Beyond kvm.ko

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KVM Developers Forum
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Agenda

- Large pages
- Containers & Isolation
- Scheduling
- Swapping
- Storage
- Conclusions
Large pages

- 4KB page tables consume memory
  - 2MB per 1GB RAM
  - Leads to cache pressure on TLB intensive workloads
  - One TLB-induced cache miss per random access

- NPT/EPT make the problem worse
  - 4MB per 1GB
  - Two TLB-induced cache misses per random access

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<th>Shadow memory access penalties</th>
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<tbody>
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<td>Guest pages</td>
<td>Host pages</td>
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<td>4KB</td>
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Easy solution: use large host pages to back guest memory
  - Just 4KB per 1GB (doubled for xPT)

New problems
  - Provisioning: hard to configure Linux for large pages
    - Okay for dedicated virtualization host
  - Doesn't swap
    - Kills overcommit
  - Won't balloon
Fixing large pages

- **Fixes**
  - Memory defragmentation
  - Transparent coalescing/fragmentation of large pages
  - Large page swapping (?!)
  - Large page ballooning

- **Problems**
  - Opposition from Linus
  - Will increase core VM complexity
Containers & Isolation

- Reduce the impact of one guest on others
- Scheduler groups
  - Treat a group of tasks as a unit for the purpose of allocating resources
- Scheduler caps and guarantees
  - Allow SLAs instead of best effort
- Memory containers
  - Account each page to its container
  - Allows preferentially swapping some guests
- I/O accounting
  - Each I/O in flight is correctly accounted to initiating task
    - Including swap activity!
  - Important for I/O scheduling
  - Important for troubleshooting
Scheduling

- **Gang scheduling**
  - Schedule a guest iff there are processors available for all vcpus
  - Prevents spinning in spinlocks, IPIs, or other busy-wait scenarios

- **Paravirtualized spinlocks, IPIs**
  - Guest tells host when it spins
  - Host can reallocate resources
Swapping & overcommit

- Ballooning is too simplistic
  - Host depends on guest ability to free memory
  - What if the guest is slow? Or hung? Or malicious?

- Swapping is too slow
  - Host estimate of which page to swap may be inaccurate
  - Always need to write out data
    - Even if the guest can recreate it
  - Guest hangs when paging in data
Swapping fixes

- Simple fix: don't swap out zeroed pages
- Complex fix: guest/host cooperation
  - Guest tells host which pages need not be saved
  - Host tells guest which pages were not saved
  - Host tells guest which pages are not present
- Can steal most from s90
- Problem: some of this is incredibly complex
Many similar guests cause a lot of duplicate storage

Current solution: baseline + delta images

Delta images only a partial solution
  - Deltas degrade over time
  - Needs planning
    - Won't work when P2Ving an existing installation
  - Disk-in-file is overhead
Storage fixes

- **Block-level deduplication**
  - Filesystem or block device looks for identical blocks
  - ... and consolidates them
  - Can be done as a background task
  - Btrfs seems well prepared
    - Reverse mappings
    - Snapshots

- **Hostfs + file-based deduplication**
  - No more virtual block device
  - Guest filesystem is a host directory
  - Host can carry out file dedup in the background
  - Requires changes in guest
Conclusions

- A lot of work remains besides the core hypervisor
- Much to be done on the host level
- Some on the guest level
- Having the host features useful for non-virtualization workloads will be important for acceptance
- We won't be out of work anytime soon
Thank You