**GROMACS - Bug #1880**

PP-PME load balancing issue

12/16/2015 03:24 PM - Szilárd Páll

<table>
<thead>
<tr>
<th>Status:</th>
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<td>Priority:</td>
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</tr>
<tr>
<td>Assignee:</td>
<td>Berk Hess</td>
</tr>
<tr>
<td>Category:</td>
<td>mdrun</td>
</tr>
<tr>
<td>Target version:</td>
<td>future</td>
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<td>Affected version - extra info:</td>
<td>5.1</td>
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<td>Affected version:</td>
<td>git master</td>
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<td>Difficulty:</td>
<td>hard</td>
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**Description**

In some cases the first measurement proves to be very slow and the consecutive setting much faster than the it can happen that the first setting is pruned and never tried again which will lead to suboptimal performance due to the CPU waiting for the GPU. Example below, repro case (rnase cubic) + log attached.

Perhaps we should (always?) repeat measurements with the first setting?

```
step  80: timed with pme grid 56 56 56, coulomb cutoff 0.900: 167.6 M-cycles
step 160: timed with pme grid 48 48 48, coulomb cutoff 1.046: 149.1 M-cycles
step 240: timed with pme grid 44 44 44, coulomb cutoff 1.141: 169.0 M-cycles
step 320: timed with pme grid 48 48 48, coulomb cutoff 1.046: 145.6 M-cycles
step 400: timed with pme grid 48 48 48, coulomb cutoff 1.046: 143.2 M-cycles
```

**Related issues:**

Related to GROMACS - Feature #1715: improve cycle counting GPU sharing and mu... New

**Associated revisions**

Revision b33a991d - 01/08/2016 05:55 PM - Berk Hess

Fix PME load balancing skipping a setup

During stage 0 of the PME tuning we only time every second setup. In stage 1 only a reduced range of setups is considered. If the tpr setup (setup index 0) was not part of this reduced range, the first setup in the range would never be timed. This could lead to choosing a non-bonded cut-off that was longer than optimal.

Fixes #1880

Also fixed two conditionals (but this had no effect on the settings).

Change-Id: ld9f361d23e3294e41553b39ae8e8f37ceb80bbe5

**History**

#1 - 12/16/2015 03:29 PM - Szilárd Páll

- File _test3.log added

After a few tries I got the idea that this may be caused by the sluggish frequency scaling of the GPUs. I ran multiple mdruns back-to-back to test. The results are mixed and, while the number of cases where the tuning did find the correct cut-off (see attached) has increased, this is not always the case.

Any ideas how to eliminate this first, very much off measurement?

#2 - 01/04/2016 03:10 PM - Gerrit Code Review Bot

Gerrit received a related patchset `1' for Issue #1880.
Uploader: Berk Hess (hess@kth.se)
Change-Id: ld9f361d23e3294e41553b39ae8e8f37ceb80bb5
Gerrit URL: https://gerrit.gromacs.org/5523
The main issue here seems to be that the first potentially useful setup is skipped in the second stage (grid 52 in this case), when the tpr setup is not included in the final range. I uploaded a fix for this.

I see some variation in the timing of the first (tpr) setup, but not so much that it seems to be problematic.

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I have more data that still shows more or less the same as the initial report - even with the fix included. This seems to be caused by timing issues. On the one hand, as I guessed initially, the load balancing can erroneously discard the base cut-off due to the first measurement being consistently very much off (see test_1x16_tune_1.log), but even when it re-tries the shorter cut-offs (including the base) it will very often measures higher timings with shorter cut-offs that otherwise obviously give better overall performance.

The attached files clearly show that the picked 1.046 nm cut-off leads to worse performance (and large GPU wait time).

I'm considering reopening this but I can also file a new report if that's preferred.

---

It looks like only the first 56x56x56 of test_1x16_tune_1.log has a higher time. I assume you did several replicates of this run - what was the baseline variability of this first segment, vs later segments. Is this an artefact of a cold GPU?

but even when it re-tries the shorter cut-offs (including the base) it will very often measures higher timings with shorter cut-offs that otherwise obviously give better overall performance.

Is there data here to show that? The grid repeats in both test_1x16_tune_1.log look OK to me.

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There's a case for this kind of tuning moving to the next grid setup only when performance has stabilized, which might mitigate the effect of init-time transients. Thus, rather than (as here) 2'rstlist segments, run multiple rstlist segments and accept a performance number only when there's been 2+ segments with less than a couple of percent variation. Here, 56x56x56 ran at 132.4 and 123.8 which is 7% variation.

Is that also workable in the presence of DLB?

---

Mark Abraham wrote:

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See the data attached. It shows load-balancer reported timings from runs with tweaked limits to trigger more passes. This illustrates quite well that the first two cut-off settings (0.9 nm and 0.966 nm) both show 10-20% lower timings after the 2nd/3rd measurements while the third cut-off, 1.046 nm, is affected much less (even though it is the second setting during the 1st pass). The fourth cut-off shows similarly small 2-4% deviation.

but even when it re-tries the shorter cut-offs (including the base) it will very often measures higher timings with shorter cut-offs that otherwise obviously give better overall performance.

Is there data here to show that? The grid repeats in both test_1x16_tune_15.log look OK to me.

