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Serverless Computing & Lightweight Virtualization with OpenFaaS

Outline

- Serverless Computing
- OpenFaaS
- Lightweight Virtualization for Serverless Platforms
- Demo

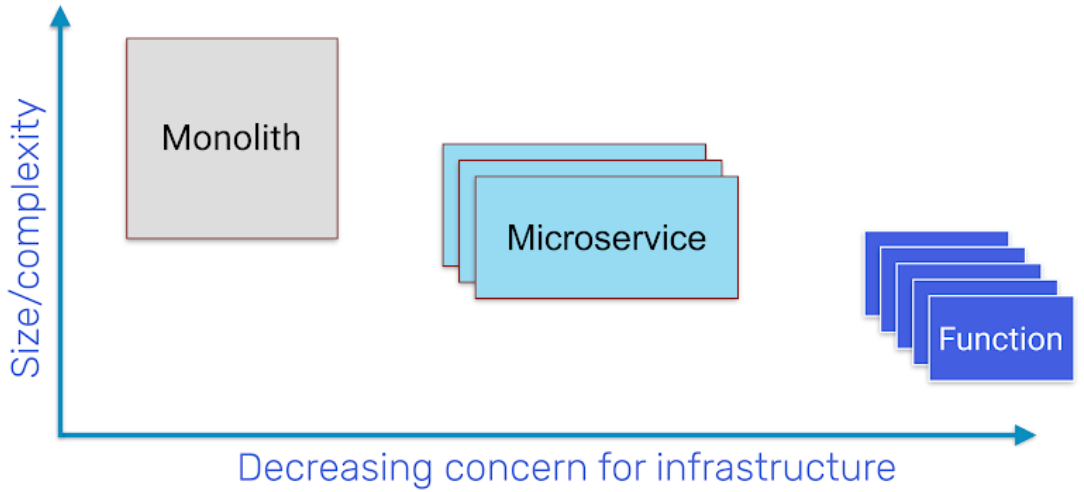
What is Serverless Computing?

- Fine-grained deployment model for cloud/edge/fog computing services
- No provisioning, updating, and managing server infrastructure (= serverless)
- Focus on code
- Automatic scalability
- No compute cost when idle

What is Serverless Computing?

Functions-as-a-Service (*FaaS*):

- Focus on code
- Modular
- Event driven / REST endpoints
- Stateless
- Isomorphic



From LinuxFoundationX: LFS157x,Introduction to Serverless on Kubernetes

What is Serverless Computing?

Scalability in serverless platforms takes two forms:

- Scaling down idle functions to save costs and reduce load on the system. Increased latency as the code is re-deployed, or re-initialized (cold start mode)

- Scaling up functions proportionally as demand increases.

Serverless Benefits vs Drawbacks

Benefits:

- Automated scaling
- OS, runtime, and even container lifecycle is completely abstracted
- Smart resources usage
- Strongly reduced infrastructure maintenance

Drawbacks:

- Complex debugging
- Lack of standardization and ecosystem maturity
- Occasionally, more operational surface area for the same amount of logic
- Risk of latency and performance issues (cold start)

General Scope

Serverless approach is particularly suitable for workloads:

- Asynchronous, concurrent and easy to parallelize into units of work
- Stateless, ephemeral and/or not too latency sensitive (cold start issues)
- With unpredictable variance in scaling requirements
- Highly dynamic in terms of changing business requirements

Use Cases

- Executing logic in response to database changes
- Performing analytics on IoT sensor input messages
- HTTP REST APIs and web applications (client serverless)
- Serving pre-trained machine learning and AI services

