

Edge Computing: A Decentralized Evolution of the Cloud

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- Rapid growth of connected devices and real-time applications
- Traditional cloud computing reaches its limits
- **Edge computing** brings computation closer to the data source

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.

- Rapid growth of connected devices and real-time applications
- Traditional cloud computing reaches its limits
- **Edge computing** brings computation closer to the data source

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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└ Why Edge Computing?

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.

Why Edge Computing?

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Architecture Overview

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

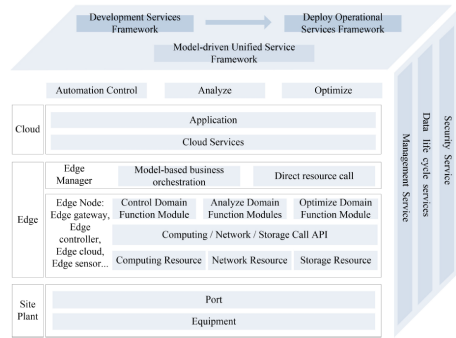


Figure 1: Edge computing reference architecture

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Architecture Overview

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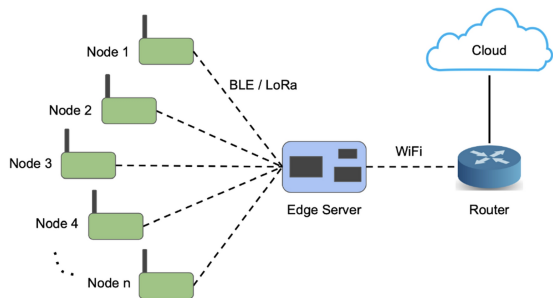
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Figure 1: Edge computing reference architecture

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



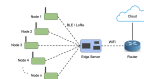
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Use Case: Internet of Things (IoT)

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.

Use Case: Internet of Things (IoT)

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Use Case: Autonomous Vehicles

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



Figure 2: Smart homes architecture

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└ Use Case: Autonomous Vehicles

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.

Use Case: Autonomous Vehicles

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Figure 2: Smart homes architecture

Use Case: Smart Cities

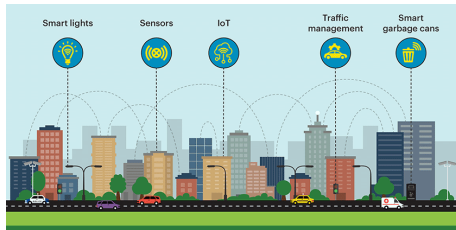


Figure 4: Smart cities architecture

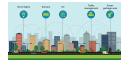
- Real-time traffic management
- Public safety and surveillance
- Energy optimization and environmental monitoring

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Use Case: Smart Cities

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

Use Case: Smart Cities



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

Figure 4: Smart cities architecture

Use Case: Healthcare and Telemedicine

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

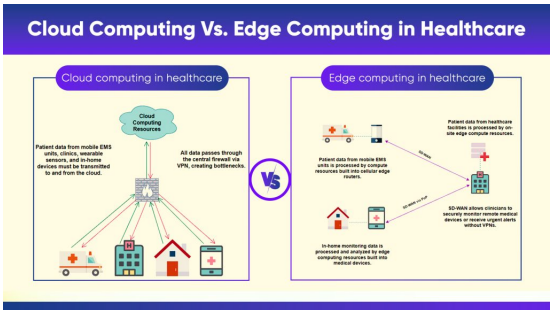


Figure 4: Edge computing

reference architecture

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└ Use Case: Healthcare and Telemedicine

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

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 4: Edge computing reference architecture

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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Advantages and Challenges

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.

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- 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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└ Trends and Future Perspectives

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.

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- 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

Thank you!

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Conclusion

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.

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

Thank you!

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?

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└ Open Discussion

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?

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References

- *Figure 1*: K. Cao, Y. Liu, G. Meng, et Q. Sun, «An Overview on Edge Computing Research», IEEE Access, vol. 8, p. 85714-85728, 2020, doi: 10.1109/ACCESS.2020.2991734.
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