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Subject: Elective 3 **Date:** 11/23/25

Narrative Report on *"Virtualization vs. Containerization: A Comparative Approach for Application Deployment in the Computing Continuum Focused on the Edge"*

Introduction

The research study titled *"Virtualization vs. Containerization: A Comparative Approach for Application Deployment in the Computing Continuum Focused on the Edge"* by Hamish Sturley and colleagues was assigned to me for review. As a backend developer, I am already familiar with virtualization, containerization, and edge computing, having worked with both virtual machines and containers in different development and deployment scenarios. This background allowed me to approach the study with a practical perspective, understanding the nuances of each deployment method and their real-world implications for performance, scalability, and resource efficiency. The study examines how VMs and containers perform under different workloads, especially in edge environments where hardware resources are limited. Its central goal determining which approach is more effective for modern application deployment is highly relevant for developers and organizations making decisions about infrastructure design.

Purpose of the Study

The main purpose of the research was to compare virtualization and containerization to determine which method is more efficient, compatible, and sustainable. The authors aimed to identify which approach offers better performance, energy efficiency, and scalability, particularly in edge and cloud computing environments where resource constraints are critical. The study provides guidance for developers and organizations, helping them choose the deployment strategy that best aligns with their goals whether it's maximizing flexibility and speed with containers or ensuring full system isolation with VMs.

Research Process and Methodology

The researchers conducted experiments to compare both technologies under the same conditions. They used benchmarking tools like stress-ng to simulate workloads, system monitors like top to track resource usage, and power meters to measure energy consumption. Different deployment setups were tested using Docker, Podman, Docker Compose, and Kubernetes on both ARM-based devices (Raspberry Pi) and x86 systems (Proxmox Virtual Environment). These

experiments allowed the researchers to evaluate performance across different hardware architectures and deployment methods. To provide practical context, the study included a real-world use case: drone image processing using OpenDroneMap. This scenario demonstrated how containerization and orchestration tools can improve speed and scalability for complex computing tasks, highlighting the practical benefits of containers in distributed workloads.

Findings and Insights

The study found that containers are generally more lightweight and energy-efficient than virtual machines. Docker and Podman offered faster performance and simpler deployment for smaller workloads, while Kubernetes proved effective for large-scale, long-running operations requiring automation and orchestration. ARM-based systems were more energy-efficient and better suited for edge computing, whereas x86 systems could struggle when emulating older hardware architectures. In the drone data use case, distributing tasks through containers significantly sped up image processing and optimized resource utilization, demonstrating the real-world advantages of containerized deployments.

Reflection

As someone experienced with backend development and familiar with both virtualization and containerization, this study reinforced my understanding of the trade-offs between the two approaches. While I already knew that virtual machines provide full isolation and containers offer lightweight, flexible deployment, the research provided concrete experimental data and insights on energy efficiency and performance in edge computing. It was also interesting to see how hardware choice ARM versus x86 impacts efficiency and performance, emphasizing that deployment decisions should consider both the software and underlying infrastructure. The study validated the practical benefits I have observed firsthand with containerized applications, particularly in improving scalability and optimizing resource usage.

Conclusion

In conclusion, this research highlights the complementary roles of virtualization and containerization in modern computing. Containers excel in lightweight, flexible, and scalable deployments, especially in edge environments, while virtual machines remain essential for applications requiring full isolation or system control. Reading this study strengthened my appreciation of these technologies and their impact on cloud and edge computing. It provided both theoretical and practical insights that align closely with my experience as a backend developer, enhancing my understanding of how organizations can optimize their deployment strategies for efficiency, scalability, and sustainability.

Reference

Sturley, H., Fournier, A., Salcedo-Navarro, A., Garcia-Pineda, M., & Segura-Garcia, J. (2024). *Virtualization vs. Containerization: A Comparative Approach for Application Deployment in the Computing Continuum Focused on the Edge.* Future Internet, 16(11), 427. https://doi.org/10.3390/fi16110427