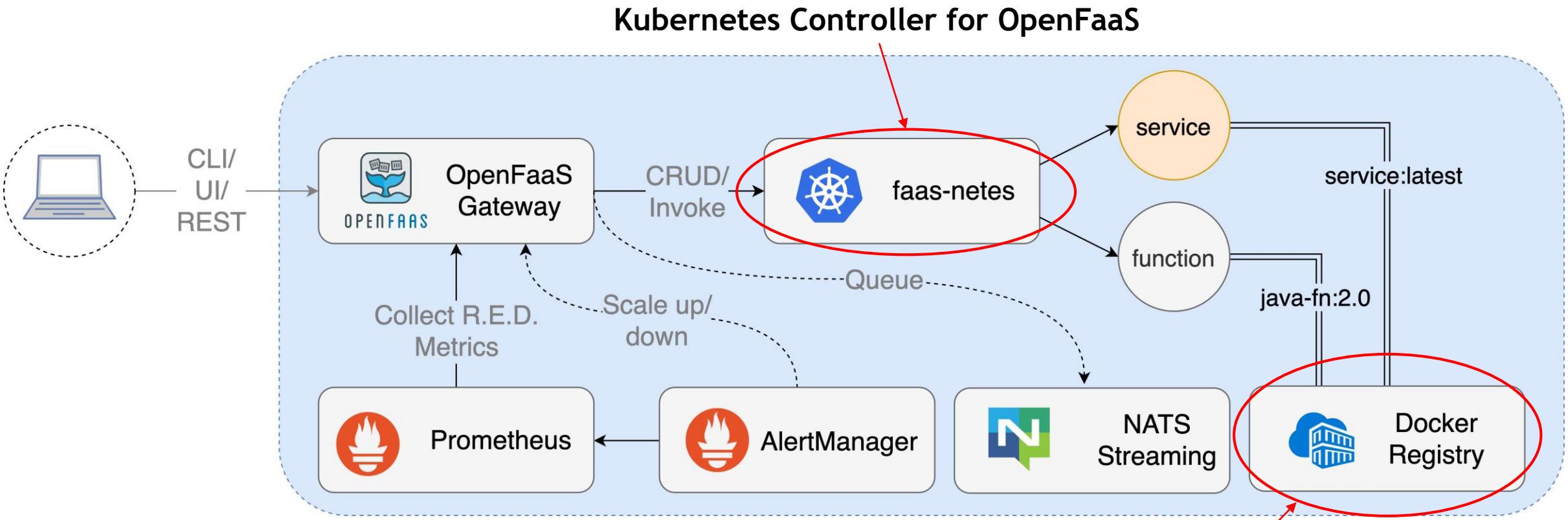
Opensource Serverless Platforms

Various opensource serverless platform: OpenFaaS, Apache Openwhisk, Kubeless, Fission…

OpenFaaS is the platform with the highest adoption rate, with over 22k GitHub stars:

- It provides a flexible framework to deploy functions on Docker Swarm or Kubernetes, exposed via REST API. Templates for different languages are available.
- Auto-scaling with Prometheus or Kubernetes HPAv2.
- Event triggers: Apache Kafka, NATS, MQTT, and others

OpenFaaS Conceptual Workflow



From https://docs.openfaas.com/architecture/stack/

Lightweight Virtualization for Serverless

Virtual machines often lead to long startup time and resource overprovisioning.

