Master Thesis Project Proposal

Performance evaluation of container runtimes for real-time application workloads in Kubernetes-based edge infrastructure

Objective

This master's thesis project involves evaluating various cutting-edge container runtimes[1] to aid in the realization of data-driven real-time application workloads (e.g., industrial IoT applications) at the edge infrastructures.

Background

Realizing factory automation in which time-critical industrial processes are managed from the edge necessitates the support of real-time requirements by edge infrastructures. These edge infrastructures are being realized through lightweight virtualization technologies, such as docker containers which are managed by Kubernetes (K8s)[2]. Kubernetes is a portable, extensible, open-source platform for managing containerized workloads and services. In Kubernetes, Kubelet[3] is an agent that runs on every computing node. It receives commands specifying what containers should be running and relays them to a container runtime on the node. It also collects information from the container runtime about currently running containers and passes it back to the Kubernetes control plane. The selection of a container runtime itself becomes critical in the case of strict performance requirements.

The goal of this thesis project is to evaluate various combinations of Open Container Initiative (OCI) runtimes (e.g., runC) and Container Runtime Interface (CRI) (e.g., containerd) for real-time application workloads deployment in an edge infrastructure and then recommend the best possible combination for required performance guarantees. Evaluation aspects of container runtimes may include criteria such as the performance of running containers, container runtime operations, scalability, and security.

Basic Requirements & Expected Outcomes

- Expertise in programming languages (e.g., Python, Go, C).
- Good understanding of the Linux Operating System (OS).

[1] https://www.aquasec.com/cloud-native-academy/container-security/container-runtime/
[2] https://kubernetes.io/docs/concepts/overview/
[3] https://kubernetes.io/docs/reference/command-line-tools-reference/kubelet/

- Basic understanding of container management and orchestration platforms (e.g., Docker, Kubernetes, etc.).
- The expected deliverable would be an evaluation and recommendation with potential container runtimes that is/are best suited for real-time application workloads in edge infrastructures.

Please Note: The scope of the project can be aligned according to the student's abilities and interests. The description provided here is to get started.

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