Abstract

rb_control_frame_t has a field klass, which is used to search super class when super is called (and also several usages). super is only for methods. However, all of rb_control_frame_t requires to keep klass on other frames such as block and so on.

This patch solve this issue by introducing rb_callable_method_entry_t.

https://github.com/ko1/ruby/tree/remove_cf_klass

rb_callable_method_entry_t is similar to rb_method_entry_t (actually, same data layout), but it has defined_class.

Background

For methods defined to classes, then owner of these methods are also defined_class.

class C1 < C0
  def foo # foo's owner is C1, and foo's defined class is C0.
    super
  end
end

We can start to search super class from C1's super class (C0).

However, when we define methods in a modules, then defined class is not fixed.

module M
  def foo # foo's owner is M, however, defined class is not fixed.
    super
  end
end

We can not search super class from module M.
M is used when some classes include (extend, prepend). These classes determine super classes.

class C1 < C0
  include M
end

In this case, we can know super class of M#foo (included by C1) is C0.

To represent a correct class hierarchy, MRI uses special class T_ICLASS.
T_ICLASS is internal class points including (extending and prepending) modules like that:

C1 -> T_ICLASS -> C0
    |  
    |  +-- M

# Let's use notation I(M) to represent this data structure.
# C1 -> I(M) -> C0
We can't determine defined class of M#foo, but we can determine a defined class I(M)#foo (in this case, it is C0).

Current MRI pushes defined class of methods onto control frame stack (rb_control_frame_t::klass).
However, it becomes overhead, especially for non-method frames such as blocks and so on.

To overcome this issue, I introduced rb_callable_method_entry_t,
which is similar to rb_method_entry_t, but has defined_class.

(rb_callable_method_entry_t is T_IMEMO/imemo_ment, same as rb_method_entry_t)

For C1#foo, the defined class is just C1. So rb_method_entry_t of C1#foo is also rb_callable_method_entry_t.

For M#foo, the defined class is not fixed. So rb_method_entry_t of M#foo is not a rb_callable_method_entry_t.

rb_callable_method_entry_t is created when M#foo is called by I(M).
We can find I(M) when we search M#foo in a class hierarchy C1 -> I(M) -> C0.
Let's call created rb_callable_method_entry_t for M#foo with I(M) as I(M)#foo.

It is inefficient that we make I(M)#foo everytime when M#foo is called.
So I(M)#foo is cached in a table pointed by I(M).
This table will be cleared when M is redefined.

pros. and cons.

Advantage:

- Faster pushing control frame especially for block invocation.
- Simplify codes around searching super classes.

Disadvantage:

- Increase memory consumption because of two reasons
  - Duplicate method entries for methods defined by modules.
  - Cache table kept by I(M)
- Increase complexity maintaining method entries. rb_method_entry_t was a simple enough data structure. We need to consider which data structures are required.

Measurement

For performance.

I do benchmark repeating 10 times (pickup the fastest results).

Speedup ratio: compare with the result of `trunk' (greater is better)

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file.copipa-temp-image.png

Not so big change. vm2_super/zsuper should improve performance so I need to check it again.

**Memory consumption**

Runing this script to check process memory on Linux Ubuntu.

```ruby
N = 100_000
$mod = true
$cls = true

module M
  N.times{|i|
    define_method("foo#{i}"){}
  } if $mod
end

class C
  include M
  N.times{|i|}
```
This program makes 100,000 methods for a module and classes. Maybe it is too big an example.

Making methods on classes and a module.

ruby 2.2
VmHWM: 247624 kB
trunk
VmHWM: 234004 kB
modified
VmHWM: 252236 kB

Making methods only on a module.

ruby 2.2
VmHWM: 77848 kB
trunk
VmHWM: 86452 kB
modified
VmHWM: 108756 kB

Making methods only on classes.

ruby 2.2
VmHWM: 175780 kB
trunk
VmHWM: 182944 kB
modified
VmHWM: 179216 kB

As you can see, first result shows 2% increase for memory usage compare to Ruby 2.2. Second result shows 40% increase, but it is worst case. Third result is best case (no methods in modules).

We need to check real usage.

