EDGE COMPUTING:

DEFINING EDGE COMPUTING AND APPLYING IT TO THE BUILT ENVIRONMENT

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UNDERSTANDING EDGE COMPUTING

Edge Computing is an optimized method of Cloud computing systems in which data processing is performed at the 'Edge' of the network, near the source of the data.

In conventional Cloud computing, devices at the **Edge** of the network are connected to a central network to which data is transmitted for processing and the response is sent back to the **Edge device**. This method creates **latency*** and in certain applications even the smallest delay can impact the overall system.[1]

CLOUD

- Big Data Processing
- Data Storage
- Machine Learning

In Cloud computing, data is hosted in a central location that can be accessed through a network.

Phone apps can be hosted by providers/third-parties, with the phone itself being the entry point to that application.

EDGE/FOG

- Real-Time Data Processing
- Basic Analytics
- On-Premise Processing

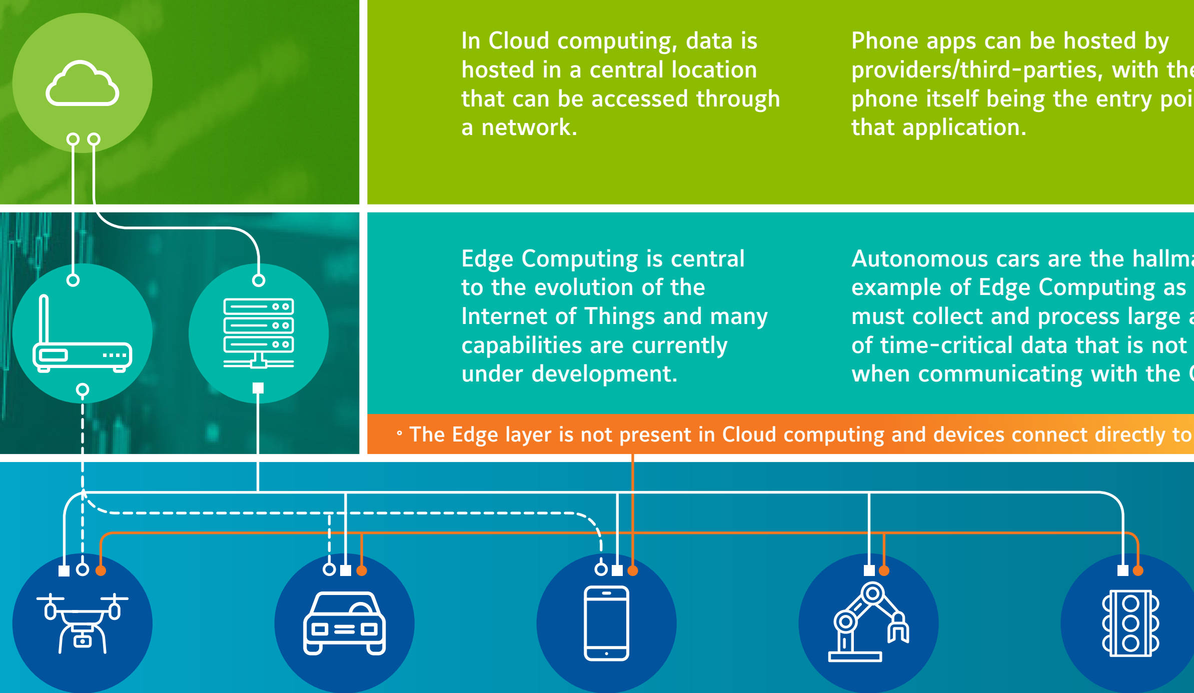
Edge Computing is central to the evolution of the Internet of Things and many capabilities are currently under development.

Autonomous cars are the hallmark example of Edge Computing as they must collect and process large amounts of time-critical data that is not feasible when communicating with the Cloud.

◦ The Edge layer is not present in Cloud computing and devices connect directly to the Cloud.

DEVICES

- Interact with World
- Collect Data



*Latency: the delay before a transfer of data begins following an instruction for its transfer

Source: [1]Mi

THE VALUE OF EDGE COMPUTING

Edge Computing delivers the significant value propositions that open up new avenues of computing.

- Reduced latency drives 'near real-time' processing
- 'Near real-time' processing opens up other avenues of applications such as autonomous cars

- Cyber attacks could be limited to the device they target and would not affect the whole network[1]
- Only transformed/condensed data is transferred to main hub as opposed to all data within the system

- Decentralized nodes function independently of each other
- Only affected nodes will stop functioning in the case of an interruption such as a power outage

Edge Computing is a major driving force behind the development of the Internet of Things (IoT) as it manufacturers and application developers are uncovering the benefits of increasing computing and analytics on the devices themselves.[1]

In the past, the power of the Cloud was required to process the data, but Edge devices are now equipped to run compute-intensive artificial intelligence (AI) operations. In many cases, the Edge device is becoming the preferred platform for running AI-powered applications.[2]

Source: [1]Network World | [2]Technology Review

EARLY APPLICATIONS IN BUILDINGS AND CITIES

Edge Computing is a means of **horizontally scaling*** work, reducing latency and making services, systems and applications more resilient. Already, the impact of this technology can be observed due to the devices we interact with such as[1]:

- Adjust temperature in the home based on data collected about users' habits[2]

- On-device visual processing to detect for motion, identify family members, and send alerts only if someone is not recognized or doesn't fit pre-defined parameters[3]

- Installing sensors and using street lights to inform drivers of open parking spaces in busy cities is an application already being used in San Francisco today[4]