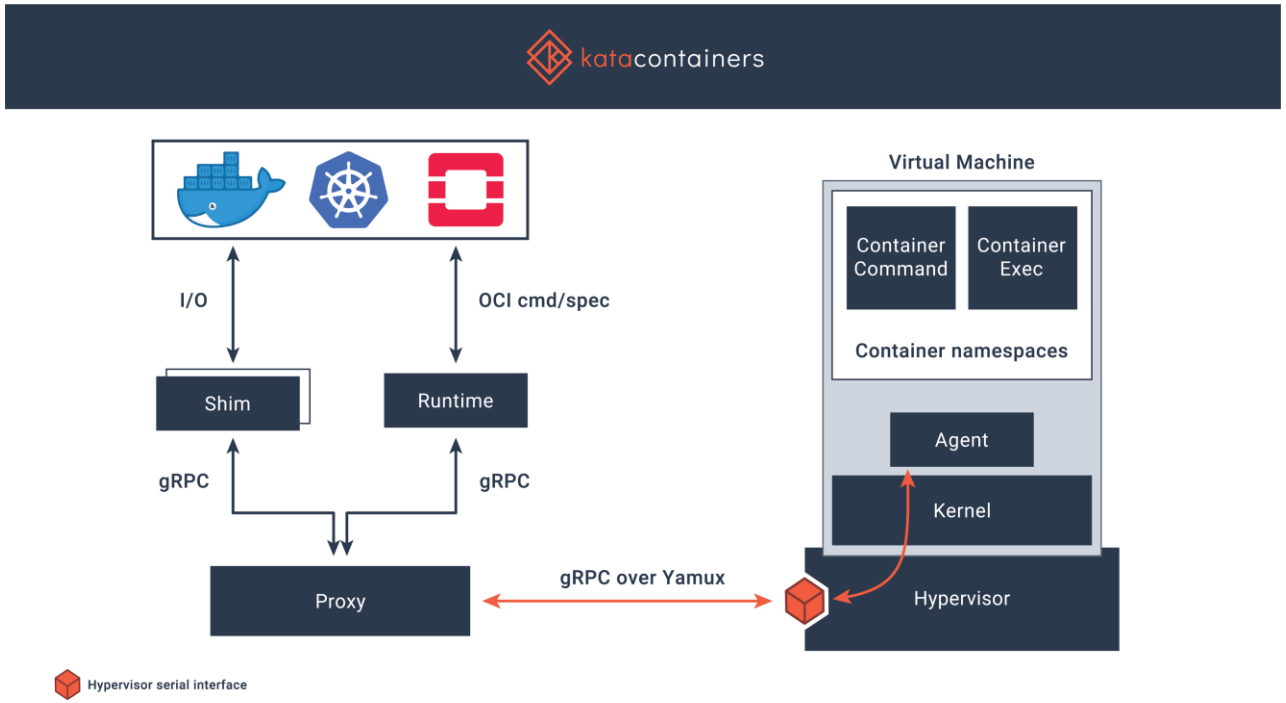
The standard virtualization approach for serverless computing relies on containers.

Containers are faster and lighter than VMs, but in some security-sensitive cases the usage of a shared kernel could be an issue.

It is interesting to explore new lightweight virtualization solutions.

Kata Containers

- Openstack Foundation project started in 2017, merger of two existing open source projects: Intel Clear Containers and Hyper runV
- Containers wrapped into dedicated microVMs
- It supports multiple hypervisors including QEMU, NEMU, Cloud Hypervisor and Firecracker
- Compatible with Docker, Kubernetes and Openstack Zun.
- Available OpenFaaS runtime
- Written in Rust



Modular Hypervisors for MicroVMs

Lightweight hypervisors based on Rust-VMM (Virtual Machine Manager).
The focus is on minimal device emulation, low memory footprint and performance.

Amazon Firecracker:

- It exposes a client API, serial console and a reset controller
- Limitations in filesystem sharing, device hotplug support and dynamic resizing of resources
- Fast startup time
- Available on Kubernetes via Weave Firekube

Intel Cloud Hypervisor:

- It supports device hotplug support and dynamic resizing of resources
- Available for Kubernetes runtime
- Initial Windows guests support
- Less mature than Amazon Firecracker

Demo

- Deployment of a mock machine learning serverless function in OpenFaaS
- Scaling via API requests

For more info

Benedetti, P.; Femminella, M.; Reali, G.; Steenhaut, K. Experimental Analysis of the Application of Serverless Computing to IoT Platforms. Sensors 2021, 21, 928. https://doi.org/10.3390/s21030928

Available at: https://www.mdpi.com/1424-8220/21/3/928/pdf

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