
Subject: [PATCH 18/23] slub: charge allocation to a memcg
Posted by [Glauber Costa](#) on Sun, 22 Apr 2012 23:53:35 GMT
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This patch charges allocation of a slab object to a particular memcg.

The cache is selected with `mem_cgroup_get_kmem_cache()`, which is the biggest overhead we pay here, because it happens at all allocations. However, other than forcing a function call, this function is not very expensive, and try to return as soon as we realize we are not a memcg cache.

The charge/uncharge functions are heavier, but are only called for new page allocations.

The `kmalloc_no_account` variant is patched so the base function is used and we don't even try to do cache selection.

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include/linux/slub_def.h | 32 ++++++++--
mm/slub.c | 124 ++++++++-----
2 files changed, 138 insertions(+), 18 deletions(-)

diff --git a/include/linux/slub_def.h b/include/linux/slub_def.h
index 9a8000a..e75efcb 100644

--- a/include/linux/slub_def.h
+++ b/include/linux/slub_def.h
@@ -13,6 +13,7 @@
#include <linux/kobject.h>

#include <linux/kmemleak.h>
+#include <linux/memcontrol.h>

enum stat_item {
ALLOC_FASTPATH, /* Allocation from cpu slab */
@@ -210,14 +211,21 @@ static __always_inline int kmalloc_index(size_t size)
* This ought to end up with a global pointer to the right cache
* in kmalloc_caches.
*/

```

-static __always_inline struct kmem_cache *kmalloc_slab(size_t size)
+static __always_inline struct kmem_cache *kmalloc_slab(gfp_t flags, size_t size)
{
+ struct kmem_cache *s;
  int index = kmalloc_index(size);

  if (index == 0)
    return NULL;

- return kmalloc_caches[index];
+ s = kmalloc_caches[index];
+
+ rcu_read_lock();
+ s = mem_cgroup_get_kmem_cache(s, flags);
+ rcu_read_unlock();
+
+ return s;
}

```

```

void *kmem_cache_alloc(struct kmem_cache *, gfp_t);
@@ -225,13 +233,27 @@ void *kmalloc_no_account(size_t size, gfp_t);
void *__kmalloc(size_t size, gfp_t flags);

```

```

static __always_inline void *
-kmalloc_order(size_t size, gfp_t flags, unsigned int order)
+kmalloc_order_base(size_t size, gfp_t flags, unsigned int order)
{
  void *ret = (void *) __get_free_pages(flags | __GFP_COMP, order);
  kmemleak_alloc(ret, size, 1, flags);
  return ret;
}

```

```

+static __always_inline void *
+kmalloc_order(size_t size, gfp_t flags, unsigned int order)
+{
+ void *ret = NULL;
+
+ if (!mem_cgroup_charge_kmem(flags, size))
+   return NULL;
+
+ ret = kmalloc_order_base(size, flags, order);
+ if (!ret)
+   mem_cgroup_uncharge_kmem((1 << order) << PAGE_SHIFT);
+ return ret;
+}
+
+/**

```

* Calling this on allocated memory will check that the memory

```

* is expected to be in use, and print warnings if not.
@@ -276,7 +298,7 @@ static __always_inline void *kmalloc(size_t size, gfp_t flags)
    return kmalloc_large(size, flags);

    if (!(flags & SLUB_DMA)) {
- struct kmem_cache *s = kmalloc_slab(size);
+ struct kmem_cache *s = kmalloc_slab(flags, size);

    if (!s)
        return ZERO_SIZE_PTR;
@@ -309,7 +331,7 @@ static __always_inline void *kmalloc_node(size_t size, gfp_t flags, int
node)
{
    if (__builtin_constant_p(size) &&
        size <= SLUB_MAX_SIZE && !(flags & SLUB_DMA)) {
- struct kmem_cache *s = kmalloc_slab(size);
+ struct kmem_cache *s = kmalloc_slab(flags, size);

    if (!s)
        return ZERO_SIZE_PTR;
diff --git a/mm/slub.c b/mm/slub.c
index d754b06..9b22139 100644
--- a/mm/slub.c
+++ b/mm/slub.c
@@ -1283,11 +1283,17 @@ static inline struct page *alloc_slab_page(gfp_t flags, int node,
    return alloc_pages_exact_node(node, flags, order);
}

+static inline unsigned long size_in_bytes(unsigned int order)
+{
+ return (1 << order) << PAGE_SHIFT;
+}
+
static struct page *allocate_slab(struct kmem_cache *s, gfp_t flags, int node)
{
- struct page *page;
+ struct page *page = NULL;
    struct kmem_cache_order_objects oo = s->oo;
    gfp_t alloc_gfp;
+ unsigned int memcg_allowed = oo_order(oo);

    flags &= gfp_allowed_mask;

@@ -1296,13 +1302,29 @@ static struct page *allocate_slab(struct kmem_cache *s, gfp_t flags,
int node)

    flags |= s->allocflags;