"...the adoption of Edge is accelerating at a fast pace. The reason for this has to do with the fact that sensors, machines, and devices (the Internet of Things) are already deployed in many organizations. Data is generated, collected, and used to manage and control industrial systems. The path to business and operational efficiency is within reach, and the savings associated with these efficiencies makes deploying an Edge strategy worth the investment."
- Matt Kimball, Senior Datacenter Analyst, Moor Insights & Strategy[5]

*Horizonal scaling: the ability to add more computing instances to a service, application, or system.
Source: [1]Simplicable | [2]Business Insider | [3]Network World | [4]TechRepublic | [5]Forbes

TECHNOLOGY DEVELOPMENT

Trends have come together to help organizations turn massive amounts of data into actionable intelligence closer to the source of the data. Upcoming capabilities and applications **that will strengthen Edge Computing solutions** include:

LOW-POWER COMPUTING

- Embedded flash memory to perform deep-learning computations and greatly reduce the amount of power required to do so[1]

HETEROGENEOUS COMPUTING & AI

- Multiple processors/cores that can run AI tasks with high performance at relatively lower power[2]

5G WIRELESS NETWORKS

- Increased bandwidth to transmit the large amounts of data generated by connected devices[2]

CONTAINERS & FUNCTIONS -AS-A-SERVICE

- New software paradigms make it easier for code to move and run anywhere, in the Cloud or on the Edge

The development of these technologies is already creating opportunities by taking the capabilities of what were once ‘supercomputers’ and putting them in the hands of the public, within homes, and inside buildings.

“5G will enable devices to more freely communicate with each other to share data and share context.” With this development, we will experience a fully connected universe of intelligent Edge devices, facilitating more personalized, real-time user experiences.”

- Gary Brotman, Product Management Director at Qualcomm[2]

Source: [1]IEEE Spectrum | [2]Technology Review

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CHALLENGES MOVING TOWARD AN EDGE FUTURE

SECURITY

- Increased complexity of the Edge devices increases the security surface of the device, making it harder to keep all of the code free of defects.
- Proliferation of Edge devices means reliably keeping devices up to date is harder. Automatic updates help but do not entirely solve the problem.
- Integration of Edge devices into local IT environments while staying secure is an ongoing challenge.

NAMING & PROGRAMMING

- A diversity of "Edge things" will inevitably proliferate.
- No standards exist for naming these IoT things across industries or domains.
- No clear way to coordinate the programming of things to achieve specific goals or to fit a diversity of Edge data into applications that will function based on the distributed inputs of the "Edge things".

DATA ABSTRACTION

- Creating an integrated data table from data shared in various formats.
- Rules to govern what data to send to the Cloud.
- How to preserve privacy by stripping some identifiers out?
- How to handle bad data from malfunctioning sensors?

SHOWING ROI FOR RETROFIT INVESTMENTS

- Ultimately, building owners will need to make new investments to benefit from the future advantages of Edge Computing and analytics in buildings.
- If we take the adoption curve of intelligent buildings as a gauge, there will be a strong market for education and some patience required.

Sources: IEEE: Edge Computing: Vision and Challenges, 2016, Arteris website

USING EDGE COMPUTING IN BUILDINGS

As both the software and hardware elements evolve, Edge Computing is expected to be more common in daily life. And while smart buildings are a particularly interesting application, connecting an entire building is difficult and costly. As a result, today's building solutions focus on feeding data from different building technologies into the same user interface.[1]

CASE STUDY: JOHNSON CONTROLS DIGITAL VAULT

Johnson Controls Digital Vault data ingestion service connects the Cloud with the Edge seamlessly for any building systems and devices. The gateway component can process and filter data before sending it to the Cloud. If connectivity is down, the gateway buffers data until the connection returns. To be cyber-secure, Digital Vault makes only outgoing connections to known hosts. The data ingestion service allows building operators to better manage the facilities to improve operational efficiency and perform predictive maintenance.

Source: [1]WNC Green Building

EXAMPLE

TECHNOLOGY OVERVIEW

Johnson Controls Converged Cyber-Physical Security (CCS) leverages AI, complex event processing, and Edge Computing to create a security application that enables a proactive security posture. It accurately identifies dynamic risks associated enterprise resources including people, places, and assets via situation-aware machine learning models.

CCS leverages high volumes of signals from various sources, including physical security devices, intrusion sensors, peoples' data or external sources such as weather, and social media feeds. Once connected, CCS offers insights and recommendations from the aggregation of the disparate sources. It can then apply AI to predict threats, issue an alarm or alert, and provide appropriate context to allow security operations teams to effectively collaborate and respond. On the Edge, AI-enabled smart cameras use facial recognition to further verify identities in some access control decisions.

USE CASE: DIGITAL TRANSFORMATION FOR A FORTUNE 50 ENTERPRISE GLOBAL SECURITY OPERATIONS CENTER

This digital transformation requires data ingestion, transformation and storage for a large variety and velocity of data sources so that applications can be built rapidly and address a comprehensive list of use cases and personas. Example application is a global single pane of visualization of people, spaces and assets of the enterprise to enable dynamic and real-time security monitoring. The data sources categories include:

- Building Lifecycle data (BIM, real estate information, device mapping, service and maintenance)
- External data (weather, disaster, geopolitical, emergency)
- Operational Technology (video surveillance, access control systems, video management system)
- Information Technology (people, travel management, visitor management, Calendar, collaboration tool)

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