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VILNIUS TECH
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Hybrid Autoscaling Algorithm of Containerized Microservices for QoS Assurance in SaaS Systems

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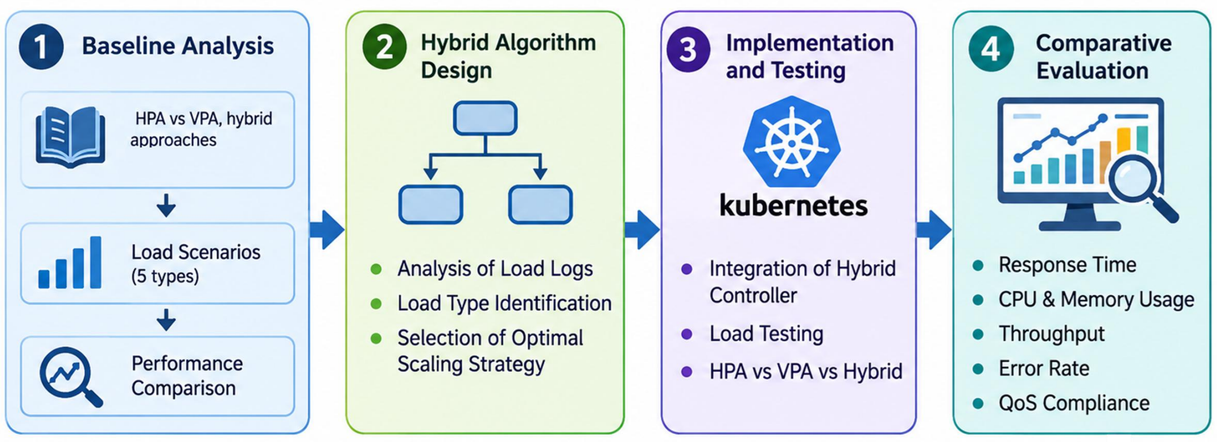
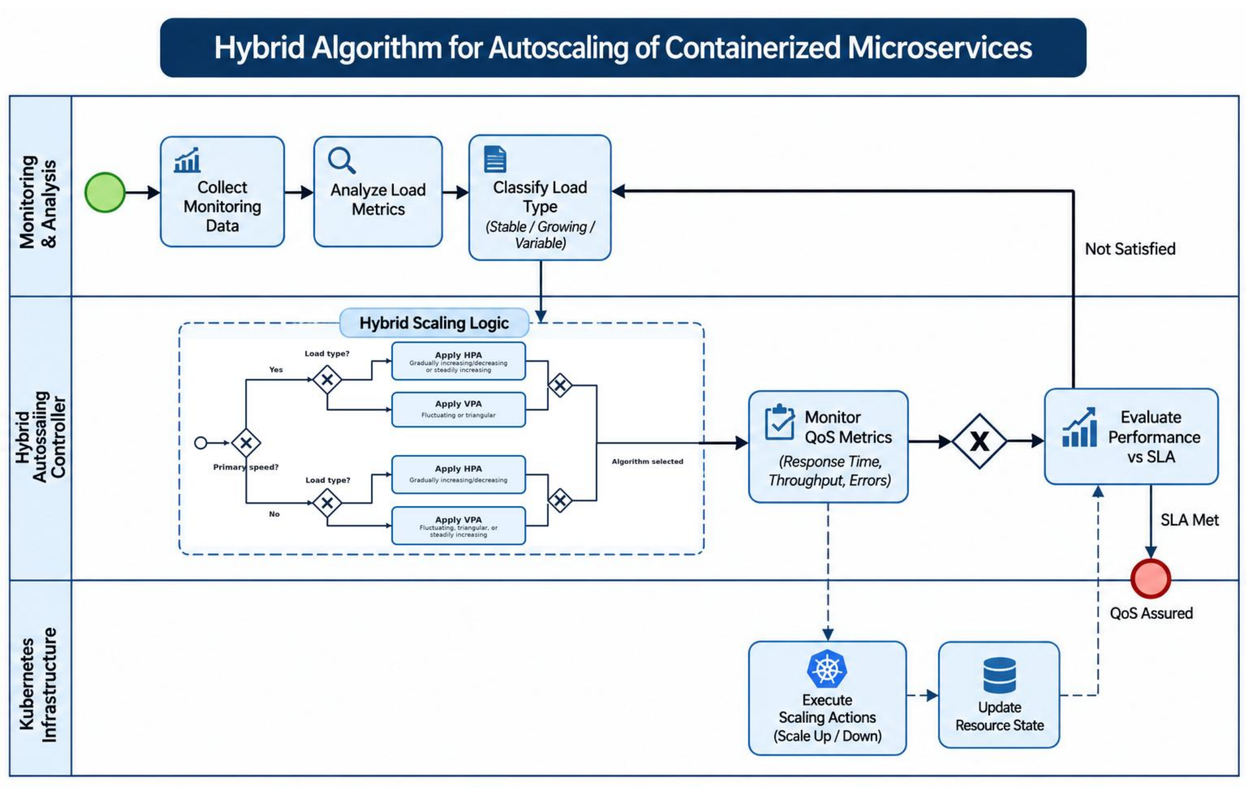
Summary. QoS assurance in Kubernetes-based microservice architectures typically rely on either horizontal (HPA) or vertical (VPA) pod autoscaling, but each autoscaler has inherent limitations: HPA offers elasticity at the cost of resource overhead and cold-start delays, while VPA is resource-efficient but constrained by node capacity. A hybrid autoscaling algorithm is proposed and evaluated. It dynamically identifies incoming load patterns using a sliding-window regression model and selects the most suitable pods autoscaling method – HPA or VPA – accordingly. The model operates on real-time metrics allowing the algorithm to adapt to workload shifts without the latency. The approach was implemented and validated on a Kubernetes cluster using a CPU-intensive load under five distinct load profiles. Results show that the hybrid autoscaler reduces average response time by up to 90% and decreases error rates by up to 99.7% compared to traditional Kubernetes autoscalers, while sustaining high throughput.