```

```

- /*
- * Let the initial higher-order allocation fail under memory pressure
- * so we fall-back to the minimum order allocation.
- */
- alloc_gfp = (flags | __GFP_NOWARN | __GFP_NORETRY) & ~__GFP_NOFAIL;
+ memcg_allowed = oo_order(oo);
+ if (!mem_cgroup_charge_slab(s, flags, size_in_bytes(memcg_allowed))) {
+
+ memcg_allowed = oo_order(s->min);
+ if (!mem_cgroup_charge_slab(s, flags,
+     size_in_bytes(memcg_allowed))) {
+     if (flags & __GFP_WAIT)
+         local_irq_disable();
+     return NULL;
+ }
+ }
+
+ if (memcg_allowed == oo_order(oo)) {
+ /*
+ * Let the initial higher-order allocation fail under memory
+ * pressure so we fall-back to the minimum order allocation.
+ */
+ alloc_gfp = (flags | __GFP_NOWARN | __GFP_NORETRY) &
+     ~__GFP_NOFAIL;
+
+ page = alloc_slab_page(alloc_gfp, node, oo);
+ }

- page = alloc_slab_page(alloc_gfp, node, oo);
- if (unlikely(!page)) {
-     oo = s->min;
- }
- /*
@@@ -1313,13 +1335,23 @@@ static struct page *allocate_slab(struct kmem_cache *s, gfp_t flags,
int node)

    if (page)
        stat(s, ORDER_FALLBACK);
+ /*
+ * We reserved more than we used, time to give it back
+ */
+ if (page && memcg_allowed != oo_order(oo)) {
+     unsigned long delta;
+     delta = memcg_allowed - oo_order(oo);
+     mem_cgroup_uncharge_slab(s, size_in_bytes(delta));
+ }
+ }

    if (flags & __GFP_WAIT)

```

```

    local_irq_disable();

- if (!page)
+ if (!page) {
+ mem_cgroup_uncharge_slab(s, size_in_bytes(memcg_allowed));
+ return NULL;
+ }

    if (kmemcheck_enabled
        && !(s->flags & (SLAB_NOTRACK | DEBUG_DEFAULT_FLAGS))) {
@@ -1393,6 +1425,24 @@ out:
    return page;
}

#ifdef CONFIG_CGROUP_MEM_RES_CTLR_KMEM
+static unsigned long slab_nr_pages(struct kmem_cache *s)
+{
+ int node;
+ unsigned long nr_slabs = 0;
+
+ for_each_online_node(node) {
+ struct kmem_cache_node *n = get_node(s, node);
+
+ if (!n)
+ continue;
+ nr_slabs += atomic_long_read(&n->nr_slabs);
+ }
+
+ return nr_slabs << oo_order(s->oo);
+}
+
+static void __free_slab(struct kmem_cache *s, struct page *page)
+{
+ int order = compound_order(page);
@@ -1419,6 +1469,12 @@ static void __free_slab(struct kmem_cache *s, struct page *page)
+ if (current->reclaim_state)
+ current->reclaim_state->reclaimed_slab += pages;
+ __free_pages(page, order);
+
+ mem_cgroup_uncharge_slab(s, (1 << order) << PAGE_SHIFT);
#ifdef CONFIG_CGROUP_MEM_RES_CTLR_KMEM
+ if (s->memcg_params.memcg && (slab_nr_pages(s) == 0))
+ mem_cgroup_destroy_cache(s);
+}

#define need_reserve_slab_rcu \

```

@@ -2300,8 +2356,9 @@ new_slab:

*

* Otherwise we can simply pick the next object from the lockless free list.

