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Subject: [PATCH] cfq: get rid of cfqq hash  
Posted by [Vasily Tarasov](#) on Tue, 24 Apr 2007 11:53:15 GMT  
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From: Vasily Tarasov <[vtaras@openvz.org](mailto:vtaras@openvz.org)>

cfq hash is no more necessary. We always can get cfqq from io context. cfq\_get\_io\_context\_noalloc() function is introduced, because we don't want to allocate cic on merging and checking may\_queue. In order to identify sync queue we've used hash key = CFQ\_KEY\_ASYNC. Since hash is eliminated we need to use other criterion: sync flag for queue is added. In all places where we dig in rb\_tree we're in current context, so no additional locking is required.

Advantages of this patch: no additional memory for hash, no seeking in hash, code is cleaner. But it is necessary now to seek cic in per-ioc rbtree, but it is faster:

- most processes work only with few devices
- most systems have only few block devices
- it is a rb-tree

Signed-off-by: Vasily Tarasov <[vtaras@openvz.org](mailto:vtaras@openvz.org)>

---

block/cfq-iosched.c | 141 ++++++-----  
1 files changed, 50 insertions(+), 91 deletions(-)

```
--- linux-2.6.21-rc7/block/cfq-iosched.c.hashrm 2007-04-24 14:09:04.000000000 +0400
+++ linux-2.6.21-rc7/block/cfq-iosched.c 2007-04-24 14:30:00.000000000 +0400
@@ -29,14 +29,11 @@ static int cfq_slice_idle = HZ / 125;
#define CFQ_IDLE_GRACE (HZ / 10)
#define CFQ_SLICE_SCALE (5)

-#define CFQ_KEY_ASYNC (0)
-
/*
 * for the hash of cfqq inside the cfqd
 */
#define CFQ_QHASH_SHIFT 6
#define CFQ_QHASH_ENTRIES (1 << CFQ_QHASH_SHIFT)
-#define list_entry_qhash(entry) hlist_entry((entry), struct cfq_queue, cfq_hash)

#define list_entry_cfqq(ptr) list_entry((ptr), struct cfq_queue, cfq_list)

@@ -59,11 +56,6 @@ static struct completion *ioc_gone;
#define cfq_cfqq_dispatched(cfqq) \
```

```

((cfqq)->on_dispatch[ASYNC] + (cfqq)->on_dispatch[SYNC])

-#define cfq_cfqq_class_sync(cfqq) ((cfqq)->key != CFQ_KEY_ASYNC)
-
-#define cfq_cfqq_sync(cfqq) \
- (cfq_cfqq_class_sync(cfqq) || (cfqq)->on_dispatch[SYNC])
-
#define sample_valid(samples) ((samples) > 80)

/*
@@ -81,11 +73,6 @@ struct cfq_data {
    struct list_head idle_rr;
    unsigned int busy_queues;

- /*
-  * cfqq lookup hash
-  */
- struct hlist_head *cfq_hash;
-
    int rq_in_driver;
    int hw_tag;

@@ -127,10 +114,6 @@ struct cfq_queue {
    atomic_t ref;
    /* parent cfq_data */
    struct cfq_data *cfqd;
- /* cfqq lookup hash */
- struct hlist_node cfq_hash;
- /* hash key */
- unsigned int key;
    /* member of the rr/busy/cur/idle cfqd list */
    struct list_head cfq_list;
    /* sorted list of pending requests */
@@ -172,6 +155,7 @@ enum cfqq_state_flags {
    CFQ_CFQQ_FLAG_prio_changed, /* task priority has changed */
    CFQ_CFQQ_FLAG_queue_new, /* queue never been serviced */
    CFQ_CFQQ_FLAG_slice_new, /* no requests dispatched in slice */
+ CFQ_CFQQ_FLAG_sync, /* synchronous queue */
};

#define CFQ_CFQQ_FNS(name) \
@@ -198,11 +182,14 @@ CFQ_CFQQ_FNS(idle_window);
CFQ_CFQQ_FNS(prio_changed);
CFQ_CFQQ_FNS(queue_new);
CFQ_CFQQ_FNS(slice_new);
+CFQ_CFQQ_FNS(sync);
#undef CFQ_CFQQ_FNS

```

```

-static struct cfq_queue *cfq_find_cfq_hash(struct cfq_data *, unsigned int, unsigned short);
+static struct cfq_io_context *
+cfq_get_io_context_noalloc(struct cfq_data *, struct task_struct *);
  static void cfq_dispatch_insert(request_queue_t *, struct request *);
-static struct cfq_queue *cfq_get_queue(struct cfq_data *cfqd, unsigned int key, struct task_struct
*tsk, gfp_t gfp_mask);
+static struct cfq_queue *cfq_get_queue(struct cfq_data *cfqd,
+ int is_sync, struct task_struct *tsk, gfp_t gfp_mask);

/*
 * scheduler run of queue, if there are requests pending and no one in the
@@ -221,17 +208,6 @@ static int cfq_queue_empty(request_queue
  return !cfqd->busy_queues;
}

-static inline pid_t cfq_queue_pid(struct task_struct *task, int rw, int is_sync)
- {
- /*
-  * Use the per-process queue, for read requests and synchronous writes
-  */
- if (!(rw & REQ_RW) || is_sync)
- return task->pid;
-
- return CFQ_KEY_ASYNC;
- }
-
/*
 * Scale schedule slice based on io priority. Use the sync time slice only
 * if a queue is marked sync and has sync io queued. A sync queue with async
@@ -445,7 +421,7 @@ static void cfq_resort_rr_list(struct cf
  n = n->next;
}
list_add_tail(&cfqq->cfq_list, n);
- } else if (!cfq_cfqq_class_sync(cfqq)) {
+ } else if (!cfq_cfqq_sync(cfqq)) {
/*
 * async queue always goes to the end. this wont be overly
 * unfair to writes, as the sort of the sync queue wont be
@@ -463,7 +439,7 @@ static void cfq_resort_rr_list(struct cf
while ((n = n->prev) != list) {
  struct cfq_queue *__cfqq = list_entry_cfqq(n);

- if (!cfq_cfqq_class_sync(cfqq) || !__cfqq->service_last)
+ if (!cfq_cfqq_sync(cfqq) || !__cfqq->service_last)
  break;
  if (time_before(__cfqq->service_last, cfqq->service_last))
  break;
@@ -546,10 +522,14 @@ static struct request *

