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Cloud-Natives Edge Computing for 5G Applications

Prof. S.K. Totade[1], Akanksha Deshmukh[2], Janhvi Yadav[3], Tushar Chunatkar[4], Jesika Chourpagar[5]

Assistant Professor, Department of MCA, Vidya Bharati Mahavidyalaya, Amaravati, India[1]

Student, Department of MCA, Vidya Bharati Mahavidyalaya, Amaravati, India[2-5]

Abstract: The integration of cloud-native technologies with edge computing is transforming the deployment of 5G applications by enabling ultra-low latency, scalable, and reliable services. This paper provides an overview of cloud-native edge computing in the context of 5G networks, discussing its architecture, benefits, challenges, security concerns, and real-world applications.

Keywords: 5G, Cloud-Native, Edge Computing, Kubernetes, Microservices, IoT, Low Latency

I. INTRODUCTION

The rise of 5G technology has driven innovations in communication networks, offering faster speeds, ultra-low latency, and enhanced connectivity. Edge computing processes data close to the source, reducing backhaul and supporting real-time applications. Combined with cloud-native technologies, this enables dynamic, scalable service delivery at the edge of 5G networks.

Service providers:

- Google Cloud
- AWS(Amazon web server)
- Microsoft Azur

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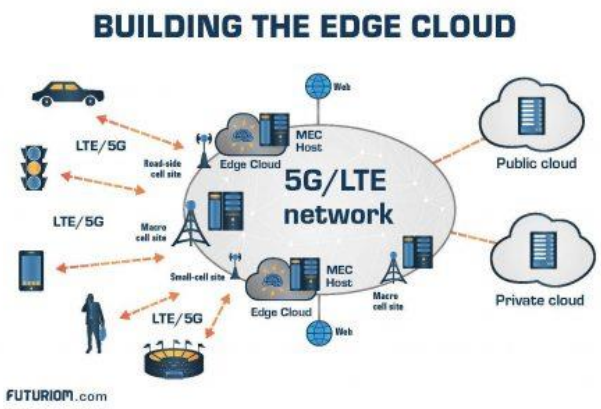
II. CLOUD-NATIVE TECHNOLOGY OVERVIEW

ECC encryption efficiently encrypts messages by utilizing varying points on an elliptic curve. This method uses a short key size of 256 bits which makes it difficult for algorithms to attack the encryption system as the computing complexity of attacking algorithms is O (2^128). Cloud clients' IDs and private keys are stored in their smart cards to prevent illegal users from generating a valid digital signature.

III. EDGE COMPUTING IN 5G

Edge computing shifts processing and storage from central cloud servers to distributed edge nodes. This reduces latency and enables real-time decision-making. In 5G environments, edge nodes are often located at base stations or near IoT devices for immediate data processing.



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IV. CLOUD-NATIVE EDGE ARCHITECTURE

A cloud-native edge architecture includes:

- Microservices-based application design
- Containerization (e.g., Docker)
- Orchestration (e.g., Kubernetes)
- Distributed edge nodes
- Continuous deployment and monitoring systems

V. BENEFITS OF CLOUD-NATIVE EDGE IN 5G

- Ultra-low Latency: Real-time data processing
- Scalability: Easy horizontal scaling
- Resource Optimization: Reduced backbone load
- Flexibility: Deployable across diverse edge devices
- Resilience: Localized outages do not crash entire system

VI. SECURITY IN CLOUD-NATIVE EDGE COMPUTING

Security mechanisms include:

- Zero-trust authentication
- End-to-end encryption
- Role-based access control
- Secured container images and orchestration
- Automated threat detection at edge nodes

VII. CHALLENGES IN CLOUD-NATIVE EDGE FOR 5G

- Distributed management complexity
- Hardware heterogeneity
- Network latency variability
- Multi-vendor platform integration
- Data privacy and compliance risks

VIII. ORCHESTRATION IN EDGE ENVIRONMENTS

Orchestration tools like Kubernetes manage containerized applications across clusters. Lightweight versions such as K3s are often used in IoT or edge devices to maintain:

- Auto-scaling
- Self-healing
- Load balancing
- Continuous updates

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IX. USE CASES OF CLOUD-NATIVE EDGE IN 5G

1. Autonomous Vehicles – Real-time object detection

2. Smart Cities – Traffic control, surveillance

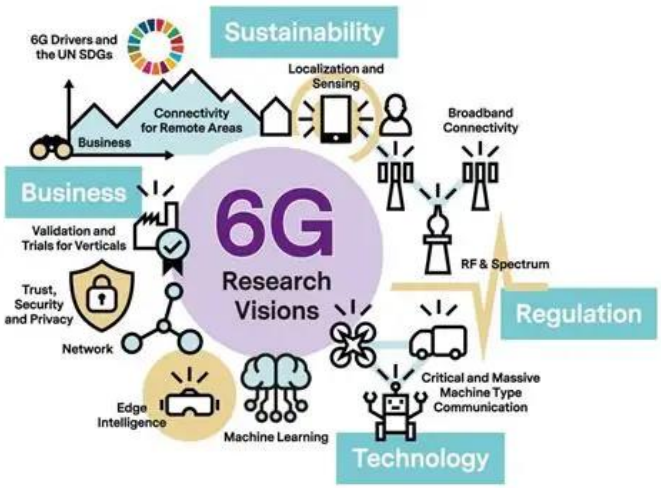
3. Healthcare – Remote surgery via robotics

4. Augmented Reality/Virtual Reality – High-speed rendering

5. Industrial IoT – Predictive maintenance, automation

X. FUTURE TRENDS AND RESEARCH SCOPE

- Future directions include:
- AI-enabled edge devices
- Distributed machine learning
- Blockchain-powered distributed edge security
- 6G-powered hyper-speed edge networks



XI. CONCLUSION

Cloud-native edge computing is a key enabler for 5G applications, providing scalability, security, and low latency. While challenges remain in orchestration, integration, and security, ongoing innovations promise improved efficiency and reliability. The fusion of 5G, edge computing, and cloud-native technologies is set to transform industries and deliver real-time intelligence to the edge.

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