*/

```
-static __always_inline void *slab_alloc(struct kmem_cache *s,  
- gfp_t gfpflags, int node, unsigned long addr)  
+static __always_inline void *slab_alloc_base(struct kmem_cache *s,  
+      gfp_t gfpflags, int node,  
+      unsigned long addr)
```

```
{  
    void **object;  
    struct kmem_cache_cpu *c;  
@@ -2369,6 +2426,24 @@ redo:  
    return object;  
}
```

```
+static __always_inline void *slab_alloc(struct kmem_cache *s,  
+ gfp_t gfpflags, int node, unsigned long addr)  
+{  
+  
+ if (slab_pre_alloc_hook(s, gfpflags))  
+ return NULL;  
+  
+ if (in_interrupt() || (current == NULL) || (gfpflags & __GFP_NOFAIL))  
+ goto kernel_alloc;  
+  
+ rcu_read_lock();  
+ s = mem_cgroup_get_kmem_cache(s, gfpflags);  
+ rcu_read_unlock();  
+  
+kernel_alloc:  
+ return slab_alloc_base(s, gfpflags, node, addr);  
+}
```

```
+void *kmem_cache_alloc(struct kmem_cache *s, gfp_t gfpflags)  
{  
    void *ret = slab_alloc(s, gfpflags, NUMA_NO_NODE, _RET_IP_);  
@@ -3194,6 +3269,13 @@ void kmem_cache_destroy(struct kmem_cache *s)  
    s->refcount--;  
    if (!s->refcount) {  
        list_del(&s->list);  
+ifdef CONFIG_CGROUP_MEM_RES_CTLR_KMEM  
+ /* Not a memcg cache */  
+ if (s->memcg_params.id != -1) {  
+ mem_cgroup_release_cache(s);  
+ mem_cgroup_flush_cache_create_queue();  
+ }  
+endif
```

```

    up_write(&slub_lock);
    if (kmem_cache_close(s)) {
        printk(KERN_ERR "SLUB %s: %s called for cache that "
@@ -3273,6 +3355,7 @@ static struct kmem_cache *__init create_kmalloc_cache(const char
*name,
    goto panic;

    list_add(&s->list, &slab_caches);
+ mem_cgroup_register_cache(NULL, s);
    return s;

panic:
@@ -3364,15 +3447,21 @@ void *kmalloc_no_account(size_t size, gfp_t flags)
    struct kmem_cache *s;
    void *ret;

- if (unlikely(size > SLUB_MAX_SIZE))
- return kmalloc_large(size, flags);
+ if (unlikely(size > SLUB_MAX_SIZE)) {
+ unsigned int order = get_order(size);
+ ret = kmalloc_order_base(size, flags, order);
+ #ifdef CONFIG_TRACING
+ trace_kmalloc(_RET_IP_, ret, size, PAGE_SIZE << order, flags);
+ #endif
+ return ret;
+ }

    s = get_slab(size, flags);

    if (unlikely(ZERO_OR_NULL_PTR(s)))
        return s;

- ret = slab_alloc(s, flags, NUMA_NO_NODE, _RET_IP_);
+ ret = slab_alloc_base(s, flags, NUMA_NO_NODE, _RET_IP_);

    trace_kmalloc(_RET_IP_, ret, size, s->size, flags);

@@ -3387,10 +3476,17 @@ static void *kmalloc_large_node(size_t size, gfp_t flags, int node)
    void *ptr = NULL;

    flags |= __GFP_COMP | __GFP_NOTRACK;
+
+ if (!mem_cgroup_charge_kmem(flags, size))
+ goto out;
+
    page = alloc_pages_node(node, flags, get_order(size));
    if (page)
        ptr = page_address(page);

```

```

+ else
+ mem_cgroup_uncharge_kmem(size);

+out:
    kmemleak_alloc(ptr, size, 1, flags);
    return ptr;
}
@@ -3938,8 +4034,10 @@ static struct kmem_cache *find_mergeable(struct mem_cgroup
*memcg, size_t size,
    if (s->size - size >= sizeof(void *))
        continue;

#ifdef CONFIG_CGROUP_MEM_RES_CTLR_KMEM
    if (memcg && s->memcg_params.memcg != memcg)
        continue;
#endif

    return s;
}
--
1.7.7.6

```
