CZone: Memory-Efficient Serverless Container Management with MCPV Model

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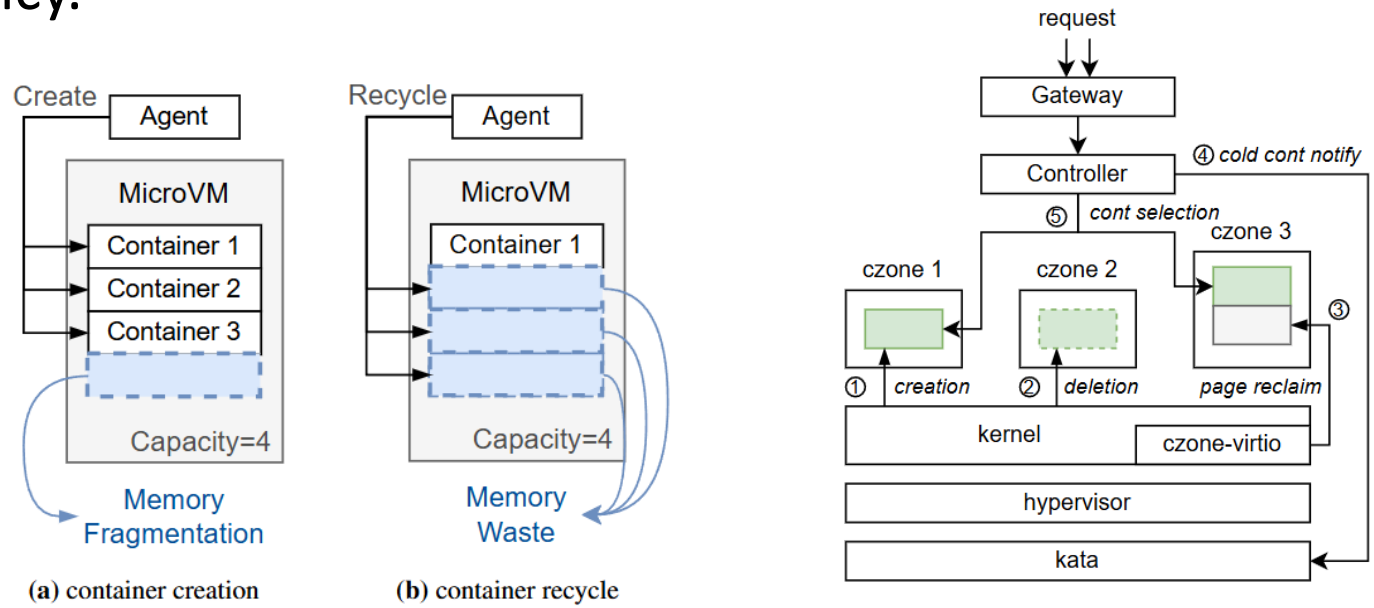
Frontiers of Computer Science, DOI: 10.1007/s11704-024-40756-5

Problems & Ideas

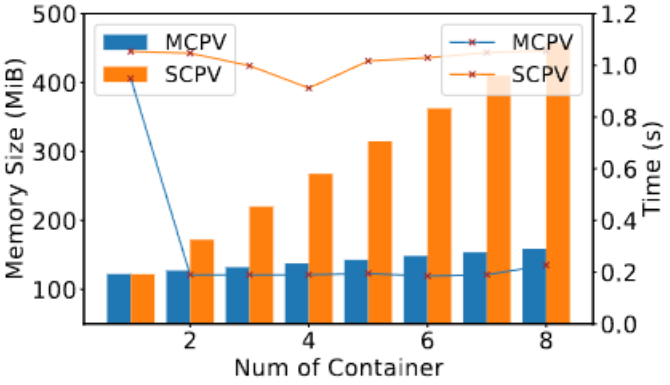
- Problems of Single-Container-Per-VM (SCPV):
  - High Startup Latency: microVM startup is costly
  - Memory Waste: microVM's guestOS & hypervisor take a lot of memory
- Ideas: Multi-Containers-Per-VM (MCPV) model that allows for the dynamic creation of multiple containers within a microVM, effectively amortizing memory overhead and reducing startup latency.



Comparison between SCPV and MCPV Left: The memory fragmentation during container creation and memory waste during container recycling for SCPV Right: Architecture of MCPV with Czone that solves the memory waste issue

Main Contributions

- Contributions:
  - A novel CZone implementation that extends the existing Linux memory zones, enabling efficient container memory hotplug and hot-unplug operations;
  - A page identification function that extends the Linux page management system, allowing the guest VM to track which of its pages are using host physical memory;
  - A paravirtualized virtio device, czone-virtio, that facilitates the reclamation of guest idle pages still consuming host physical memory.



(a) Startup Latency (Line) & Memory (Bar)

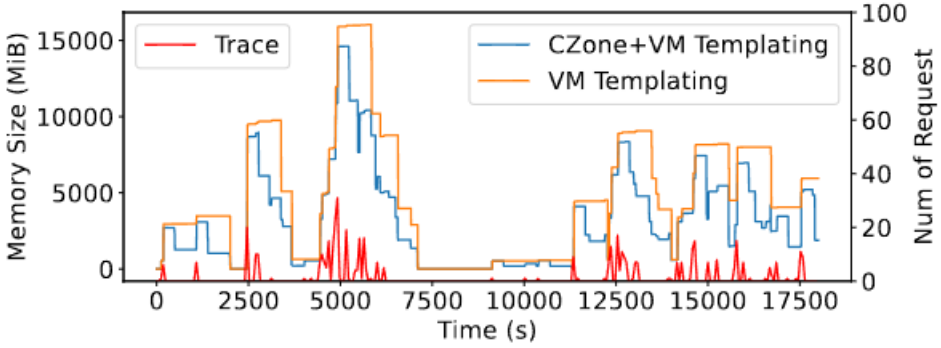


Fig. 12 Azure Trace Simulation.

Performance between SCPV and MCPV Left: The average startup latency, total memory usage of SCPV and MCPV Right: Host Memory Usage during Azure Trace Simulation of SCPV and MCPV