```

```

cfq_find_rq_fmerge(struct cfq_data *cfqd, struct bio *bio)
{
    struct task_struct *tsk = current;
- pid_t key = cfq_queue_pid(tsk, bio_data_dir(bio), bio_sync(bio));
+ struct cfq_io_context *cic;
    struct cfq_queue *cfqq;

- cfqq = cfq_find_cfq_hash(cfqd, key, tsk->ioprio);
+ cic = cfq_get_io_context_noalloc(cfqd, tsk);
+ if (!cic)
+ return NULL;
+
+ cfqq = cic->cfqq[bio_sync(bio)];
    if (cfqq) {
        sector_t sector = bio->bi_sector + bio_sectors(bio);

@@ -642,9 +622,8 @@ static int cfq_allow_merge(request_queue
    struct bio *bio)
{
    struct cfq_data *cfqd = q->elevator->elevator_data;
- const int rw = bio_data_dir(bio);
+ struct cfq_io_context *cic;
    struct cfq_queue *cfqq;
- pid_t key;

    /*
     * Disallow merge of a sync bio into an async request.
@@ -656,9 +635,11 @@ static int cfq_allow_merge(request_queue
     * Lookup the cfqq that this bio will be queued with. Allow
     * merge only if rq is queued there.
     */
- key = cfq_queue_pid(current, rw, bio_sync(bio));
- cfqq = cfq_find_cfq_hash(cfqd, key, current->ioprio);
+ cic = cfq_get_io_context_noalloc(cfqd, current);
+ if (!cic)
+ return 0;

+ cfqq = cic->cfqq[bio_sync(bio)];
    if (cfqq == RQ_CFQQ(rq))
        return 1;

@@ -889,7 +870,7 @@ static inline struct request *cfq_check_
    if (list_empty(&cfqq->fifo))
        return NULL;

- fifo = cfq_cfqq_class_sync(cfqq);
+ fifo = cfq_cfqq_sync(cfqq);
    rq = rq_entry_fifo(cfqq->fifo.next);

```

```

if (time_after(jiffies, rq->start_time + cfqd->cfq_fifo_expire[fifo]))
@@ -934,7 +915,7 @@ static struct cfq_queue *cfq_select_queue
else if (cfq_cfqq_slice_new(cfqq) || cfq_cfqq_dispatched(cfqq)) {
    cfqq = NULL;
    goto keep_queue;
- } else if (cfq_cfqq_class_sync(cfqq)) {
+ } else if (cfq_cfqq_sync(cfqq)) {
    if (cfq_arm_slice_timer(cfqd))
        return NULL;
}
@@ -1108,34 +1089,9 @@ static void cfq_put_queue(struct cfq_queue
    * it's on the empty list and still hashed
    */
    list_del(&cfqq->cfq_list);
- hlist_del(&cfqq->cfq_hash);
    kmem_cache_free(cfq_pool, cfqq);
}

-static struct cfq_queue *
-__cfq_find_cfq_hash(struct cfq_data *cfqd, unsigned int key, unsigned int prio,
-    const int hashval)
-{
- struct hlist_head *hash_list = &cfqd->cfq_hash[hashval];
- struct hlist_node *entry;
- struct cfq_queue *__cfqq;
-
- hlist_for_each_entry(__cfqq, entry, hash_list, cfq_hash) {
- const unsigned short __p = IOPRIO_PRIO_VALUE(__cfqq->org_ioprio_class,
-    __cfqq->org_ioprio);
-
- if (__cfqq->key == key && (__p == prio || !prio))
-     return __cfqq;
- }
-
- return NULL;
-}

-static struct cfq_queue *
-cfq_find_cfq_hash(struct cfq_data *cfqd, unsigned int key, unsigned short prio)
-{
- return __cfq_find_cfq_hash(cfqd, key, prio, hash_long(key, CFQ_QHASH_SHIFT));
-}

static void cfq_free_io_context(struct io_context *ioc)
{
    struct cfq_io_context *__cic;
@@ -1295,7 +1251,7 @@ static inline void changed_ioprio(struct