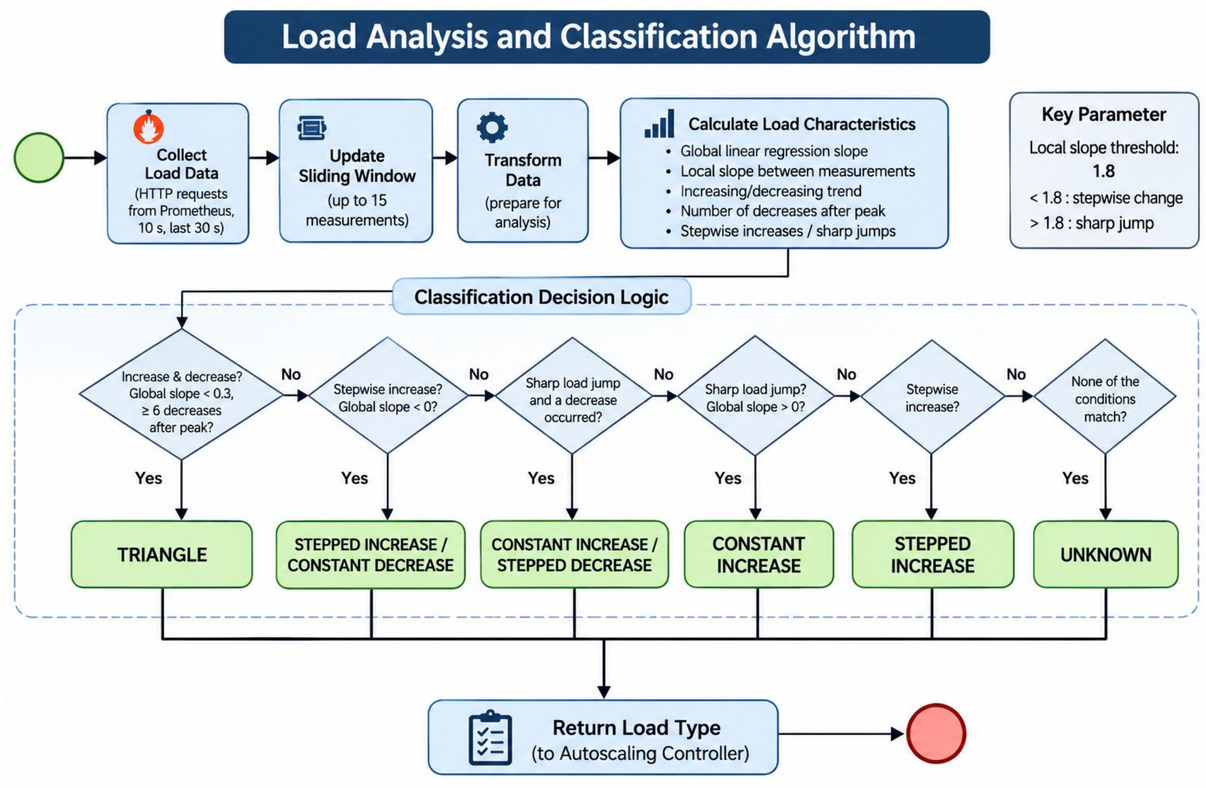
RESEARCH WORKFLOW



HYBRID ALGORITHM



LAOD CLASSIFICATION ALGORITH



RESULTS & DISCUSSION

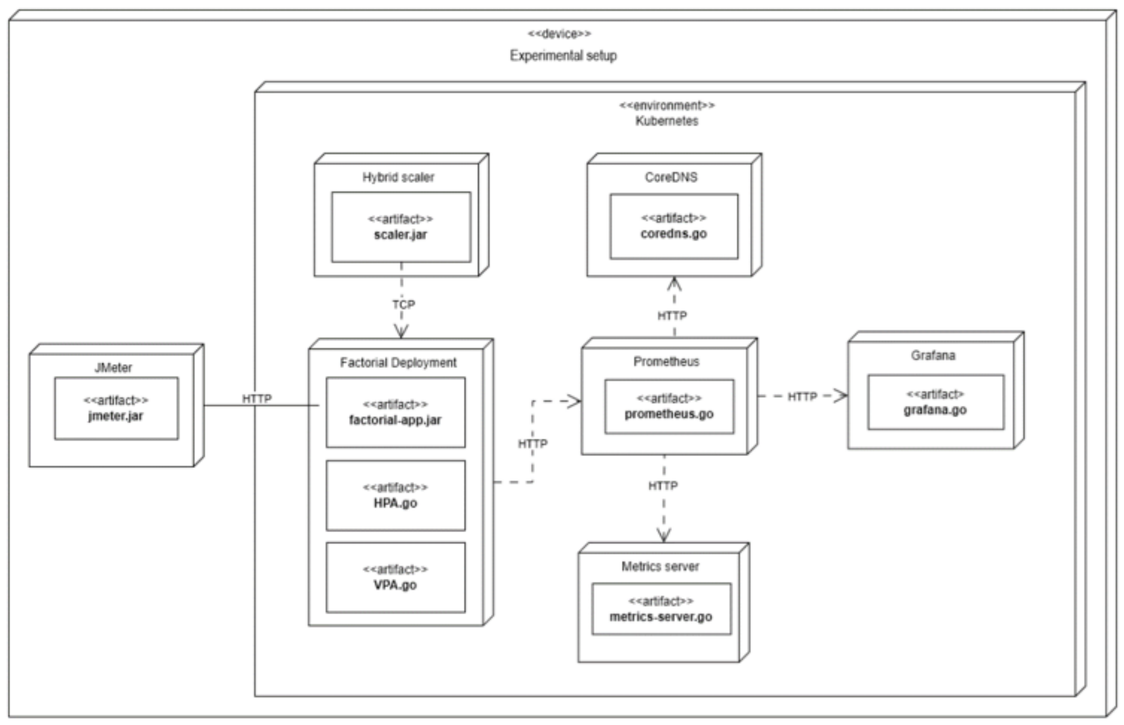


Fig 1. Experimental Setup

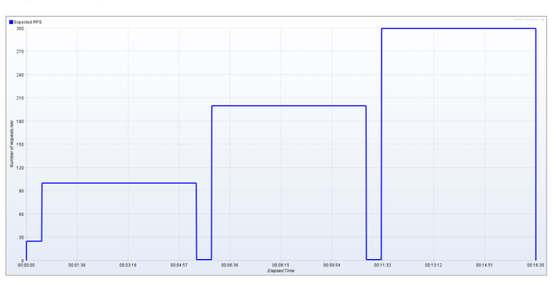


Fig 2. Increasing Load Type