The attached plots show how can this happen, essentially it seems that performance shorter cut-offs/finer grids take longer to stabilize. During the first pass 0.966 nm is not tested, hence the first data point on the curve here belongs to the second pass (I realize now that a different representation or lat least shifting 0.966 could’ve been better). At the second pass 0.900 is still slower than 1.046 and that’s when 0.966 nm is first timed.

Based on what I’ve seen so far this does not seem to be caused by a "cold" GPU. Back-to-back runs without pause between them show the same pattern and the fact that the 1.046 nm run is less affected even though it’s the 2nd setup the load balancer tried, seems to indicate the same.

it would be good to know what's the root cause of this behavior, so unless we have another idea, I should get a trace an see if it reveals where the performance change originates from.

There's a case for this kind of tuning moving to the next grid setup only when performance has stabilized, which might mitigate the effect of init-time transients. Thus, rather than (as here) 2*ntlist segments, run multiple ntlist segments and accept a performance number only when there's been 2+ segments with less than a couple of percent variation. Here, 56x56x56 ran at 132.4 and 123.8 which is 7% variation.

Yes, that would make sense. It would also make sense to allow re-balancing later (or periodically).

Is that also workable in the presence of DLB?

We delay turning on DLB until the balancer picks grit+cutoff and turn it on again only after that, so DLB it can not interfere.

#10 - 01/14/2016 11:36 PM - Mark Abraham
What do the colours show, please?

#11 - 01/14/2016 11:50 PM - Szilárd Pál
The different colored curves represent 10 repeats with 10s pause in between.

#12 - 01/15/2016 01:05 AM - Szilárd Pál
Skipping 15-20 ntlist cycles (that is 600-800 steps here) in the beginning seems to eliminate the effect. I have so far only done a quick test that increases the number of cycles for each configuration (i.e. set->count), but it looks like it may be enough to simply start later. Your suggestion of monitoring variation between consecutive segments still seems like a good idea.

#13 - 01/27/2016 01:14 PM - Mark Abraham
- Target version changed from 5.1.2 to 5.1.3

#14 - 06/01/2016 11:29 AM - Mark Abraham
- Target version changed from 5.1.3 to 2016

Release-5-1 branch is shortly moving into correctness-only fixing, so if we can/do fix anything about this in a release branch, it will only be in release-2016.

#15 - 07/09/2016 03:30 AM - Szilárd Pál
I had a core spin-up solution in testing but as it was thought to be an undesirable hack (though I still thought it was better than nothing), I postponed it. Funnily enough there is now code to spin up cores that will likely be merged into 2016 which could solve this issue too (1-2 second of spinning will bring x86 cores clock up to allow reliable measurements). So if that spin-up code goes in, we could consider enabling it when -tunepme later on.

Not a blocker for 2016 RC anyway.

#16 - 07/11/2016 05:08 PM - Mark Abraham
Isn't it better all round to spin up by doing some MD steps before launching this tuning?
It can be reasonable, but we don't know how long is and MD step and therefore that's not a very reliable way to ensure that independent of the
time/step, we always spin up cores to the same extent. This is not an issue as long as steps are much shorter than the required spin-up time, but that
may not always be the case, right?

Szilárd Páll wrote:

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time/step, we always spin up cores to the same extent. This is not an issue as long as steps are much shorter than the required spin-up time,
but that may not always be the case, right?

We're never going to know how long spin-up time is, so that problem is common to the idea of writing/using some spin-up code, and doing MD steps
has the benefit of being useful to the user (assuming we're not shooting ourselves in the foot with different tuning interacting suboptimally).

We do know that the assumption of constant performance characteristics per step is wrong unless both the simulation contents and the hardware
conform to idealized behaviour, so as above I think we need to move in the direction of being more sophisticated about when we accept a
performance estimate. If there might be a starting transient that takes hundreds of steps to die away, and mdrun will never know in advance when that
might be true, and also mdrun can never know when the network performance, or node sharing, or CPU clocks, or GPU clocks might change (where
applicable, and we can probably hard-wire a few things), we have to address this with better high-level management code. It might be quite useful to
try plausible alternatives every few hundred or so nstlist steps, where "plausible" depends on how confident we were that the current choice was
better than the alternatives, and whether the current performance characteristics are still consistent with the data that led to that choice.

I assume nobody has plans to try to fix anything here for 2016

Mark Abraham wrote:

I don't think it is as the present issue is only related to measurements on a possibly "cold" CPU which can only result in suboptimal cut-off picked, but
not in corruption.

Erik Lindahl wrote:

Given that the load balancing iterations take at least several hundred steps in itself, I think it makes a lot of sense to wait e.g. 500 steps before we
start doing it.

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start doing it.

That's what I/we considered initially too and it would be an acceptable workaround for in the majority of the cases. However, if the time/step is in the
~1 ms or lower regime, that will give <1s delay which, at least on the i7 6960X, is a bit too short.

Mark Abraham wrote:

Indeed, which is why we have to plan to move to a style where we observe actual performance rather than hard-code assumptions about whether
there is a steady state. Doing it in a more responsive way might also help resolve #1715 "naturally," where GPU sharing between simulations can
increase jitter in the per-simulation performance measurements.

Target version changed from 2016 to 2018
#26 - 12/21/2017 03:20 PM - Mark Abraham
- Target version changed from 2018 to 2019

We need to rework all of this code at some point

#27 - 10/03/2018 09:45 PM - Mark Abraham
- Target version changed from 2019 to future

## Files

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