
Subject: [PATCH v6 01/10] Basic kernel memory functionality for the Memory Controller

Posted by [Glauber Costa](#) on Fri, 25 Nov 2011 17:38:07 GMT

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This patch lays down the foundation for the kernel memory component of the Memory Controller.

As of today, I am only laying down the following files:

- * memory.independent_kmem_limit
- * memory.kmem.limit_in_bytes (currently ignored)
- * memory.kmem.usage_in_bytes (always zero)

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```
Documentation/cgroups/memory.txt | 36 ++++++++
init/Kconfig                      | 14 +++++
mm/memcontrol.c                  | 107 ++++++++
3 files changed, 150 insertions(+), 7 deletions(-)
```

```
diff --git a/Documentation/cgroups/memory.txt b/Documentation/cgroups/memory.txt
index 06eb6d9..bf00cd2 100644
```

```
--- a/Documentation/cgroups/memory.txt
```

```
+++ b/Documentation/cgroups/memory.txt
```

```
@@ -44,8 +44,9 @@ Features:
```

- oom-killer disable knob and oom-notifier
- Root cgroup has no limit controls.

- Kernel memory and Hugepages are not under control yet. We just manage
- pages on LRU. To add more controls, we have to take care of performance.
- + Hugepages is not under control yet. We just manage pages on LRU. To add more
- + controls, we have to take care of performance. Kernel memory support is work
- + in progress, and the current version provides basically functionality.

Brief summary of control files.

```
@@ -56,8 +57,11 @@ Brief summary of control files.
```

```
(See 5.5 for details)
```

```
memory.memsw.usage_in_bytes # show current res_counter usage for memory+Swap
```

```
(See 5.5 for details)
```

```
+ memory.kmem.usage_in_bytes # show current res_counter usage for kmem only.
```

```
+ (See 2.7 for details)
```

```
memory.limit_in_bytes # set/show limit of memory usage
```

```
memory.memsw.limit_in_bytes # set/show limit of memory+Swap usage
```

- + memory.kmem.limit_in_bytes # if allowed, set/show limit of kernel memory
- memory.failcnt # show the number of memory usage hits limits
- memory.memsw.failcnt # show the number of memory+Swap hits limits
- memory.max_usage_in_bytes # show max memory usage recorded
- @@ -72,6 +76,9 @@ Brief summary of control files.
- memory.oom_control # set/show oom controls.
- memory.numa_stat # show the number of memory usage per numa node

- + memory.independent_kmem_limit # select whether or not kernel memory limits are
- + independent of user limits
- +

1. History

The memory controller has a long history. A request for comments for the memory

@@ -255,6 +262,31 @@ When oom event notifier is registered, event will be delivered.

per-zone-per-cgroup LRU (cgroup's private LRU) is just guarded by zone->lru_lock, it has no lock of its own.

+2.7 Kernel Memory Extension (CONFIG_CGROUP_MEM_RES_CTLR_KMEM)

- +
- + With the Kernel memory extension, the Memory Controller is able to limit
- +the amount of kernel memory used by the system. Kernel memory is fundamentally
- +different than user memory, since it can't be swapped out, which makes it
- +possible to DoS the system by consuming too much of this precious resource.
- +Kernel memory limits are not imposed for the root cgroup.
- +
- +Memory limits as specified by the standard Memory Controller may or may not
- +take kernel memory into consideration. This is achieved through the file
- +memory.independent_kmem_limit. A Value different than 0 will allow for kernel
- +memory to be controlled separately.
- +
- +When kernel memory limits are not independent, the limit values set in
- +memory.kmem files are ignored.
- +
- +Currently no soft limit is implemented for kernel memory. It is future work
- +to trigger slab reclaim when those limits are reached.
- +
- +CAUTION: As of this writing, the kmem extention may prevent tasks from moving
- +among cgroups. If a task has kmem accounting in a cgroup, the task cannot be
- +moved until the kmem resource is released. Also, until the resource is fully
- +released, the cgroup cannot be destroyed. So, please consider your use cases
- +and set kmem extention config option carefully.
- +

3. User Interface

0. Configuration