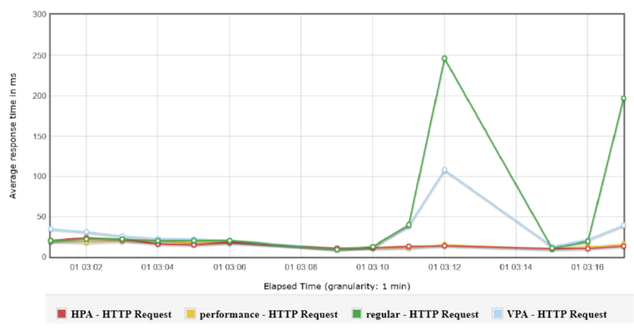


Fig 3. Response When Increasing Load is Applied

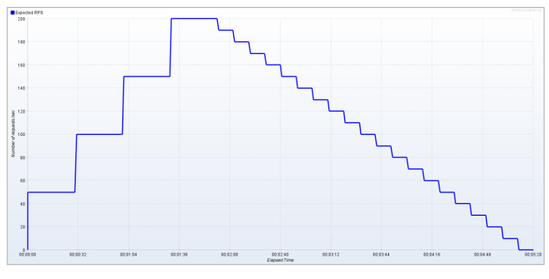


Fig 4. Increasing/Decreasing Load Type

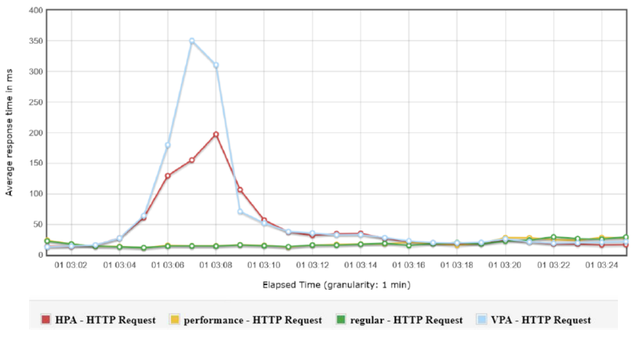


Fig 5. Increasing/Decreasing Load is Applied

