Use GMP to accelerate Bignum operations

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.size*8/15*14)) 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_/, "")}" methods.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?
"akr (Akira Tanaka)" *akr@fsij.org* wrote:

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disables this feature.
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So, my patch uses GMP by default, if it is available.

I'm happy with LGPL :)  

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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.

#2 - 08/17/2013 09:53 AM - akr (Akira Tanaka)
2013/8/17 Eric Wong normalperson@yhbt.net:

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?

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

#3 - 08/31/2013 03:57 PM - matz (Yukihiro Matsumoto)

- 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.

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