**Future work**
I will try class level cache proposed by funnyfalcon before, over there.

Related issues:
- Related to Ruby master - Bug #11279: remove rb_control_frame_t::klass
  - Closed
- Related to Ruby master - Bug #12164: Binding UnboundMethod to BasicObject
  - Closed

Associated revisions
Revision Se8a1474 - 07/03/2015 11:24 AM - ko1 (Koichi Sasada)

- method.h: introduce rb_callable_method_entry_t to remove rb_control_frame_t::klass. [Bug #11278], [Bug #11279] rb_method_entry_t data belong to modules/classes. rb_method_entry_t::owner points defined module or class. module M def foo; end end In this case, owner is M. rb_callable_method_entry_t data belong to only classes. For modules, MRI creates corresponding T_ICLASS internally. rb_callable_method_entry_t can also belong to T_ICLASS. rb_callable_method_entry_t::defined_class points T_CLASS or T_ICLASS. rb_method_entry_t data for classes (not for modules) are also rb_callable_method_entry_t data because it is completely same data. In this case, rb_method_entry_t::owner = rb_method_entry_t::defined_class. For example, there are classes C and D, and includes M, class C; include M; end class D; include M, end then, two T_ICLASS objects for C's super class and D's super class will be created. When C.new.foo is called, then Mifoo is searched and rb_callable_method_t data is used by VM to invoke Mifoo. rb_method_entry_t data is only one for Mifoo. However, rb_callable_method_entry_t data are two (and can be more). It is proportional to the number of including (and prepending) classes (the number of T_ICLASS which point to the module). Now, created rb_callable_method_entry_t are collected when the original module M was modified. We can think it is a cache. We need to select what kind of method entry data is needed. To operate definition, then you need to use rb_method_entry_t. You can access them by the following functions.
  - rb_method_entry(VALUE klass, ID id);
  - rb_method_entry(VALUE klass, ID id);
  - rb_method_entry(VALUE klass, ID id);
  - rb_method_entry(VALUE klass, ID id);
  - rb_method_entry(VALUE klass, ID id);
  - rb_method_entry(VALUE klass, ID id);
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- method.h: renamed from rb_method_entry_t::klass to rb_method_entry_t::owner.
- internal.h: add rb_classext_struct::callable_m_tbl to cache rb_callable_method_entry_t data. We need to consider about this field again because it is only active for T_ICLASS.
- class.c (method_entry_i): ditto.
- class.c (rb_define_attr): rb_method_entry() does not takes defiend_class_ptr.
- gc.c (mark_method_entry): mark RCLASS_CALLABLE_M_TBL() for T_ICLASS.
- cont.c (fiber_init): rb_control_frame_t::klass is removed.
- proc.c: fix `struct METHOD' data structure because rb_callable_method_t has all information.
- vm_core.h: remove several fields.
  - rb_control_frame_t::klass.
  - rb_block_t::klass. And catch up changes.
- eval.c: catch up changes.
- gc.c: ditto.
- insns.def: ditto.
- vm.c: ditto.
- vm_args.c: ditto.
- vm_backtrace.c: ditto.
- vm_dump.c: ditto.
- vm_eval.c: ditto.
- vmInsnhelper.c: ditto.
- vm_method.c: ditto.

Revision 51126 - 07/03/2015 11:24 AM - ko1 (Koichi Sasada)

- method.h: introduce rb_callable_method_entry_t to remove rb_control_frame_t::klass. [Bug #11278], [Bug #11279] rb_method_entry_t data belong to modules/classes. rb_method_entry_t::owner points defined module or class. module M def foo; end end In this case, owner is M. rb_callable_method_entry_t data belong to only classes. For modules, MRI creates corresponding T_ICLASS internally. rb_callable_method_entry_t can also belong to T_ICLASS. rb_callable_method_entry_t::defined_class points T_CLASS or T_ICLASS. rb_method_entry_t data for classes (not for modules) are also rb_callable_method_entry_t data because it is completely same data. In this case, rb_method_entry_t::owner = rb_method_entry_t::defined_class. For example, there are classes C and D, and includes M, class C; include M; end class D; include M, end then, two T_ICLASS objects for C's super class and D's super class will be created. When C.new.foo is called, then Mifoo is searched and rb_callable_method_t data is used by VM to invoke Mifoo. rb_method_entry_t data is only one for Mifoo. However, rb_callable_method_entry_t data are two (and can be more). It is proportional to the number of including (and prepending) classes (the number of T_ICLASS which point to the module). Now, created rb_callable_method_entry_t are collected when the original module M was modified. We can think it is a cache. We need to select what kind of method entry data is needed. To operate definition, then you need to use rb_method_entry_t. You can access them by the following functions.
  - rb_method_entry(VALUE klass, ID id);
  - rb_method_entry(VALUE klass, ID id);

