

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

Liang Zhang*
Theophilus Benson†‡

*Northeastern University

James Litton†
Dave Levin†

†University of Maryland

Frank Cangialosi†
Alan Mislove*

‡Duke University

MOTIVATION

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

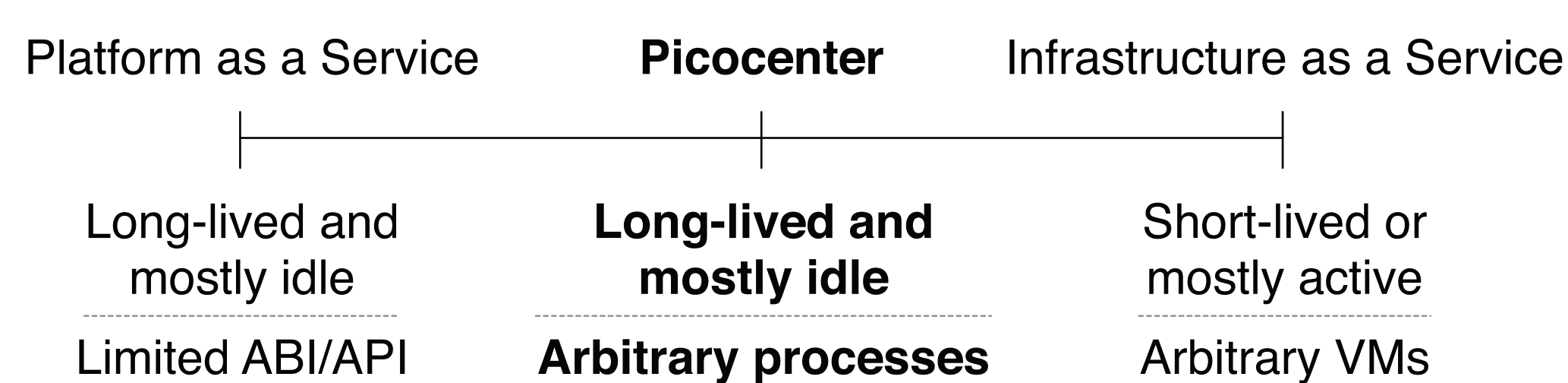
These applications are **long-lived but mostly idle (LLMI) apps**

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



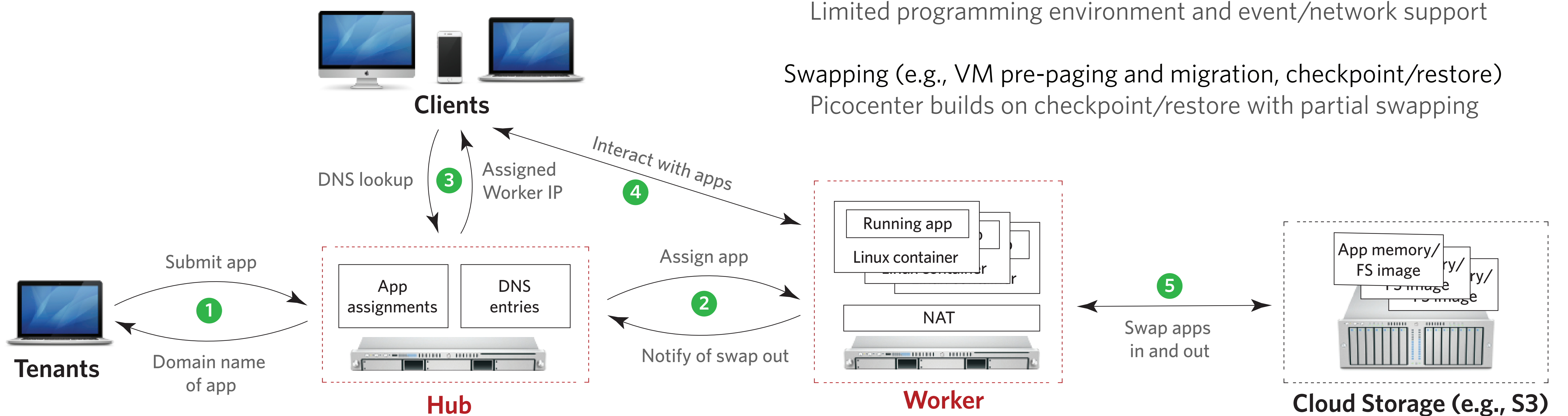
Options for running LLMI apps in the cloud today:

1. Platform as a Service (PaaS): limited programming environment
2. Infrastructure as a Service (IaaS): can be expensive to run