```

```

cfqq = cic->cfqq[ASYNC];
if (cfqq) {
    struct cfq_queue *new_cfqq;
- new_cfqq = cfq_get_queue(cfqd, CFQ_KEY_ASYNC, cic->ioc->task,
+ new_cfqq = cfq_get_queue(cfqd, ASYNC, cic->ioc->task,
    GFP_ATOMIC);
    if (new_cfqq) {
        cic->cfqq[ASYNC] = new_cfqq;
@@ -1327,16 +1283,16 @@ static void cfq_ioc_set_ioprio(struct io
    }

static struct cfq_queue *
-cfq_get_queue(struct cfq_data *cfqd, unsigned int key, struct task_struct *tsk,
+cfq_get_queue(struct cfq_data *cfqd, int is_sync, struct task_struct *tsk,
    gfp_t gfp_mask)
{
- const int hashval = hash_long(key, CFQ_QHASH_SHIFT);
    struct cfq_queue *cfqq, *new_cfqq = NULL;
- unsigned short ioprio;
+ struct cfq_io_context *cic;

    retry:
- ioprio = tsk->ioprio;
- cfqq = __cfq_find_cfq_hash(cfqd, key, ioprio, hashval);
+ cic = cfq_get_io_context_noalloc(cfqd, tsk);
+ /* cic always exists here */
+ cfqq = cic->cfqq[is_sync];

    if (!cfqq) {
        if (new_cfqq) {
@@ -1361,18 +1317,17 @@ retry:

        memset(cfqq, 0, sizeof(*cfqq));

- INIT_HLIST_NODE(&cfqq->cfq_hash);
        INIT_LIST_HEAD(&cfqq->cfq_list);
        INIT_LIST_HEAD(&cfqq->fifo);

- cfqq->key = key;
- hlist_add_head(&cfqq->cfq_hash, &cfqd->cfq_hash[hashval]);
        atomic_set(&cfqq->ref, 0);
        cfqq->cfqd = cfqd;

        cfq_mark_cfqq_idle_window(cfqq);
        cfq_mark_cfqq_prio_changed(cfqq);
        cfq_mark_cfqq_queue_new(cfqq);
+ if (is_sync)
+ cfq_mark_cfqq_sync(cfqq);

```

```

    cfq_init_prio_data(cfqq);
}

@@ -1502,6 +1457,19 @@ err:
    return NULL;
}

+static struct cfq_io_context *
+cfq_get_io_context_noalloc(struct cfq_data *cfqd, struct task_struct *tsk)
+{
+ struct cfq_io_context *cic = NULL;
+ struct io_context *ioc;
+
+ ioc = tsk->io_context;
+ if (ioc)
+ cic = cfq_cic_rb_lookup(cfqd, ioc);
+
+ return cic;
+}
+
static void
cfq_update_io_thinktime(struct cfq_data *cfqd, struct cfq_io_context *cic)
{
@@ -1791,10 +1759,8 @@ static int cfq_may_queue(request_queue_t
{
    struct cfq_data *cfqd = q->elevator->elevator_data;
    struct task_struct *tsk = current;
+ struct cfq_io_context *cic;
    struct cfq_queue *cfqq;
- unsigned int key;
-
- key = cfq_queue_pid(tsk, rw, rw & REQ_RW_SYNC);

/*
 * don't force setup of a queue from here, as a call to may_queue
@@ -1802,7 +1768,11 @@ static int cfq_may_queue(request_queue_t
 * so just lookup a possibly existing queue, or return 'may queue'
 * if that fails
 */
- cfqq = cfq_find_cfq_hash(cfqd, key, tsk->ioprio);
+ cic = cfq_get_io_context_noalloc(cfqd, tsk);
+ if (!cic)
+ return ELV_MQUEUE_MAY;
+
+ cfqq = cic->cfqq[rw & REQ_RW_SYNC];
    if (cfqq) {
        cfq_init_prio_data(cfqq);
        cfq_prio_boost(cfqq);

```

```

@@ -1846,7 +1816,6 @@ cfq_set_request(request_queue_t *q, struct
    struct cfq_io_context *cic;
    const int rw = rq_data_dir(rq);
    const int is_sync = rq_is_sync(rq);
- pid_t key = cfq_queue_pid(tsk, rw, is_sync);
    struct cfq_queue *cfqq;
    unsigned long flags;

@@ -1860,7 +1829,8 @@ cfq_set_request(request_queue_t *q, struct
    goto queue_fail;

    if (!cic->cfqq[is_sync]) {
- cfqq = cfq_get_queue(cfqd, key, tsk, gfp_mask);
+ cfqq = cfq_get_queue(cfqd, is_sync, tsk, gfp_mask);
+
    if (!cfqq)
        goto queue_fail;

@@ -1996,7 +1966,6 @@ static void cfq_exit_queue(elevator_t *e

    cfq_shutdown_timer_wq(cfqd);

- kfree(cfqd->cfq_hash);
    kfree(cfqd);
}

@@ -2019,13 +1988,6 @@ static void *cfq_init_queue(request_queue_t *q)
    INIT_LIST_HEAD(&cfqd->idle_rr);
    INIT_LIST_HEAD(&cfqd->cic_list);

- cfqd->cfq_hash = kmalloc_node(sizeof(struct hlist_head) * CFQ_QHASH_ENTRIES,
GFP_KERNEL, q->node);
- if (!cfqd->cfq_hash)
- goto out_free;
-
- for (i = 0; i < CFQ_QHASH_ENTRIES; i++)
- INIT_HLIST_HEAD(&cfqd->cfq_hash[i]);
-
    cfqd->queue = q;

    init_timer(&cfqd->idle_slice_timer);
@@ -2049,9 +2011,6 @@ static void *cfq_init_queue(request_queue_t *q)
    cfqd->cfq_slice_idle = cfq_slice_idle;

    return cfqd;
-out_free:
- kfree(cfqd);
- return NULL;

```



}

static void cfq\_slab\_kill(void)

---

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Subject: Re: [PATCH] cfq: get rid of cfqq hash  
Posted by [Jens Axboe](#) on Tue, 24 Apr 2007 12:27:39 GMT  
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On Tue, Apr 24 2007, Vasily Tarasov wrote:

> From: Vasily Tarasov <vtaras@openvz.org>

>

> cfq hash is no more necessary. We always can get cfqq from io context.

> cfq\_get\_io\_context\_noalloc() function is introduced, because we don't want to

> allocate cic on merging and checking may\_queue.

> In order to identify sync queue we've used hash key = CFQ\_KEY\_ASYNC. Since hash

> is eliminated we need to use other criterion: sync flag for queue is added.

> In all places where we dig in rb\_tree we're in current context, so no

> additional locking is required.