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rb_method_entry_without_refinements(VALUE klass, ID id);
ruby_method_entry(VALUE refinements, const rb_method_entry_t *me); To invoke methods, then you need to use
rb_callable_method_entry_t which you can get by the following APIs corresponding to the above listed functions.
ruby_callable_method_entry(VALUE klass, ID id);
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ruby_callable_method_entry_without_refinements(VALUE klass, ID id);
ruby_resolve_refined_method(VALUE refinements, const rb_method_entry_t *me); VM pushes rb_callable_method_entry_t,
so that rb_vm_frame_method_entry() returns rb_callable_method_entry_t. You can check a super class of current method by
rb_callable_method_entry_t::defined_class.

- method.h: renamed from rb_method_entry_t::klass to rb_method_entry_t::owner.
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- cont.c (fiber_init): rb_control_frame_t::klass is removed.
- proc.c: fix 'struct METHOD' data structure because rb_callable_method_t has all information.
- vm_core.h: remove several fields.
- rb_control_frame_t::klass.
- rb_block_t::class. And catch up changes.
- eval.c: catch up changes.
- gc.c: ditto.
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- vm.c: ditto.
- vm_args.c: ditto.
- vm_backtrace.c: ditto.
- vm_dump.c: ditto.
- vm_eval.c: ditto.
- vm_insnhelper.c: ditto.
- vm_method.c: ditto.

Revision 51126 - 07/03/2015 11:24 AM - ko1 (Koichi Sasada)

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belong to modules/classes. rb_method_entry_t::owner points defined module or class. module M def foo; end end In this case, owner is M.
ruby_callable_method_entry_t data belong to only classes. For modules, MRI creates corresponding T_ICLASS internally.
ruby_callable_method_entry_t can also belong to T_ICLASS. rb_callable_method_entry_t::defined_class points T_CLASS or T_ICLASS.
ruby_method_entry_t data for classes (not for modules) are also rb_callable_method_entry_t data because it is completely same data. In this case,
ruby_method_entry_t::owner == rb_method_entry_t::defined_class. For example, there are classes C and D, and includes M, class C; include M;
end class D; include M; end then, two T_ICLASS objects for C's super class and D's super class will be created. When C.new.foo is called, then
M#foo is searched and rb_callable_method_t data is used by VM to invoke M#foo. rb_method_entry_t data is only one for M#foo. However,
ruby_callable_method_entry_t data are two (and can be more). It is proportional to the number of including (and prepending) classes (the number
of T_ICLASS which point to the module). Now, created rb_callable_method_entry_t are collected when the original module M was modified. We
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- rb_method_entry(VALUE klass, ID id);
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- ruby_resolve_refined_method(VALUE refinements, const rb_callable_method_entry_t *me); VM pushes rb_callable_method_entry_t,
so that rb_vm_frame_method_entry() returns rb_callable_method_entry_t. You can check a super class of current method by
ruby_callable_method_entry_t::defined_class.

- method.h: renamed from rb_method_entry_t::klass to rb_method_entry_t::owner.
- class.c (method_entry_i): ditto.
- class.c (rb_define_attr): rb_method_entry() does not takes defiend_class_ptr.
- gc.c (mark_method_entry): mark RCLASS_CALLABLE_M_TBL() for T_ICLASS.
- cont.c (fiber_init): rb_control_frame_t::klass is removed.
- proc.c: fix 'struct METHOD' data structure because rb_callable_method_t has all information.
- vm_core.h: remove several fields.
- rb_control_frame_t::klass.
- rb_block_t::class. And catch up changes.
- eval.c: catch up changes.
- gc.c: ditto.
- insns.def: ditto.
- vm.c: ditto.
- vm_args.c: ditto.
- vm_backtrace.c: ditto.
- vm_dump.c: ditto.