Goal: Support LLMI apps in cloud environments

Lower cost by allowing provider to run many LLMI apps

Leverage workload by swapping idle apps to cloud storage



DESIGN AND IMPLEMENTATION

Process-like environment with LXC

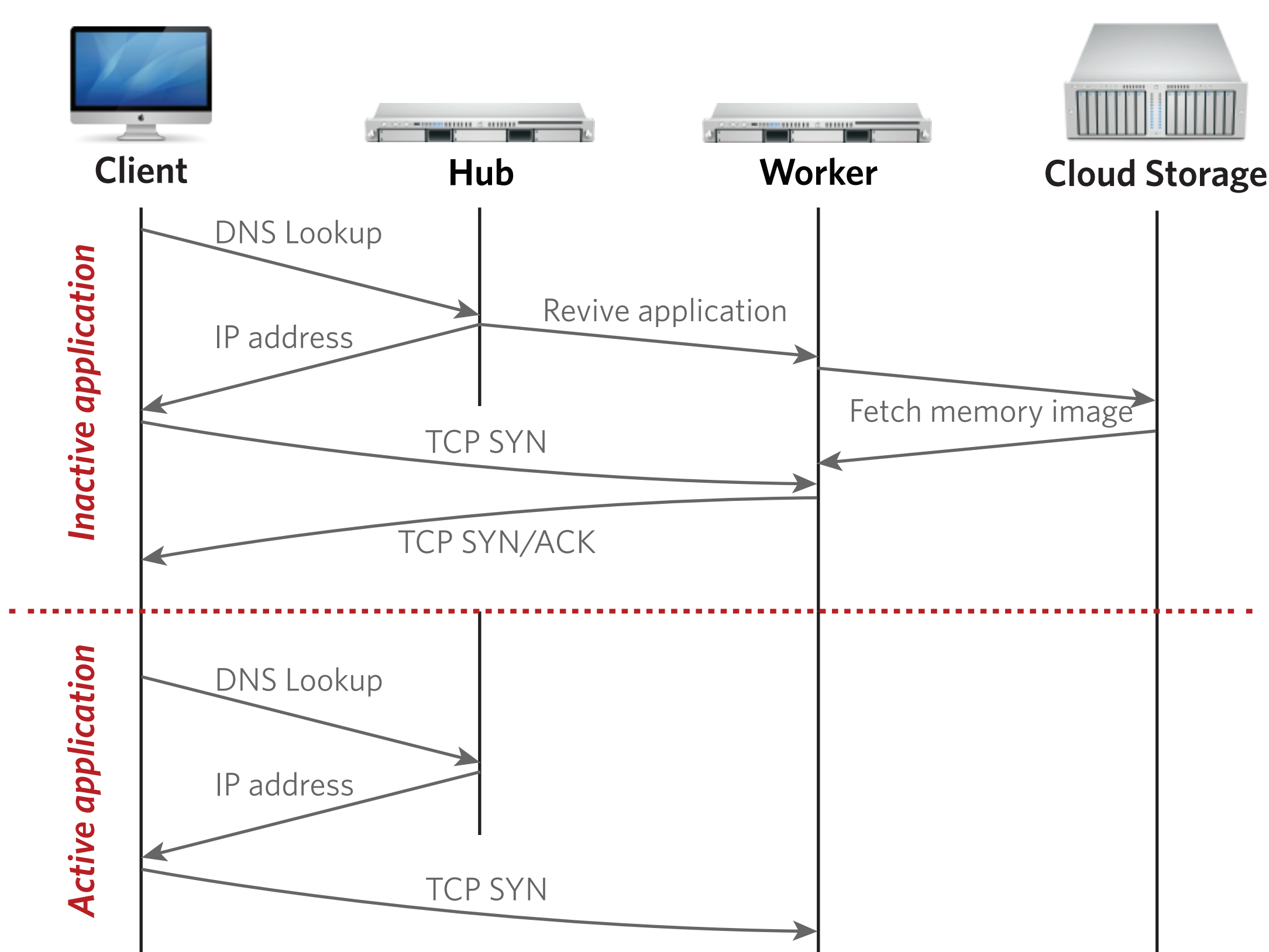
Users submit Docker-like app images and get back a DNS name

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



PICOCENTER

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

ActiveSet: predicted pages that are needed for the request

Reduce total download size compared to full checkpoint

Minimize fetching pages compared to reactive paging only

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)