>

>

> Advantages of this patch: no additional memory for hash, no seeking in hash,

> code is cleaner. But it is necessary now to seek cic in per-ioc rbtree, but

> it is faster:

> - most processes work only with few devices

> - most systems have only few block devices

> - it is a rb-tree

Vasily, thanks for doing this, it's a good cleanup. One request, though

- care to rebase this against the cfq devel branch? I'm afraid it's

nowhere near applying right now.

--

Jens Axboe

---

---

Subject: Re: [PATCH] cfq: get rid of cfqq hash  
Posted by [Vasily Tarasov](#) on Tue, 24 Apr 2007 12:51:06 GMT  
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>> From: Vasily Tarasov <vtaras@openvz.org>

>>

>> cfq hash is no more necessary. We always can get cfqq from io context.

>> cfq\_get\_io\_context\_noalloc() function is introduced, because we don't want

>> to

>> allocate cic on merging and checking may\_queue.

>> In order to identify sync queue we've used hash key = CFQ\_KEY\_ASYNC. Since

>> hash  
>> is eliminated we need to use other criterion: sync flag for queue is added.  
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>> additional locking is required.  
>>  
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>> - most systems have only few block devices  
>> - it is a rb-tree  
>  
> Vasily, thanks for doing this, it's a good cleanup. One request, though  
> - care to rebase this against the cfq devel branch? I'm afraid it's  
> nowhere near applying right now.  
> --  
> Jens Axboe

Ouch, I see the sources are changed since the moment I was getting them...  
I'll resend a fresh version!

---

Subject: Re: [PATCH] cfq: get rid of cfqq hash  
Posted by [Jens Axboe](#) on Tue, 24 Apr 2007 17:22:29 GMT  
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On Tue, Apr 24 2007, Jens Axboe wrote:  
> On Tue, Apr 24 2007, Vasily Tarasov wrote:  
>> From: Vasily Tarasov <vtaras@openvz.org>  
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>> In order to identify sync queue we've used hash key = CFQ\_KEY\_ASYNC. Since hash  
>> is eliminated we need to use other criterion: sync flag for queue is added.  
>> In all places where we dig in rb\_tree we're in current context, so no  
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>> Advantages of this patch: no additional memory for hash, no seeking in hash,  
>> code is cleaner. But it is necessary now to seek cic in per-ioc rbtree, but  
>> it is faster:  
>> - most processes work only with few devices  
>> - most systems have only few block devices  
>> - it is a rb-tree  
>  
> Vasily, this is still not against the CFQ branch, I get tons of rejects:  
>

```

> axboe@nelson:/src/linux-2.6-block $ patch -p1 --dry-run < ~/foo
> [...]
> 10 out of 27 hunks FAILED -- saving rejects to file
> block/cfq-iosched.c.rej
>
> If you don't want to use the git tree, then just grab
>
> http://brick.kernel.dk/snaps/cfq-update-20070424
>
> and apply it to 2.6.21-rc7-gitX (latest) and provide a diff against
> that. Thanks!

```

I merged it myself, care to double check it? I'll do some testing on it tomorrow, and integrate if I'm happy with it.

Have you done any multi disk testing? scsi\_debug can be quite handy for such things, testing thousands of io\_contexts and disks. Just be sure to use delay=1 and fake\_rw=1.

```

diff --git a/block/cfq-iosched.c b/block/cfq-iosched.c
index 8093733..e42c09b 100644
--- a/block/cfq-iosched.c
+++ b/block/cfq-iosched.c
@@ -9,7 +9,6 @@
#include <linux/module.h>
#include <linux/blkdev.h>
#include <linux/elevator.h>
-#include <linux/hash.h>
#include <linux/rbtree.h>
#include <linux/ioprio.h>

@@ -38,14 +37,6 @@ static int cfq_slice_idle = HZ / 125;

#define CFQ_SLICE_SCALE (5)

-#define CFQ_KEY_ASYNC (0)
-
-/*
- * for the hash of cfqq inside the cfqd
- */
-#define CFQ_QHASH_SHIFT 6
-#define CFQ_QHASH_ENTRIES (1 << CFQ_QHASH_SHIFT)
-
#define RQ_CIC(rq) ((struct cfq_io_context*)(rq)->elevator_private)
#define RQ_CFQQ(rq) ((rq)->elevator_private2)

@@ -62,8 +53,6 @@ static struct completion *ioc_gone;
#define ASYNC (0)

```

```

#define SYNC (1)

-#define cfq_cfqq_sync(cfqq) ((cfqq)->key != CFQ_KEY_ASYNC)
-
#define sample_valid(samples) ((samples) > 80)

/*
@@ -90,11 +79,6 @@ struct cfq_data {
    struct cfq_rb_root service_tree;
    unsigned int busy_queues;

- /*
- * cfqq lookup hash
- */
- struct hlist_head *cfq_hash;
-
    int rq_in_driver;
    int sync_flight;
    int hw_tag;
@@ -138,10 +122,6 @@ struct cfq_queue {
    atomic_t ref;
    /* parent cfq_data */
    struct cfq_data *cfqd;
- /* cfqq lookup hash */
- struct hlist_node cfq_hash;
- /* hash key */
- unsigned int key;
    /* service_tree member */
    struct rb_node rb_node;
    /* service_tree key */
@@ -186,6 +166,7 @@ enum cfqq_state_flags {
    CFQ_CFQQ_FLAG_prio_changed, /* task priority has changed */
    CFQ_CFQQ_FLAG_queue_new, /* queue never been serviced */
    CFQ_CFQQ_FLAG_slice_new, /* no requests dispatched in slice */
+ CFQ_CFQQ_FLAG_sync, /* synchronous queue */
};

#define CFQ_CFQQ_FNS(name) \
@@ -212,11 +193,14 @@ CFQ_CFQQ_FNS(idle_window);
CFQ_CFQQ_FNS(prio_changed);
CFQ_CFQQ_FNS(queue_new);
CFQ_CFQQ_FNS(slice_new);
+CFQ_CFQQ_FNS(sync);
#undef CFQ_CFQQ_FNS

-static struct cfq_queue *cfq_find_cfq_hash(struct cfq_data *, unsigned int, unsigned short);
+static struct cfq_io_context * cfq_get_io_context_noalloc(struct cfq_data *,
+    struct task_struct *);