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rb_method_entry_t data are only one for M#foo. However, rb_callable_method_entry_t data are two (and can be more). It is proportional to the number of including (and prepending) classes (the number of T_ICLASS which point to the module). Now, created rb_callable_method_entry_t are collected when the original module M was modified. We can think it is a cache. We need to select what kind of method entry data is needed. To operate definition, then you need to use rb_method_entry_t. You can access them by the following functions.

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- rb_resolve_refined_method Callable(VALUE refinements, const rb_callable_method_entry_t *me); VM pushes rb_callable_method_entry_t, so that rb_vm_frame_method_entry() returns rb_callable_method_entry_t. You can check a super class of current method by rb_callable_method_entry::defined_class.

Method.h: renamed from rb_method_entry_t::klass to rb_method_entry_t::owner.

internal.h: add rb_classext::struct::callable_m_tbl to cache rb_callable_method_entry_t data. We need to consider about this field again because it is only active for T_ICLASS.

class.c (method_entry_i): ditto.

class.c (rb_define_attr): rb_method_entry() does not take defined_class ptr.

gc.c (mark_method_entry): mark RCLASS_CALLABLE_M_TBL() for T_ICLASS.

tcont.c (fiber_init): rb_control_frame_t::klass is removed.

proc.c: fix `struct METHOD' data structure because rb_callable_method_t has all information.

vm::core::h: remove several fields.

- rb_control_frame_t::klass.
- rb_block_t::klass. And catch up changes.

eval.c: catch up changes.

gc.c: ditto.

insns.def: ditto.

vm.c: ditto.

vm_args.c: ditto.

vm_traceback.c: ditto.

vm_dump.c: ditto.

vm_eval.c: ditto.

vm_insnhelper.c: ditto.

vm_method.c: ditto.
rb_resolve_refined_method_callable(VALUE refinements, const rb_callable_method_entry_t *me); VM pushes rb_callable_method_entry_t, so that rb_vm_frame_method_entry() returns rb_callable_method_entry_t. You can check a super class of current method by rb_callable_method_entry_t::defined_class.

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- eval.c: catch up changes.
- gc.c: ditto.
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- vm_dump.c: ditto.
- vm_eval.c: ditto.
- vm_insnhelper.c: ditto.
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Revision 51126 - 07/03/2015 11:24 AM - ko1 (Koichi Sasada)

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  - rb_method_entry(VALUE klass, ID id);
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  - rb_method_entry_with_refinements(VALUE klass, ID id);
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- vm_core.h: remove several fields.
  - rb_control_frame_t::klass.
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- gc.c: ditto.
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- vm.c: ditto.
- vm_args.c: ditto.
- vm_backtrace.c: ditto.
- vm_dump.c: ditto.
- vm_eval.c: ditto.
- vm_insnhelper.c: ditto.
- vm_method.c: ditto.
#1 - 06/18/2015 11:36 AM - ko1 (Koichi Sasada)
- Related to Bug #11279: remove rb_control_frame_t::klass added

#2 - 07/03/2015 11:25 AM - ko1 (Koichi Sasada)
- Status changed from Open to Closed

Applied in changeset r51126.

- method.h: introduce rb_callable_method_entry_t to remove rb_control_frame_t::klass. [Bug #11278], [Bug #11279] rb_method_entry_t data belong to modules/classes. rb_method_entry_t::owner points defined module or class. module M def foo; end end In this case, owner is M.