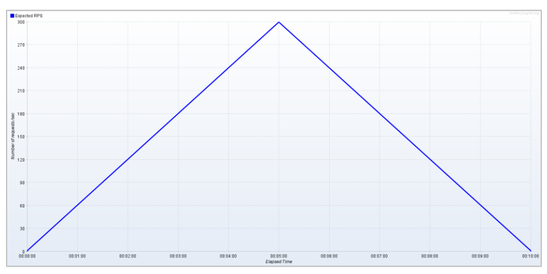


Fig 6. Triangle Load Type

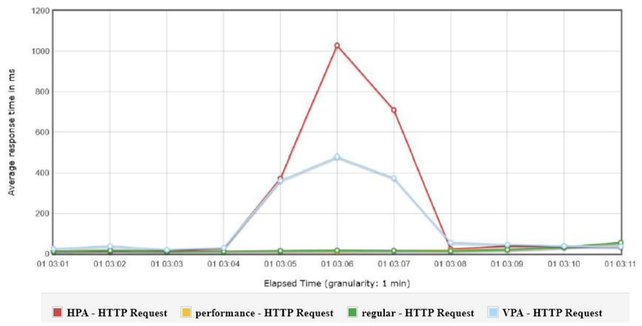


Fig 7. Response When Triangle Load is Applied

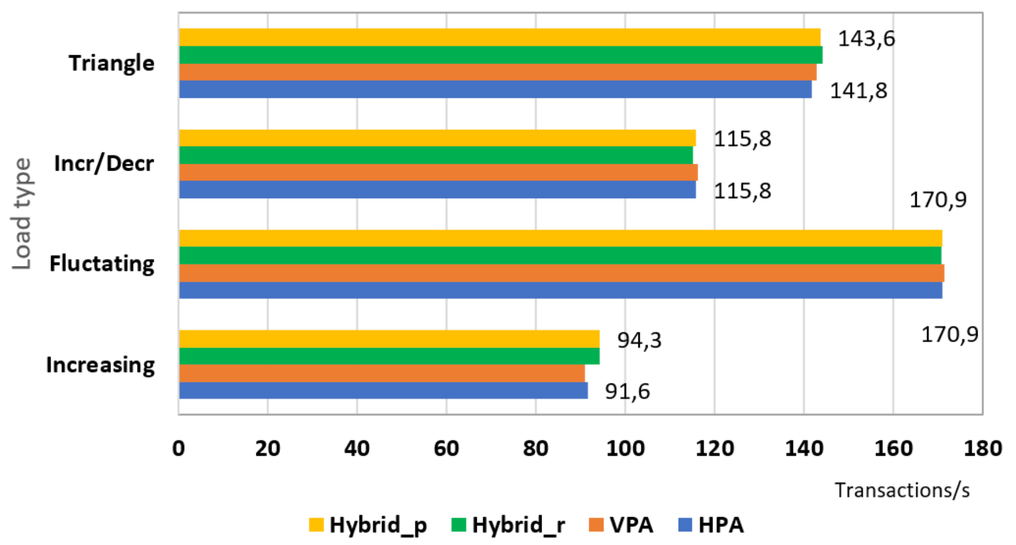


Fig 8. Throughput Comparison under Different Load