```

```

static void cfq_dispatch_insert(request_queue_t *, struct request *);
-static struct cfq_queue *cfq_get_queue(struct cfq_data *, unsigned int, struct task_struct *, gfp_t);
+static struct cfq_queue *cfq_get_queue(struct cfq_data *, int,
+      struct task_struct *, gfp_t);

/*
 * scheduler run of queue, if there are requests pending and no one in the
@@ -235,17 +219,6 @@ static int cfq_queue_empty(request_queue_t *q)
    return !cfqd->busy_queues;
}

-static inline pid_t cfq_queue_pid(struct task_struct *task, int rw, int is_sync)
-{
- /*
- * Use the per-process queue, for read requests and synchronous writes
- */
- if (!(rw & REQ_RW) || is_sync)
- return task->pid;
-
- return CFQ_KEY_ASYNC;
-}
-
/*
 * Scale schedule slice based on io priority. Use the sync time slice only
 * if a queue is marked sync and has sync io queued. A sync queue with async
@@ -602,10 +575,14 @@ static struct request *
cfq_find_rq_fmerge(struct cfq_data *cfqd, struct bio *bio)
{
    struct task_struct *tsk = current;
- pid_t key = cfq_queue_pid(tsk, bio_data_dir(bio), bio_sync(bio));
+ struct cfq_io_context *cic;
    struct cfq_queue *cfqq;

- cfqq = cfq_find_cfq_hash(cfqd, key, tsk->ioprio);
+ cic = cfq_get_io_context_noalloc(cfqd, tsk);
+ if (!cic)
+ return NULL;
+
+ cfqq = cic->cfqq[bio_sync(bio)];
    if (cfqq) {
        sector_t sector = bio->bi_sector + bio_sectors(bio);

@@ -699,9 +676,8 @@ static int cfq_allow_merge(request_queue_t *q, struct request *rq,
    struct bio *bio)
{
    struct cfq_data *cfqd = q->elevator->elevator_data;
- const int rw = bio_data_dir(bio);
+ struct cfq_io_context *cic;

```

```

struct cfq_queue *cfqq;
- pid_t key;

/*
 * Disallow merge of a sync bio into an async request.
@@ -713,9 +689,11 @@ static int cfq_allow_merge(request_queue_t *q, struct request *rq,
 * Lookup the cfqq that this bio will be queued with. Allow
 * merge only if rq is queued there.
 */
- key = cfq_queue_pid(current, rw, bio_sync(bio));
- cfqq = cfq_find_cfq_hash(cfqd, key, current->ioprio);
+ cic = cfq_get_io_context_noalloc(cfqd, current);
+ if (!cic)
+ return 0;

+ cfqq = cic->cfqq[bio_sync(bio)];
if (cfqq == RQ_CFQQ(rq))
return 1;

@@ -1148,37 +1126,9 @@ static void cfq_put_queue(struct cfq_queue *cfqq)
cfq_schedule_dispatch(cfqd);
}

- /*
- * it's on the empty list and still hashed
- */
- hlist_del(&cfqq->cfq_hash);
kmem_cache_free(cfq_pool, cfqq);
}

-static struct cfq_queue *
-__cfq_find_cfq_hash(struct cfq_data *cfqd, unsigned int key, unsigned int prio,
- const int hashval)
- {
- struct hlist_head *hash_list = &cfqd->cfq_hash[hashval];
- struct hlist_node *entry;
- struct cfq_queue *__cfqq;
-
- hlist_for_each_entry(__cfqq, entry, hash_list, cfq_hash) {
- const unsigned short __p = IOPRIO_PRIO_VALUE(__cfqq->org_ioprio_class,
__cfqq->org_ioprio);
-
- if (__cfqq->key == key && (__p == prio || !prio))
- return __cfqq;
- }
-
- return NULL;
- }

```

```

-
-static struct cfq_queue *
-cfq_find_cfq_hash(struct cfq_data *cfqd, unsigned int key, unsigned short prio)
-{
- return __cfq_find_cfq_hash(cfqd, key, prio, hash_long(key, CFQ_QHASH_SHIFT));
-}
-
static void cfq_free_io_context(struct io_context *ioc)
{
struct cfq_io_context * __cic;
@@ -1336,7 +1286,7 @@ static inline void changed_ioprio(struct cfq_io_context *cic)
cfqq = cic->cfqq[ASYNC];
if (cfqq) {
struct cfq_queue *new_cfqq;
- new_cfqq = cfq_get_queue(cfqd, CFQ_KEY_ASYNC, cic->ioc->task,
+ new_cfqq = cfq_get_queue(cfqd, ASYNC, cic->ioc->task,
GFP_ATOMIC);
if (new_cfqq) {
cic->cfqq[ASYNC] = new_cfqq;
@@ -1368,16 +1318,16 @@ static void cfq_ioc_set_ioprio(struct io_context *ioc)
}

static struct cfq_queue *
-cfq_get_queue(struct cfq_data *cfqd, unsigned int key, struct task_struct *tsk,
+cfq_get_queue(struct cfq_data *cfqd, int is_sync, struct task_struct *tsk,
gfp_t gfp_mask)
{
- const int hashval = hash_long(key, CFQ_QHASH_SHIFT);
struct cfq_queue *cfqq, *new_cfqq = NULL;
- unsigned short ioprio;
+ struct cfq_io_context *cic;

retry:
- ioprio = tsk->ioprio;
- cfqq = __cfq_find_cfq_hash(cfqd, key, ioprio, hashval);
+ cic = cfq_get_io_context_noalloc(cfqd, tsk);
+ /* cic always exists here */
+ cfqq = cic->cfqq[is_sync];

if (!cfqq) {
if (new_cfqq) {
@@ -1402,17 +1352,16 @@ retry:

memset(cfqq, 0, sizeof(*cfqq));

- INIT_HLIST_NODE(&cfqq->cfq_hash);
RB_CLEAR_NODE(&cfqq->rb_node);
INIT_LIST_HEAD(&cfqq->fifo);