- rb_callable_method_entry_t data also belong to T_CLASS. rb_callable_method_entry_t::defined_class points T_CLASS or T_ICLASS. rb_method_entry_t data for classes (not for modules) are also rb_callable_method_entry_t data because it is completely same data. In this case, rb_method_entry_t::owner == rb_method_entry_t::defined_class. For example, there are classes C and D, and include M, class C; include M; class D; include M; end end, two T_CLASS objects for C's super class and D's super class will be created. When C.new.foo is called, then M#foo is searched and rb_callable_method_t data is used by VM to invoke M#foo. However, rb_callable_method_entry_t data are two (and can be more). It is proportional to the number of including (and prepending) classes (the number of T_CLASS which point to the module). Now, created rb_callable_method_entry_t are collected when the original module M was modified. We can think it as a cache. We need to select what kind of method entry data is needed. To operate definition, then you need to use rb_method_entry_t. You can access them by the following functions.

- rb_method_entry(VALUE klass, ID id);
- rb_method_entry_with_refinements(VALUE klass, ID id);
- rb_method_entry_without_refinements(VALUE klass, ID id);
- rb_resolve_refined_method(VALUE refinements, const rb_method_entry_t *me); To invoke methods, then you need to use rb_callable_method_entry_t which you can get by the following APIs corresponding to the above listed functions.

- rb_callable_method_entry(VALUE klass, ID id);
- rb_callable_method_entry_with_refinements(VALUE klass, ID id);
- rb_callable_method_entry_without_refinements(VALUE klass, ID id);
- rb_resolve_refined_method_callable(VALUE refinements, const rb_callable_method_entry_t *me); VM pushes rb_callable_method_entry_t, so that rb_vm_frame_method_entry() returns rb_callable_method_entry_t. You can check a super class of current method by rb_callable_method_entry_t::defined_class.

- method.h: renamed from rb_method_entry_t::klass to rb_method_entry_t::owner.
- internal.h: add rb_classext_struct::callable_m_tbl to cache rb_callable_method_entry_t data. We need to consider about this field again because it is only active for T_CLASS.
- class.c (method_entry_i): ditto.
- class.c (rb_define_attr): rb_method_entry() does not takes defiend_class_ptr.
- gc.c (mark_method_entry): mark RCLASS_CALLABLE_M_TBL() for T_ICLASS.
- cont.c (fiber_init): rb_control_frame_t::klass is removed.
- proc.c: fix `struct METHOD' data structure because rb_callable_method_t has all information.
- vm_core.c: remove several fields.
- rb_control_frame_t::klass.
- rb_block_t::klass. And catch up changes.
- eval.c: catch up changes.
- gc.c: ditto.
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- vm.c: ditto.
- vm_args.c: ditto.
- vm_backtrace.c: ditto.
- vm_dump.c: ditto.
- vm_eval.c: ditto.
- vm_inshelper.c: ditto.
- vm_method.c: ditto.

#3 - 07/03/2015 11:37 AM - ko1 (Koichi Sasada)
I committed this change. If you find any regression, please report about it.

I measured some applications with https://github.com/ko1/class_stat gem. This gem reports class/module/T_ICLASS usage. For example, my rails app https://github.com/ko1/tracer_demo_rails_app:  

```
total_klasses 6204
total_included 398
total_iclasses 979
total_methods 23539
total_dup 10149
```

In this case,

- there are 6,000 classes and modules.
- 400 modules are included (or prepended).
- 1,000 T_ICLASSES are created.
- 24,000 methods are defined.
- 10,000 methods can be duplicated by this patch.

Last line needs explanation.
Without this patch, each method has one rb_method_entry_t (VALUE).
However, this patch makes that methods of modules needs additional rb_callable_method_entry_t for each T_ICLASS.

Roughly, 10,000 objects can be allocated additionally in this case.
(rb_callable_method_entry_t for methods in modules are allocated when called, so it does not mean increasing 10,000 objects immediately)

Recently, I reduced one objects per methods in trunk.
In this case, 24,000 objects. So I decided increasing 10,000 objects is acceptable.
This is why I commit-ed it.

We need to consider how to cache rb_callable_method_entry_t.
This is future work.

#4 - 03/24/2016 07:30 AM - usa (Usaku NAKAMURA)
- Related to Bug #12164: Binding UnboundMethod to BasicObject added

Files

| file.copipa-temp-image.png | 72.7 KB | 06/18/2015   | ko1 (Koichi Sasada) |