Picocenter: Supporting long-lived, mostly-idle applications in cloud environments

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Motivation

End-users wish to run wide range of applications in the cloud  
E.g., iRedMail, ownCloud, GitLab, Rocket.Chat

These applications are long-lived but mostly idle (LLMI) apps  
Long-lived: Users wish them to be available for a long time
Mostly-idle: Personalized services are likely to be idle

Problem:  
Current cloud computing models are not suited for LLMI apps

A hosting infrastructure designed to run lots of LLMI apps in the cloud
Provide a process-like environment and arbitrary network protocols
Support wide variety of applications
Swap idle applications to cloud storage
Use cloud resources efficiently, thus dramatically reduce cost

Key challenge: swap in application quickly on request  
Reactive page faulting and prefetching with ActiveSet

Related Work

Operating system containers (e.g., VServer, Docker, BSD Jail)  
Do not support checkpoint/restore and partial swap ins

Dedicated runtime (e.g., AppEngine, Lambda, Azure Functions)  
Limited programming environment and event/network support

Swapping (e.g., VM pre-paging and migration, checkpoint/restore)  
Picocenter builds on checkpoint/restore with partial swapping

Design and Implementation

Process-like environment with LXC  
Users submit Docker-like app images and get back a DNS name
An extended CRIU supports partial swap ins and ActiveSet
A FUSE application catches page faults and builds ActiveSet

The Hub: Serves DNS requests; assigns apps to workers

The Workers: Host and run applications; provide NAT for IPv4

Evaluation

We deploy Picocenter on Amazon Virginia datacenter
How quickly can Picocenter restore real-world applications?  
Picocenter restores real-world applications in under 250 ms

How much does ActiveSet help to reduce the time to restore?  
ActiveSet reduces latencies by a factor of 1.5x – 5x

Source code: https://github.com/LeoLiangZhang/Picocenter