```
diff --git a/init/Kconfig b/init/Kconfig
index 31ba0fd..e4b6246 100644
```

```

--- a/init/Kconfig
+++ b/init/Kconfig
@@ -689,6 +689,20 @@ config CGROUP_MEM_RES_CTLR_SWAP_ENABLED
    For those who want to have the feature enabled by default should
    select this option (if, for some reason, they need to disable it
    then swapaccount=0 does the trick).
+config CGROUP_MEM_RES_CTLR_KMEM
+ bool "Memory Resource Controller Kernel Memory accounting (EXPERIMENTAL)"
+ depends on CGROUP_MEM_RES_CTLR && EXPERIMENTAL
+ default n
+ help
+  The Kernel Memory extension for Memory Resource Controller can limit
+  the amount of memory used by kernel objects in the system. Those are
+  fundamentally different from the entities handled by the standard
+  Memory Controller, which are page-based, and can be swapped. Users of
+  the kmem extension can use it to guarantee that no group of processes
+  will ever exhaust kernel resources alone.
+
+  WARNING: The current experimental implementation does not allow a
+  task to move among different cgroups with a kmem resource being held.

```

```

config CGROUP_PERF
    bool "Enable perf_event per-cpu per-container group (cgroup) monitoring"
diff --git a/mm/memcontrol.c b/mm/memcontrol.c
index 2d57555..1cb7daa 100644
--- a/mm/memcontrol.c
+++ b/mm/memcontrol.c
@@ -226,6 +226,10 @@ struct mem_cgroup {
    */
    struct res_counter memsw;
    /*
+ * the counter to account for kmem usage.
+ */
    struct res_counter kmem;
    /*
    * Per cgroup active and inactive list, similar to the
    * per zone LRU lists.
    */
@@ -276,6 +280,11 @@ struct mem_cgroup {
    */
    unsigned long move_charge_at_immigrate;
    /*
+ * Should kernel memory limits be stabilshed independently
+ * from user memory ?
+ */
    int kmem_independent_accounting;
    /*
    * percpu counter.

```

```

*/
struct mem_cgroup_stat_cpu *stat;
@@ -343,9 +352,14 @@ enum charge_type {
};

/* for encoding cft->private value on file */
#define _MEM (0)
#define _MEMSWAP (1)
#define _OOM_TYPE (2)
+
+enum mem_type {
+ _MEM = 0,
+ _MEMSWAP,
+ _OOM_TYPE,
+ _KMEM,
+};
+
#define MEMFILE_PRIVATE(x, val) (((x) << 16) | (val))
#define MEMFILE_TYPE(val) (((val) >> 16) & 0xffff)
#define MEMFILE_ATTR(val) ((val) & 0xffff)
@@ -3838,10 +3852,17 @@ static inline u64 mem_cgroup_usage(struct mem_cgroup *mem,
bool swap)
    u64 val;

    if (!mem_cgroup_is_root(mem)) {
+ val = 0;
#ifdef CONFIG_CGROUP_MEM_RES_CTLR_KMEM
+ if (!mem->kmem_independent_accounting)
+ val = res_counter_read_u64(&mem->kmem, RES_USAGE);
#endif
        if (!swap)
- return res_counter_read_u64(&mem->res, RES_USAGE);
+ val += res_counter_read_u64(&mem->res, RES_USAGE);
        else
- return res_counter_read_u64(&mem->memsw, RES_USAGE);
+ val += res_counter_read_u64(&mem->memsw, RES_USAGE);
+
+ return val;
    }

    val = mem_cgroup_recursive_stat(mem, MEM_CGROUP_STAT_CACHE);
@@ -3874,6 +3895,11 @@ static u64 mem_cgroup_read(struct cgroup *cont, struct cftype *cft)
    else
        val = res_counter_read_u64(&mem->memsw, name);
    break;
#ifdef CONFIG_CGROUP_MEM_RES_CTLR_KMEM
+ case _KMEM:
+ val = res_counter_read_u64(&mem->kmem, name);

```

