Use GMP to accelerate Bignum operations

08/17/2013 04:10 AM - akr (Akira Tanaka)

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<tr>
<td>Assignee</td>
<td>akr (Akira Tanaka)</td>
</tr>
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<td>Target version</td>
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How about using GMP to accelerate Bignum operations?

GMP: The GNU Multiple Precision Arithmetic Library
http://gmplib.org/

I wrote a simple patch to use GMP to accelerate Bignum multiplication.

If a user don't want to use GMP, a configure option, `--without-gmp`, disables this feature.

Since GMP is licensed as LGPL, some people would need it. However I think most people can accept LGPL as Ruby 1.8’s regex engine. So, my patch uses GMP by default, if it is available.

It converts bignums from RBignum to mpz_t and back for each large Bignum multiplication.
RBignum structure itself is not changed and ABI compatible.
(So, this is different from ko1’s idea mentioned in Feature #6083)

The conversion cost is O(n).
It is negligible for operations slower than O(n) with large inputs.
Multiplication is a kind of such operation.

I measured the performance as follows.

```ruby
% ./ruby -I.ext/x86_64-linux -r-test-/bignum -e 'methods = %i[big_mul_normal big_mul_karatsuba big_mul_toom3 big_mul_gmp]
m = 1000
n1 = 3**60
100.times {
n1 = n1 * (n1 >> (n1.size*8/1514))
n2 = n1 + 1
bits = n1.size*8
methods.dup.each {|meth|
t1 = Process.clock_gettime(Process::CLOCK_THREAD_CPUTIME_ID, :nanoseconds)
n1.send(meth, n2) rescue next
(m-1).times { n1.send(meth, n2) }
t2 = Process.clock_gettime(Process::CLOCK_THREAD_CPUTIME_ID, :nanoseconds)
t = (t2 - t1)*1e-9 / m
puts "#{bits},#{t},#{meth.to_s.sub("big_mul_", "")}"meths.delete(meth) if 1.0/m < t
}
STDOUT.flush
'
```

It seems GMP is faster when multiplication arguments are longer than 1000 bits on my environment.
See bignum-mul-gmp.png for details.

I guess other operations, division and radix conversion, can also be faster using GMP.

Any comments?

08/30/2022
"akr (Akira Tanaka)" wrote:

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However I think most people can accept LGPL as Ruby 1.8's regex engine. So, my patch uses GMP by default, if it is available.

I'm happy with LGPL :) 

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The conversion cost is O(n).
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Is there more performance improvement without the conversion?
How about push the conversion cost to legacy C API users to make Bignum faster for pure-Ruby use in a future patch?

I'm mainly curious about "smaller" Bignums for users on 32-bit systems, but I suspect much of that cost is object allocation.

How about push the conversion cost to legacy C API users to make Bignum faster for pure-Ruby use in a future patch?

It is same as ko1's idea.
I don't against it.
Feel free to implement and propose it.

However it has several difficulties.

- It is a big task.
  It need to implement all methods, not just slow methods.

- ABI incompatibility.
  ko1 tackles this in Feature #6083.

- LGPL
  It is no problem for me but I guess some people don't accept it. So we need to maintain non-GMP implementation anyway. Maintaining two implementations is troublesome.

- We cannot access internal of mpz_t.
  We may be limited to add new feature with optimal performance.
  (mpz_getlimbn and mpz_size may be enough?)

- It cannot embed small bignums.
  So it needs more memory allocation.
  (mpz_array_init may solve this problem?)

--
Tanaka Akira

Assignee set to akr (Akira Tanaka)
This is internal. So go ahead and experiment.

Matz.

#4 - 09/26/2013 10:38 AM - naruse (Yui NARUSE)
- Status changed from Open to Closed
- Target version set to 2.1.0

Introduced on r42743.

**Files**

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