network, storage and computation, which cover the core layers of blockchain and the main capability of edge computing. The possibility of
integration comes from both the same decentralized network infrastructure and the same functions of storage and computation, while the necessity of integration lies in the different advantages of blockchain and edge computing and accordingly their complementary roles.

Blockchain on the Edge & Edge using Blockchain

My Project aim is to:

- Incorporate blockchain into edge computing which enhances the security, privacy, and the automatic resource usage.
- Incorporate edge computing into blockchain which brings the powerful decentralized network and rich computation and storage resources in the network edge.
- Deploying ShareCert and Health Insurance with Interoperable Blockchains frameworks on the proposed setup for checking the correctness and effectiveness of the same.

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