Edge Computing: A Decentralized Evolution of the Cloud

Galiléa LE MOULLEC (Mun ID: 202415993) Félicien MOQUET (Mun ID: 202415994)

Memorial University of Newfoundland, St. John's, Canada

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Introduction

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Over the past decade, we've seen an explosion of connected devices and services. Traditional cloud computing is showing its limits in terms of speed, privacy, and efficiency. Edge computing addresses these by bringing computation closer to where the data is generated.

Why Edge Computing?

- **Latency:** Reduces delay for real-time responses
- **Bandwidth:** Minimizes data transfer volume
- **Privacy:** Keeps sensitive data local
- **Resilience:** Operates even with cloud disconnections

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Edge computing helps reduce latency by processing data locally. It decreases bandwidth use, enhances privacy, and ensures services continue running even if the cloud is unavailable.

Architecture Overview

- **Edge devices:** Sensors, wearables, cameras
- **Edge nodes:** Gateways, micro-servers, local processors
- **Cloud layer:** For large-scale analytics and storage

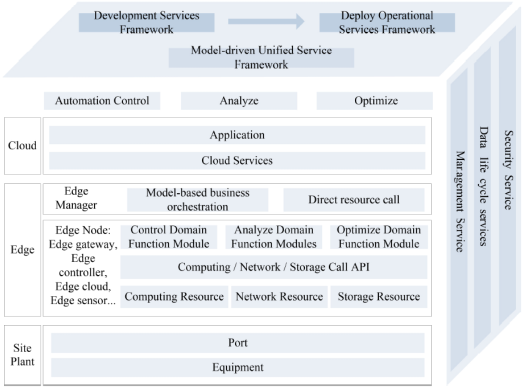
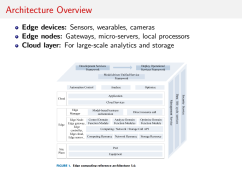


FIGURE 1. Edge computing reference architecture 3.0.



The edge architecture consists of three layers: edge devices, edge nodes, and the cloud. The goal is to shift part of the processing to the edge, while still leveraging cloud capabilities.

Use Case: Internet of Things (IoT)

- Smart homes: temperature, lighting, security
- Environmental monitoring: air quality, agriculture
- Local processing improves responsiveness and privacy

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IoT applications benefit from edge computing through fast reactions and privacy. In smart homes, sensors react immediately. In agriculture, edge devices adapt irrigation in real time.

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Autonomous vehicles need to process data within milliseconds. Edge computing allows cars to detect obstacles and make driving decisions instantly, which is essential for safety.

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- Energy optimization and environmental monitoring

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Edge computing enables cities to be smarter and more efficient. Local processing in traffic lights and surveillance systems improves responsiveness and reduces network dependency.

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Healthcare systems use edge computing for real-time monitoring and diagnostics. Patient data stays local, enhancing privacy and compliance with health data regulations.

Advantages and Challenges

Advantages:

- Lower latency and bandwidth usage
- Better data privacy and security
- Improved resilience and scalability

Challenges:

- Complex management of distributed nodes
- Interoperability with cloud platforms
- Security at the edge

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While edge computing has many strengths, it introduces new challenges. Managing and securing distributed nodes is complex, and integration with existing cloud systems remains tricky.

Trends and Future Perspectives

- Integration with AI and 5G for smarter edge decisions
- Lightweight containers and orchestration (e.g. K3s)
- Research in privacy-preserving analytics, federated learning

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Edge computing is evolving. With AI, devices make smarter decisions. 5G supports high-speed communication. New tools like K3s make edge deployment easier, and research continues on privacy.

Conclusion

- Edge computing addresses key limitations of centralized cloud
- Use cases show strong benefits in latency, privacy, and efficiency
- Future: a hybrid cloud-edge ecosystem

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In conclusion, edge computing complements the cloud. It improves response times, protects data, and enables smarter systems. The future lies in combining both models for flexibility and power.

Discussion Point

Edge computing reduces data exchanges by processing locally. But:
With network demands constantly rising, will edge computing be enough?
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Open Discussion
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With network demands constantly rising, will edge computing be enough?
Or is it just a temporary relief before a new saturation point?

Let's open the floor: Do you think edge computing is a long-term solution, or just a short-term patch? Can it keep up with the exploding demand for connectivity and data?