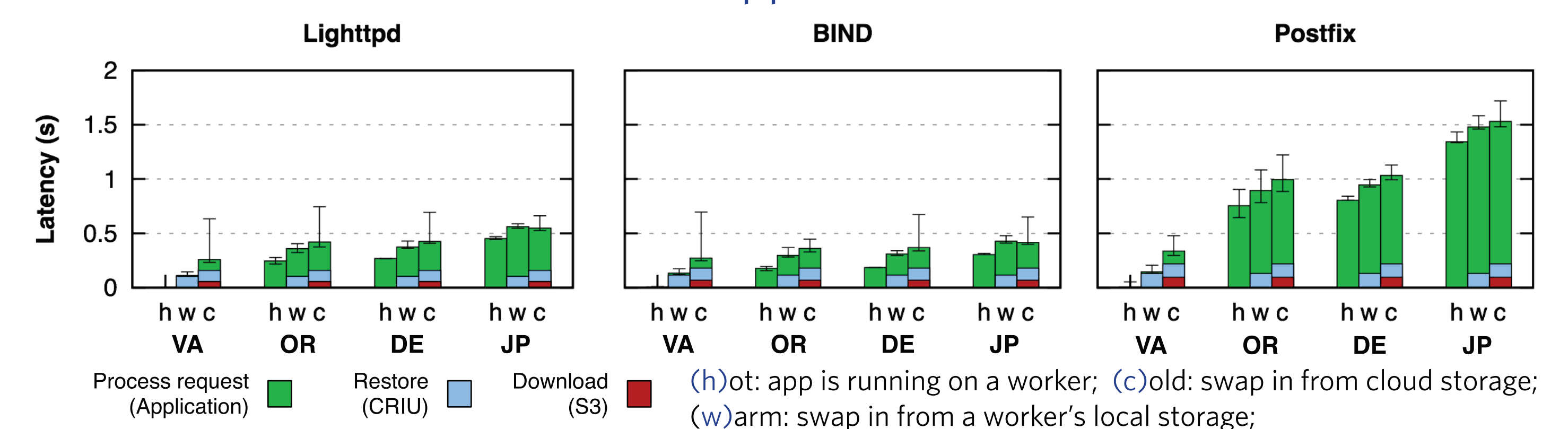
PicoCenter builds on checkpoint/restore with partial swapping

EVALUATION

We deploy PicoCenter on Amazon Virginia datacenter

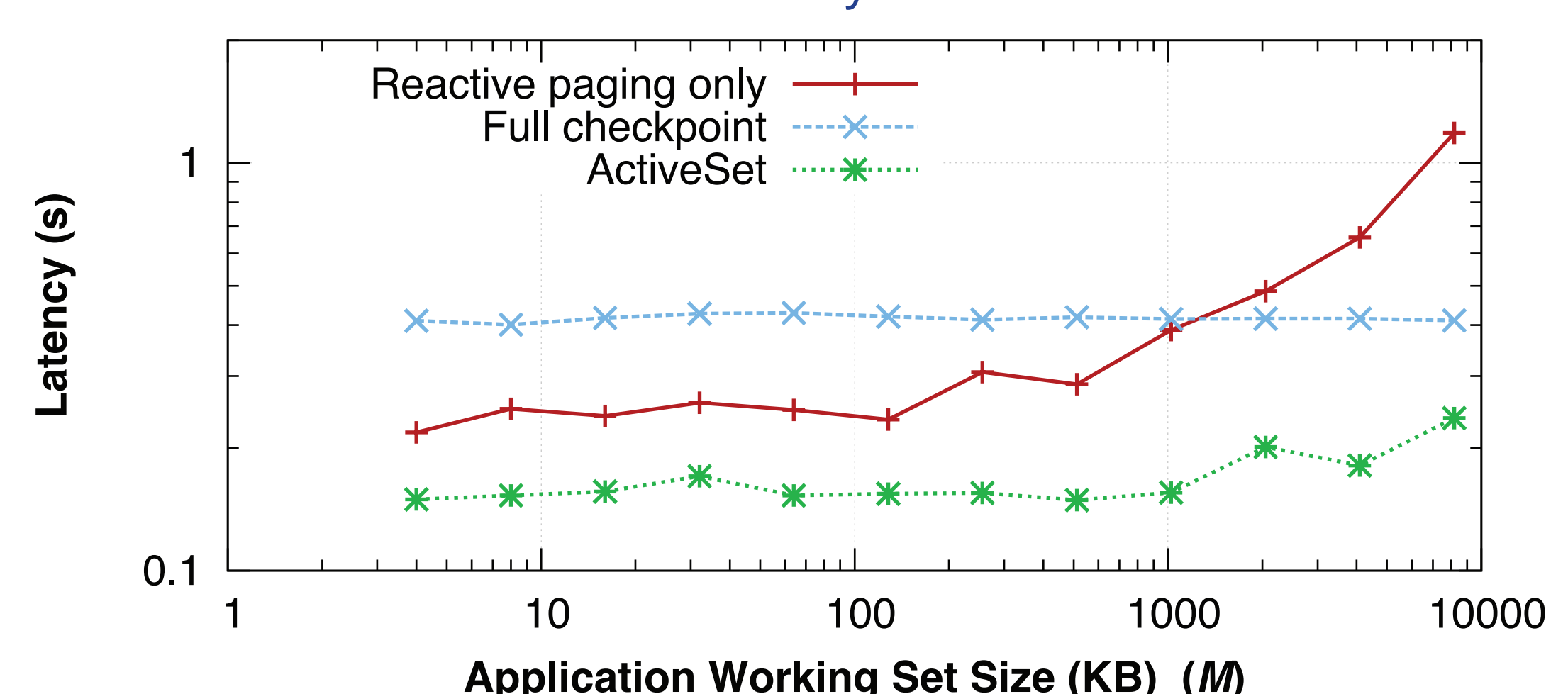
How quickly can PicoCenter restore real-world applications?

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>