



Master thesis No. 1088

Design and Implementation of a Lightweight VM Orchestrator for Cooperative PCIe Device Sharing



Methods

Simulation

Topics

Network control

Background

Modern cloud infrastructures are commonly managed using large orchestration platforms such as OpenStack, which provide extensive services for compute, networking, and storage management. While these systems are suitable for production-scale deployments, their control planes require considerable resources and introduce significant operational overhead. Even small installations often require several gigabytes of memory solely for the orchestration infrastructure, limiting their usability for small clusters, laboratory environments, or edge deployments. At the same time, modern networking hardware exposes advanced capabilities such as hardware offloading, which are essential for high-performance networking experiments, time-sensitive workloads, and software-defined networking research. Lightweight and modular orchestration architectures therefore represent a promising approach for enabling flexible research infrastructures with minimal overhead.

Problem Description

The objective of this student work is to design and implement a lightweight virtual machine orchestration prototype intended for laboratory and research environments. The system should manage virtual machines across multiple hypervisor nodes while maintaining a minimal controlplane footprint and a modular architecture. The work consists of the following tasks:

- Familiarization with existing cloud orchestration platforms and lightweight infrastructure architectures
- Design of a modular orchestration architecture for managing hypervisors and virtual machines in a cluster
- Implementation of a prototype supporting VM lifecycle management, networking, and storage integration
- Integration of hardware features such as PCIe passthrough for high-performance networking experiments
- Experimental evaluation of system overhead and scalability compared to existing orchestration platforms

Acquired Knowledge and Skills

The student will gain practical experience in designing distributed infrastructure systems and implementing lightweight cloud orchestration software. The work provides insights into virtualization technologies, networking integration, and hardware acceleration mechanisms. Furthermore, the student will strengthen skills in distributed system architecture, infrastructure automation, and the experimental evaluation of resource efficiency and scalability in modern cloud environments.

Requirements

Programming Experience
Basic Machine Learning Knowledge

Contact

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