

Edge Computing: A Decentralized Evolution of the Cloud

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Introduction

Definition

Edge computing is a distributed computing paradigm that integrates networking, computing, storage, and application resources **near data sources** to provide intelligent services with minimal delay. By processing and storing data closer to its origin, edge computing **minimizes latency**, **optimizes bandwidth usage**, and **enhances system responsiveness**

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

Architecture Overview

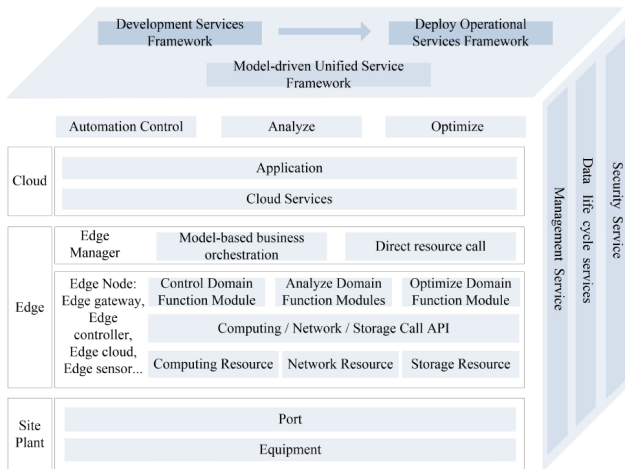


Figure 1: Edge computing reference architecture

Use Case: Internet of Things (IoT)

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

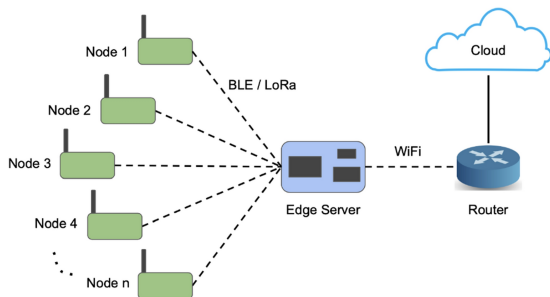


Figure 2: IoT use case

Use Case: Autonomous Vehicles

- Onboard sensors generate huge data streams
- Requires instant decision-making (e.g. braking)
- Edge computing enables safety-critical operations

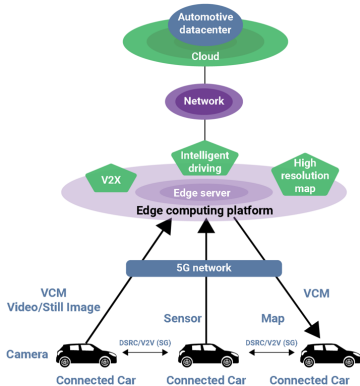
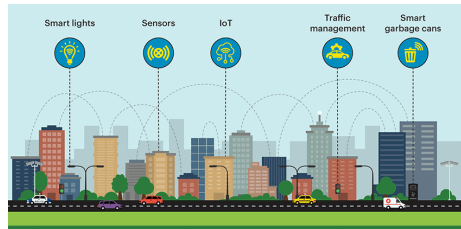


Figure 3: Autonomous vehicles use case

Use Case: Smart Cities



- Real-time traffic management
- Public safety and surveillance
- Energy optimization and environmental monitoring

Figure 4: Smart cities use case

Use Case: Healthcare and Telemedicine

- Real-time patient monitoring
- On-site diagnostics in emergencies
- Strong data privacy and compliance (e.g. GDPR)

Cloud Computing Vs. Edge Computing in Healthcare

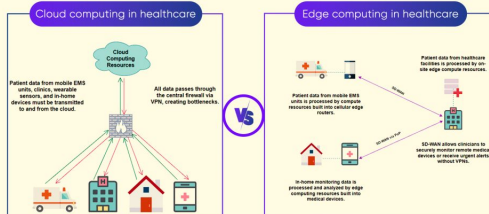


Figure 5: Healthcare use case

Advantages and Challenges

Advantages:

- Lower latency and bandwidth usage
- Better data privacy
- Improved resilience and reliability

Challenges:

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

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

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

Open Discussion

Discussion Point

Edge computing reduces data exchanges by processing locally. But:
With network demands constantly rising, will edge computing be enough?

Or is it just a temporary relief before a new saturation point?

References

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- *Figure 2:* Nature, "The rise of IoT: Edge computing applications," Sci. Rep. 11, 2021. Available: <https://www.nature.com/articles/s41598-021-01431-y>
- *Figure 3:* GSA Global, "Edge AI Computing Advancements Driving Autonomous Vehicle Potential," 2023. Available: <https://www.gsaglobal.org/forums/edge-ai-computing-advancements-driving-autonomous-vehicle-potential/>
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- *Figure 5:* CIO Influence, "Best Practices for Integrating Edge Computing in Healthcare," 2023. Available: <https://cioinfluence.com/it-and-devops/best-practices-for-integrating-edge-computing-in-healthcare/>