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OPTIMIZED STRATEGY IN CLOUD-NATIVE ENVIRONMENT FOR INTER-SERVICE COMMUNICATION IN MICROSERVICES

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Dissertation submitted in partial fulfillment of the requirements for the degree

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DECLARATION

I declare that this is my own work, and this dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date: 20/05/2025

The above candidate has carried out research for the PhD dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Prof. Indika Perera

Signature of the Supervisor: Date: 20.05.2025

Dedicated to my family for their constant love, support, and encouragement throughout my journey.

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ABSTRACT

Microservices architecture has become the most popular architecture for building scalable and flexible applications due to its inherent advantages over monolithic and Service-Oriented Architecture (SOA) systems. It allows developers to scale individual components independently, improve maintainability through smaller codebases, and increase resilience by isolating service failures. Additionally, microservices are well-suited for cloud-native environments, supporting containerization and orchestration platforms. However, transforming monolithic systems into microservice-based systems introduces challenges with inter-service communication, leading to performance bottlenecks and increased latency due to the decentralized and distributed nature of the architecture. This research addresses the above challenge by proposing a novel communication model for cloud-native environments, focusing on optimizing inter-service communication in microservice architecture. The proposed strategy operates on top of the TCP network layer rather than the application layer, leveraging TCP streams but using a request-response-based communication model. All distributed systems typically rely on TCP-based communication over a network. To reduce the overhead of opening and closing socket connections, the proposed strategy persists the TCP connection when a microservice starts and maintains it until the service goes down. This solution reduces network resource consumption by serializing messages into binary form, thereby enhancing response times and application throughput. When sending messages over the TCP connection, we have established a method for ensuring exact-once delivery, improving the reliability and efficiency of message transfer. The proposed solution was implemented within a microservice architecture and deployed in a cloud-native environment to assess its effectiveness for cloud-native applications. The solution has been evaluated against the traditional HTTP-based communication method in the same microservice-architected environment and has shown improved performance in terms of latency and overall throughput. This research offers a robust communication model for microservices that addresses performance challenges while maintaining compatibility with cloud-native concepts. The proposed approach is a step toward optimizing microservices communication, enabling developers to build scalable, efficient, and resilient applications in distributed environments.

Keywords: Microservices, Inter-service communication, Performance

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LIST OF ABBREVIATIONS

Abbreviation	Description
OOA	Object-Oriented Architecture
SOA	Service Oriented Architecture
ESB	Enterprise Service Bus
IaaS	Infrastructure as a Service
SaaS	Software as a Service
PaaS	Platform as a Service
FaaS	Function as a Service
TPS	Transactions per second
API	Application Programming Interfaces
JMS	Java Message Service
XML	Extensible Markup Language
WSDL	Web Services Description Language
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
RPC	Remote Procedure Call
TCP	Transmission Control Protocol
IP	Internet Protocol
REST	Representational State Transfer
RESP	Redis Serialization Protocol
LLD	Low Level Diagram
VM	Virtual Machine
JVM	Java Virtual Machine
GCP	Google Cloud Platform
GKE	Google Kubernetes Engine
CI	Continues Integration
CD	Continues Delivery