```

```

- cfqq->key = key;
- hlist_add_head(&cfqq->cfq_hash, &cfqd->cfq_hash[hashval]);
  atomic_set(&cfqq->ref, 0);
  cfqq->cfqd = cfqd;

- if (key != CFQ_KEY_ASYNC)
+ if (!is_sync)
  cfq_mark_cfqq_idle_window(cfqq);
+ else
+ cfq_mark_cfqq_sync(cfqq);

  cfq_mark_cfqq_prio_changed(cfqq);
  cfq_mark_cfqq_queue_new(cfqq);
@@ -1548,6 +1497,19 @@ err:
  return NULL;
}

+static struct cfq_io_context *
+cfq_get_io_context_noalloc(struct cfq_data *cfqd, struct task_struct *tsk)
+{
+ struct cfq_io_context *cic = NULL;
+ struct io_context *ioc;
+
+ ioc = tsk->io_context;
+ if (ioc)
+ cic = cfq_cic_rb_lookup(cfqd, ioc);
+
+ return cic;
+}
+
static void
cfq_update_io_thinktime(struct cfq_data *cfqd, struct cfq_io_context *cic)
{
@@ -1839,10 +1801,8 @@ static int cfq_may_queue(request_queue_t *q, int rw)
{
  struct cfq_data *cfqd = q->elevator->elevator_data;
  struct task_struct *tsk = current;
+ struct cfq_io_context *cic;
  struct cfq_queue *cfqq;
- unsigned int key;
-
- key = cfq_queue_pid(tsk, rw, rw & REQ_RW_SYNC);

/*
 * don't force setup of a queue from here, as a call to may_queue
@@ -1850,7 +1810,11 @@ static int cfq_may_queue(request_queue_t *q, int rw)
 * so just lookup a possibly existing queue, or return 'may queue'

```



```

* if that fails
*/
- cfqq = cfq_find_cfq_hash(cfqd, key, tsk->ioprio);
+ cic = cfq_get_io_context_noalloc(cfqd, tsk);
+ if (!cic)
+ return ELV_MQUEUE_MAY;
+
+ cfqq = cic->cfqq[rw & REQ_RW_SYNC];
  if (cfqq) {
    cfq_init_prio_data(cfqq);
    cfq_prio_boost(cfqq);
@@ -1894,7 +1858,6 @@ cfq_set_request(request_queue_t *q, struct request *rq, gfp_t
gfp_mask)
  struct cfq_io_context *cic;
  const int rw = rq_data_dir(rq);
  const int is_sync = rq_is_sync(rq);
- pid_t key = cfq_queue_pid(tsk, rw, is_sync);
  struct cfq_queue *cfqq;
  unsigned long flags;

@@ -1908,7 +1871,8 @@ cfq_set_request(request_queue_t *q, struct request *rq, gfp_t
gfp_mask)
  goto queue_fail;

  if (!cic->cfqq[is_sync]) {
- cfqq = cfq_get_queue(cfqd, key, tsk, gfp_mask);
+ cfqq = cfq_get_queue(cfqd, is_sync, tsk, gfp_mask);
+
  if (!cfqq)
    goto queue_fail;

@@ -2044,14 +2008,12 @@ static void cfq_exit_queue(elevator_t *e)

  cfq_shutdown_timer_wq(cfqd);

- kfree(cfqd->cfq_hash);
  kfree(cfqd);
}

static void *cfq_init_queue(request_queue_t *q)
{
  struct cfq_data *cfqd;
- int i;

  cfqd = kmalloc_node(sizeof(*cfqd), GFP_KERNEL, q->node);
  if (!cfqd)
@@ -2062,13 +2024,6 @@ static void *cfq_init_queue(request_queue_t *q)
  cfqd->service_tree = CFQ_RB_ROOT;

```

```

INIT_LIST_HEAD(&cfqd->cic_list);

- cfqd->cfq_hash = kmalloc_node(sizeof(struct hlist_head) * CFQ_QHASH_ENTRIES,
GFP_KERNEL, q->node);
- if (!cfqd->cfq_hash)
- goto out_free;
-
- for (i = 0; i < CFQ_QHASH_ENTRIES; i++)
- INIT_HLIST_HEAD(&cfqd->cfq_hash[i]);
-
cfqd->queue = q;

init_timer(&cfqd->idle_slice_timer);
@@ -2092,9 +2047,6 @@ static void *cfq_init_queue(request_queue_t *q)
cfqd->cfq_slice_idle = cfq_slice_idle;

return cfqd;
-out_free:
- kfree(cfqd);
- return NULL;
}

static void cfq_slab_kill(void)

```

--  
Jens Axboe

---

Subject: Re: [PATCH] cfq: get rid of cfqq hash  
Posted by [Jens Axboe](#) on Tue, 24 Apr 2007 18:29:07 GMT  
[View Forum Message](#) <> [Reply to Message](#)

On Tue, Apr 24 2007, Jens Axboe wrote:

```

> - if (key != CFQ_KEY_ASYNC)
> + if (!is_sync)
>   cfq_mark_cfqq_idle_window(cfqq);
> + else
> +   cfq_mark_cfqq_sync(cfqq);

```

Woops, should be

```

if (is_sync) {
    cfq_mark_cfqq_idle_window(cfqq);
    cfq_mark_cfqq_sync(cfqq);
}

```

of course.

```
> +static struct cfq_io_context *
> +cfq_get_io_context_noalloc(struct cfq_data *cfqd, struct task_struct *tsk)
> +{
> + struct cfq_io_context *cic = NULL;
> + struct io_context *ioc;
> +
> + ioc = tsk->io_context;
> + if (ioc)
> +   cic = cfq_cic_rb_lookup(cfqd, ioc);
> +
> + return cic;
> +}
```

I'll change that to just call `cfq_cic_rb_lookup()`, returning NULL for NULL ioc.

