IDEAL/OPTIMAL MEMORY MANAGEMENT FOR FUTURE VMS

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The existing guest VM memory management

• KVM re-use the existing Linux infrastructure to integrate well with Linux memory management
• They are built around page fault on files as memory
• support any generation of hardware (CPU with/without EPT/NPT)
Emerging new class of memory and use case

- Large page is suitable for performance/management
- Far/remote memory (compression, software-defined, nvdimm)
  - Software defined far memory: https://dl.acm.org/citation.cfm?id=3304053
- Encrypted memory (MKTME, SGX, SME, SEV)
- Isolation from host kernel/user/VMM/guest
  - Session: Enhancing KVM for Guest Protection and Security - Jun Nakajima
  - Friday, November 1 • 16:15 - 16:45
- fast reboot

Things have changed a lot. It’s time to revise it
requirements for new class of memory

- No mmap/kernel direct map/struct page
- No kswapd. Allow page-reclaim specific to backend. (kernel or user)
- Only EPT/NPT. Taking advantage of large page

=> Decouple guest VM mgmt from host Linux memory mgmt
What operations are needed?

- allocation/deallocation
- Guest physical address -> host physical address conversion
- Access/dirty bit logging
- Swapping out/in

KVM module

Backpacking memory
(remote/far, compressed, encrypted, nvdimm, etc.)

Allocation/deallocation
(file, offset, length)

KVM Forum Nov 1, 2019
Options for implementation

- Add logic to kvm/device model for each backing device drivers
- Define a class of device driver and port device driver to it
- Define a wrapper class as unified interface and write adapter for each device drivers

Happening now
Pseudo file system as unified interface

- memory as backing store
  - sector_t as pfn: Similar to DAX
  - Various operations defined (fallocate, punch hole, seal, fanotify)

Regular file on local file system:
- inode
  - (offset, length)

Backing store:
- (sectore_t, length)

Guest VM memory:
- (physical address, length)

Host memory:
- (physical address, length)

Various operations:
- iomap:
  - Convert file
  - Offset to sector

Various operations:
- Conversion:
  - gpa to hpa

Backing ram can be considered as backing store.
Pseudo file system as unified interface.

KVM Forum Nov 1, 2019
Pseudo file system for kvm

Device model

Guest VM memory

EPT/NPT

Page scanner/swapper (device specific)

user

kernel

Initialization/dma

iomap

On tdp page fault

notification

KVM module

Isolated memory

Encrypted memory

compressed memory

Device X etc...

Scan access/dirty bit

Swap in/out

Fallocate, punch hole

Initialization/dma

Swap in/out

Fallocate, punch hole
Memory isolation

- After initialization is done,
- Remove the region from kernel mapping (directmap)
- Optional: no struct page by hot-unplug
- Ensure that no user space mapping (or error)

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PoC: current status

• Pseudo file system
• Adapter to reserved memory
• Modification to kvm kernel module not to use page fault. (WIP)
Future work

• Discussion/Post patches
• Benchmark
• Exercise more backing memory technology
  • Encrypted memory
  • Memory compression
  • Live migration(precopy, postcopy)
  • virtio
• Preparing for memory isolation
Summary

• Need to revise guest memory management
• New unified interface for it as pseudo file system

Next step
• Discussion to align with other activities to make progress.