2025 Edition

Edge Computing

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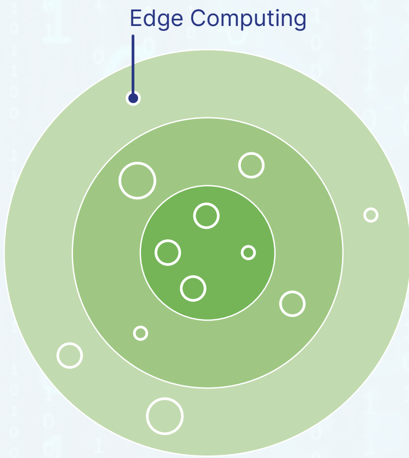
	low	medium	high
Impact	▬	▭	▭
Complexity	○	○	○



1 INTRODUCTION

Purpose

Edge computing involves processing data closer to its source rather than relying on a centralised data centre. This approach enhances performance by reducing latency, bandwidth usage and the load on central servers. Edge computing is particularly useful for applications requiring real-time data processing and low latency, such as IoT, autonomous vehicles and smart cities. It's the opposite of cloud computing.

Key benefits

Edge computing improves responsiveness and efficiency by minimising data transmission distances, leading to faster decision making, reduced network congestion and enhanced overall system performance.

2 KEY CONCEPTS

Fundamental principles

- **Proximity to Data Sources:** data is processed near its source, reducing the need to send it to distant cloud servers. This speeds up processing and is vital for real-time applications.
- **Latency Reduction:** edge computing cuts down on delays by processing data locally. This is essential for time-sensitive applications like autonomous vehicles and industrial automation.
- **Bandwidth Optimisation:** by handling data at the edge, only important or processed data is sent to the cloud, reducing network traffic. This lowers bandwidth costs and prevents network congestion.

Terminology

- Edge Node: a computing resource located at the edge of the network that performs data processing and analytics.
- Fog Computing: an extension of cloud computing that brings computation, storage and networking closer to the end user.
- Local Processing: processing data on-site rather than sending it to a remote data centre, often used in edge computing.
- Bandwidth: the capacity of a network to transmit data; edge computing helps manage bandwidth usage by reducing the need to transmit large volumes of data.

Comparison

- **Edge Computing vs Cloud Computing:** edge computing processes data locally to reduce latency, while cloud computing relies on centralised data centres, which can introduce latency and require significant bandwidth.
- **Edge Computing vs Fog Computing:** both bring computation closer to the data source, but fog computing encompasses a broader range of technologies and services beyond edge nodes.

3 POPULAR TECHNOLOGIES AND FRAMEWORKS

Primary technologies

- IoT Devices: devices that collect and send data to edge nodes for processing, such as smart sensors and cameras.
- Edge Servers: servers placed closer to the end user to handle data processing tasks at the edge of the network.
- Edge Analytics: tools and platforms that perform real-time data analysis on edge devices.

4 APPLICATIONS

Industry use cases

- **IoT:** enhancing the performance and responsiveness of IoT devices by processing data locally.
  > Best Practice: AWS IoT Greengrass.
- **Autonomous Vehicles:** real-time data processing and decision making for vehicle navigation and safety systems.
  > Best Practice: NVIDIA DRIVE.
- **Healthcare:** monitoring and analysing patient data in real-time for better diagnostics and treatment.
  > Best Practice: GE Healthcare's Edge Analytics.

Practical examples

- Microsoft Azure IoT Edge: a platform that extends Azure services to edge devices for local processing and analytics.
- Industrial Automation: Siemens uses edge computing to enable predictive maintenance by processing machinery sensor data on-site, reducing downtime and maintenance costs.
- Energy Management – Smart Grids: PG&E uses edge computing to analyse smart meter and grid sensor data in real time, optimising energy distribution and improving outage detection and renewable energy integration.

5 IMPLEMENTATION INSIGHTS

Best practices and tips

- **Integration:** ensure seamless integration of edge computing solutions with existing IT infrastructure.
- **Security:** implement robust security measures to protect data processed and stored at the edge.
- **Resilience and availability:** edge devices can continue to operate even when disconnected from the cloud.

Common challenges

- **Scalability:** managing and scaling edge computing infrastructure to accommodate varying workloads and data volumes.
- **Ensure Interoperability:** ensure that edge devices can seamlessly integrate with central systems and other devices.
- **Latency:** ensuring low latency and real-time processing.

6 KEY TRENDS AND PREDICTIONS

Top milestones in Edge Computing

- **2012:** emergence of the concept of edge computing as a distinct technology approach.
- **2017:** major tech companies begin investing heavily in edge computing infrastructure and solutions.
- **2021:** widespread adoption of edge computing in various industries, driven by the growth of IoT and smart devices.

Current trends

- **Increased IoT Deployment:** growing use of edge computing to support the expanding number of IoT devices and applications.
- **5G Integration:** integration of edge computing with 5G networks to enhance real-time data processing.
- Edge Cloud Hybrid Models: growth of hybrid models combining edge and cloud computing to optimise performance and scalability.

Future predictions

- **Enhanced AI Capabilities:** development of advanced AI and machine learning models for edge computing to support complex applications.
- **Increased Adoption:** growth in edge computing to process data closer to the source, improving speed and efficiency for applications like IoT and AI.
- **Rise of Privacy and Security Solutions:** as more sensitive data is processed locally, edge computing will drive new security and privacy innovations.

7 KEY RESOURCES AND MOST HELPFUL LINKS

Websites and blogs

- Edge Computing News: News and insights on edge computing technologies and trends.
- Network World: Edge Computing: articles and updates on edge computing developments.
- Benefits of Edge Computing by HPE: offers a compact overview of edge computing.

Online courses

- Applied Edge AI: Deep Learning Outside of the Cloud: by Open HPI.
- Edge Computing and 5G by Qualcomm Technologies: focuses on edge computing and 5G architecture.
- Edge Computing for Internet of Things – Pluralsight: how generative AI is transforming the edge computing world.

Communities and forums

- IEEE Edge Computing Community: IEEE is a renowned organisation in the tech space, and its Edge Computing Community is a go-to for professionals in research, academia and industry.
- Linux Foundation – LF Edge Community: LF Edge is an umbrella organisation under the Linux Foundation focused on building an open-source ecosystem for edge computing.
- IoT for All – Edge Computing Section: IoT for All is a popular IoT blog and community that includes a section dedicated to edge computing. It provides articles, interviews and community discussions.

8 GLOSSARY

Common terms and definitions

- Edge Devices: hardware that generates, processes and stores data at the edge of the network, including sensors, IoT devices and gateways.
- Latency: the time delay between data generation and processing; edge computing reduces latency by processing data locally.
- Data Sovereignty: the concept of keeping data within a specific geographic location or jurisdiction, which edge computing can facilitate by processing data locally.
- Decentralised Computing: distributing computational tasks across multiple locations rather than relying on a central server.

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