--  
Jens Axboe

---

---

Subject: Re: [PATCH] cfq: get rid of cfqq hash  
Posted by [Jens Axboe](#) on Tue, 24 Apr 2007 18:33:35 GMT  
[View Forum Message](#) <> [Reply to Message](#)

---

On Tue, Apr 24 2007, Jens Axboe wrote:  
> On Tue, Apr 24 2007, Jens Axboe wrote:  
>> - if (key != CFQ\_KEY\_ASYNC)  
>> + if (!is\_sync)  
>> cfq\_mark\_cfqq\_idle\_window(cfqq);  
>> + else  
>> + cfq\_mark\_cfqq\_sync(cfqq);  
>  
> Woops, should be  
>  
> if (is\_sync) {  
> cfq\_mark\_cfqq\_idle\_window(cfqq);  
> cfq\_mark\_cfqq\_sync(cfqq);  
> }  
>  
> of course.  
>  
>> +static struct cfq\_io\_context \*  
>> +cfq\_get\_io\_context\_noalloc(struct cfq\_data \*cfqd, struct task\_struct \*tsk)  
>> +{  
>> + struct cfq\_io\_context \*cic = NULL;  
>> + struct io\_context \*ioc;  
>> +  
>> + ioc = tsk->io\_context;

```

>> + if (ioc)
>> +   cic = cfq_cic_rb_lookup(cfqd, ioc);
>> +
>> + return cic;
>> +}
>
> I'll change that to just call cfq_cic_rb_lookup(), returning NULL for
> NULL ioc.

```

Updated patch below.

```

diff --git a/block/cfq-iosched.c b/block/cfq-iosched.c
index 8093733..b92e6b2 100644
--- a/block/cfq-iosched.c
+++ b/block/cfq-iosched.c
@@ -9,7 +9,6 @@
#include <linux/module.h>
#include <linux/blkdev.h>
#include <linux/elevator.h>
-#include <linux/hash.h>
#include <linux/rbtree.h>
#include <linux/ioprio.h>

@@ -38,14 +37,6 @@ static int cfq_slice_idle = HZ / 125;

#define CFQ_SLICE_SCALE (5)

-#define CFQ_KEY_ASYNC (0)
-
-/*
- * for the hash of cfqq inside the cfqd
- */
-#define CFQ_QHASH_SHIFT 6
-#define CFQ_QHASH_ENTRIES (1 << CFQ_QHASH_SHIFT)
-
#define RQ_CIC(rq) ((struct cfq_io_context*)(rq)->elevator_private)
#define RQ_CFQQ(rq) ((rq)->elevator_private2)

@@ -62,8 +53,6 @@ static struct completion *ioc_gone;
#define ASYNC (0)
#define SYNC (1)

-#define cfq_cfqq_sync(cfqq) ((cfqq)->key != CFQ_KEY_ASYNC)
-
#define sample_valid(samples) ((samples) > 80)

/*
@@ -90,11 +79,6 @@ struct cfq_data {

```

```

struct cfq_rb_root service_tree;
unsigned int busy_queues;

- /*
- * cfqq lookup hash
- */
- struct hlist_head *cfq_hash;
-
int rq_in_driver;
int sync_flight;
int hw_tag;
@@ -138,10 +122,6 @@ struct cfq_queue {
atomic_t ref;
/* parent cfq_data */
struct cfq_data *cfqd;
- /* cfqq lookup hash */
- struct hlist_node cfq_hash;
- /* hash key */
- unsigned int key;
/* service_tree member */
struct rb_node rb_node;
/* service_tree key */
@@ -186,6 +166,7 @@ enum cfqq_state_flags {
CFQ_CFQQ_FLAG_prio_changed, /* task priority has changed */
CFQ_CFQQ_FLAG_queue_new, /* queue never been serviced */
CFQ_CFQQ_FLAG_slice_new, /* no requests dispatched in slice */
+ CFQ_CFQQ_FLAG_sync, /* synchronous queue */
};

#define CFQ_CFQQ_FNS(name) \
@@ -212,11 +193,14 @@ CFQ_CFQQ_FNS(idle_window);
CFQ_CFQQ_FNS(prio_changed);
CFQ_CFQQ_FNS(queue_new);
CFQ_CFQQ_FNS(slice_new);
+CFQ_CFQQ_FNS(sync);
#undef CFQ_CFQQ_FNS

-static struct cfq_queue *cfq_find_cfq_hash(struct cfq_data *, unsigned int, unsigned short);
static void cfq_dispatch_insert(request_queue_t *, struct request *);
-static struct cfq_queue *cfq_get_queue(struct cfq_data *, unsigned int, struct task_struct *, gfp_t);
+static struct cfq_queue *cfq_get_queue(struct cfq_data *, int,
+ struct task_struct *, gfp_t);
+static struct cfq_io_context *cfq_cic_rb_lookup(struct cfq_data *,
+ struct io_context *);

/*
* scheduler run of queue, if there are requests pending and no one in the
@@ -235,17 +219,6 @@ static int cfq_queue_empty(request_queue_t *q)

