Automatic ballooning

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Agenda

- The balloon driver
- Making it automatic
- Testing & some numbers
The balloon driver
The balloon driver

- **Implements two fundamental operations**
  - Inflate: memory is taken from the guest and given to the host
  - Deflate: memory is taken from the host back to the guest

- Also supports statistics reporting and other features

- Available for Linux and Windows guests
Inflate example

Memory pages in the host
- White: page is free
- Red: page is in use

Host

After inflate

Host
Deflate example

Memory pages in the host
- White: page is free
- Red: page is in use

After deflate
Balloon's primary advantage

Memory over-committed Host
Balloon's primary disadvantage

- Monitoring
- Inflate
- Deflate

Memory over-committed Host

YOU
We do have to make it automatic

- Guests automatically shrink on host pressure
- Guests automatically grow when they face pressure themselves
- Guests are automatically managed on memory over-commited Hosts
Making it automatic
(Based on a design by Rik van Riel, help from Rafael Aquini)
vmpressure events (auto-inflate)

- Added to kernel 3.10 by Anton Vorontsov
- Part of memory controller cgroup
- Defines three pressure levels
  - **LOW**: the kernel is reclaiming memory for new allocations
  - **MEDIUM**: some swapping may be going on
  - **CRITICAL**: the system is thrashing, OOM killer may be on its way to trigger
- User-space is notified via eventfds
vmpressure usage for auto-inflate

- QEMU registers eventfds for low, medium and critical
- QEMU uses pre-defined values to perform auto-inflate
  - Low: 256 (1MB)
  - Medium: 512 (2MB)
  - Critical: 1024 (4MB)
- These values can be run-time tunables
Auto-inflate problems/solutions

- Pre-defined values don't take host nor guest need into consideration
  - **Solution**: the host tells the guest it's facing pressure and the guest releases pages accordingly

- QEMU can get as many as 20 events when host is under pressure
  - **Solution**: event throttling in QEMU (1 per sec)

- All event fds are woken up on CRITICAL level
  - **Solution**: demultiplex events in QEMU
shrink callback (auto-deflate)

- Drivers or subsystems can register a function to be called when the kernel is facing memory pressure
- The guest virtio-balloon driver implements such a function which performs auto-deflate (ie. memory is reclaimed for the guest)
Auto-deflate problems/solutions

- The shrinker API asks for (only!) 128 pages per call
- Auto-deflate can be delayed due to auto-inflate taking too long
A few words on the current status

- A prototype exists for almost a year
  - Still pretty experimental
- Two RFC versions posted upstream
  - Need more feedback!
Testing
Take it with a grain of salt

- Very hard to come up with a good test-case
- Smallest change in parameters can change the results
- Several scenarios to be tested
A very simple test-case

VM: specjbb
10 threads
idle
10 threads

VM: specjbb
idle
10 threads
idle

2G Host
## Test results: 10 runs average

<table>
<thead>
<tr>
<th></th>
<th>Vanilla</th>
<th>auto-ballon</th>
<th>Difference %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total run time (sec)</td>
<td>441</td>
<td>441</td>
<td>0%</td>
</tr>
<tr>
<td>Pages swapped in (host)</td>
<td>46346</td>
<td>41898</td>
<td>-9.60%</td>
</tr>
<tr>
<td>Pages swapped out (host)</td>
<td>209710</td>
<td>196080</td>
<td>-6.50%</td>
</tr>
<tr>
<td>Specjbb throughput – VMs (bops)</td>
<td>57378.96</td>
<td>58086.61</td>
<td>+1.23%</td>
</tr>
</tbody>
</table>
That's all folks!

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http://www.linux-kvm.org/Projects/auto-ballooning