```

+ break;
+ #endif
+ default:
+     BUG();
+     break;
@@ -4604,6 +4630,35 @@ static int mem_control_numa_stat_open(struct inode *unused, struct
file *file)
}
#endif /* CONFIG_NUMA */

+ #ifdef CONFIG_CGROUP_MEM_RES_CTLR_KMEM
+ static u64 kmem_limit_independent_read(struct cgroup *cgroup, struct cftype *cft)
+ {
+     return mem_cgroup_from_cont(cgroup)->kmem_independent_accounting;
+ }
+
+ static int kmem_limit_independent_write(struct cgroup *cgroup, struct cftype *cft,
+     u64 val)
+ {
+     struct mem_cgroup *memcg = mem_cgroup_from_cont(cgroup);
+     struct mem_cgroup *parent = parent_mem_cgroup(memcg);
+
+     + val = !!val;
+
+     + if (parent && parent->use_hierarchy &&
+         (val != parent->kmem_independent_accounting))
+     + return -EINVAL;
+     + /*
+     +  * TODO: We need to handle the case in which we are doing
+     +  * independent kmem accounting as authorized by our parent,
+     +  * but then our parent changes its parameter.
+     +  */
+     + cgroup_lock();
+     + memcg->kmem_independent_accounting = val;
+     + cgroup_unlock();
+     + return 0;
+ }
+ #endif
+
+ static struct cftype mem_cgroup_files[] = {
+ {
+     .name = "usage_in_bytes",
@@ -4719,6 +4774,42 @@ static int register_memsw_files(struct cgroup *cont, struct
cgroup_subsys *ss)
}
#endif

+

```

```

#ifdef CONFIG_CGROUP_MEM_RES_CTLR_KMEM
+static struct cftype kmem_cgroup_files[] = {
+ {
+ .name = "independent_kmem_limit",
+ .read_u64 = kmem_limit_independent_read,
+ .write_u64 = kmem_limit_independent_write,
+ },
+ {
+ .name = "kmem.usage_in_bytes",
+ .private = MEMFILE_PRIVATE(_KMEM, RES_USAGE),
+ .read_u64 = mem_cgroup_read,
+ },
+ {
+ .name = "kmem.limit_in_bytes",
+ .private = MEMFILE_PRIVATE(_KMEM, RES_LIMIT),
+ .read_u64 = mem_cgroup_read,
+ },
+};
+
+static int register_kmem_files(struct cgroup *cont, struct cgroup_subsys *ss)
+{
+ int ret = 0;
+
+ ret = cgroup_add_files(cont, ss, kmem_cgroup_files,
+     ARRAY_SIZE(kmem_cgroup_files));
+ return ret;
+};
+
+##else
+static int register_kmem_files(struct cgroup *cont, struct cgroup_subsys *ss)
+{
+ return 0;
+}
+##endif
+
+static int alloc_mem_cgroup_per_zone_info(struct mem_cgroup *mem, int node)
+{
+ struct mem_cgroup_per_node *pn;
@@ -4917,6 +5008,7 @@ mem_cgroup_create(struct cgroup_subsys *ss, struct cgroup *cont)
+ if (parent && parent->use_hierarchy) {
+     res_counter_init(&mem->res, &parent->res);
+     res_counter_init(&mem->memsw, &parent->memsw);
+ res_counter_init(&mem->kmem, &parent->kmem);
+ /*
+  * We increment refcnt of the parent to ensure that we can
+  * safely access it on res_counter_charge/uncharge.
@@ -4927,6 +5019,7 @@ mem_cgroup_create(struct cgroup_subsys *ss, struct cgroup *cont)
+ } else {

```

```

    res_counter_init(&mem->res, NULL);
    res_counter_init(&mem->memsw, NULL);
+   res_counter_init(&mem->kmem, NULL);
}
    mem->last_scanned_child = 0;
    mem->last_scanned_node = MAX_NUMNODES;
@@ -4970,6 +5063,10 @@ static int mem_cgroup_populate(struct cgroup_subsys *ss,

    if (!ret)
        ret = register_memsw_files(cont, ss);
+
+   if (!ret)
+       ret = register_kmem_files(cont, ss);
+
    return ret;
}

--
1.7.6.4

```