```

```

return !cfqd->busy_queues;
}

```

```

-static inline pid_t cfq_queue_pid(struct task_struct *task, int rw, int is_sync)

```

```

-{
- /*
- * Use the per-process queue, for read requests and synchronous writes
- */
- if (!(rw & REQ_RW) || is_sync)
- return task->pid;
-
- return CFQ_KEY_ASYNC;
-}

```

```

- /*
- * Scale schedule slice based on io priority. Use the sync time slice only
- * if a queue is marked sync and has sync io queued. A sync queue with async

```

```

@@ -602,10 +575,14 @@ static struct request *
cfq_find_rq_fmerge(struct cfq_data *cfqd, struct bio *bio)

```

```

{
struct task_struct *tsk = current;
- pid_t key = cfq_queue_pid(tsk, bio_data_dir(bio), bio_sync(bio));
+ struct cfq_io_context *cic;
struct cfq_queue *cfqq;

```

```

- cfqq = cfq_find_cfq_hash(cfqd, key, tsk->ioprio);
+ cic = cfq_cic_rb_lookup(cfqd, tsk->io_context);
+ if (!cic)
+ return NULL;

```

```

+
+ cfqq = cic->cfqq[bio_sync(bio)];
if (cfqq) {
sector_t sector = bio->bi_sector + bio_sectors(bio);

```

```

@@ -699,9 +676,8 @@ static int cfq_allow_merge(request_queue_t *q, struct request *rq,
struct bio *bio)

```

```

{
struct cfq_data *cfqd = q->elevator->elevator_data;
- const int rw = bio_data_dir(bio);
+ struct cfq_io_context *cic;
struct cfq_queue *cfqq;
- pid_t key;

```

```

/*
* Disallow merge of a sync bio into an async request.

```

```

@@ -713,9 +689,11 @@ static int cfq_allow_merge(request_queue_t *q, struct request *rq,
* Lookup the cfqq that this bio will be queued with. Allow
* merge only if rq is queued there.

```

```

*/
- key = cfq_queue_pid(current, rw, bio_sync(bio));
- cfqq = cfq_find_cfq_hash(cfqd, key, current->ioprio);
+ cic = cfq_cic_rb_lookup(cfqd, current->io_context);
+ if (!cic)
+ return 0;

+ cfqq = cic->cfqq[bio_sync(bio)];
  if (cfqq == RQ_CFQQ(rq))
    return 1;

@@ -1148,37 +1126,9 @@ static void cfq_put_queue(struct cfq_queue *cfqq)
    cfq_schedule_dispatch(cfqd);
  }

- /*
-  * it's on the empty list and still hashed
-  */
- hlist_del(&cfqq->cfq_hash);
  kmem_cache_free(cfq_pool, cfqq);
}

-static struct cfq_queue *
-__cfq_find_cfq_hash(struct cfq_data *cfqd, unsigned int key, unsigned int prio,
-    const int hashval)
- {
- struct hlist_head *hash_list = &cfqd->cfq_hash[hashval];
- struct hlist_node *entry;
- struct cfq_queue *__cfqq;
-
- hlist_for_each_entry(__cfqq, entry, hash_list, cfq_hash) {
- const unsigned short __p = IOPRIO_PRIO_VALUE(__cfqq->org_ioprio_class,
-    __cfqq->org_ioprio);
-
- if (__cfqq->key == key && (__p == prio || !prio))
- return __cfqq;
- }
-
- return NULL;
- }
-
-static struct cfq_queue *
-cfq_find_cfq_hash(struct cfq_data *cfqd, unsigned int key, unsigned short prio)
- {
- return __cfq_find_cfq_hash(cfqd, key, prio, hash_long(key, CFQ_QHASH_SHIFT));
- }
-
static void cfq_free_io_context(struct io_context *ioc)

```

```

{
  struct cfq_io_context * __cic;
@@ -1336,7 +1286,7 @@ static inline void changed_ioprio(struct cfq_io_context *cic)
  cfqq = cic->cfqq[ASYNC];
  if (cfqq) {
    struct cfq_queue *new_cfqq;
- new_cfqq = cfq_get_queue(cfqd, CFQ_KEY_ASYNC, cic->ioc->task,
+ new_cfqq = cfq_get_queue(cfqd, ASYNC, cic->ioc->task,
    GFP_ATOMIC);
    if (new_cfqq) {
      cic->cfqq[ASYNC] = new_cfqq;
@@ -1368,16 +1318,16 @@ static void cfq_ioc_set_ioprio(struct io_context *ioc)
}

```

```

static struct cfq_queue *
-cfq_get_queue(struct cfq_data *cfqd, unsigned int key, struct task_struct *tsk,
+cfq_get_queue(struct cfq_data *cfqd, int is_sync, struct task_struct *tsk,
    gfp_t gfp_mask)
{
- const int hashval = hash_long(key, CFQ_QHASH_SHIFT);
  struct cfq_queue *cfqq, *new_cfqq = NULL;
- unsigned short ioprio;
+ struct cfq_io_context *cic;

```

```

  retry:
- ioprio = tsk->ioprio;
- cfqq = __cfq_find_cfq_hash(cfqd, key, ioprio, hashval);
+ cic = cfq_cic_rb_lookup(cfqd, tsk->io_context);
+ /* cic always exists here */
+ cfqq = cic->cfqq[is_sync];

```

```

  if (!cfqq) {
    if (new_cfqq) {
@@ -1402,20 +1352,20 @@ retry:

```

```

  memset(cfqq, 0, sizeof(*cfqq));

- INIT_HLIST_NODE(&cfqq->cfq_hash);
  RB_CLEAR_NODE(&cfqq->rb_node);
  INIT_LIST_HEAD(&cfqq->fifo);

- cfqq->key = key;
- hlist_add_head(&cfqq->cfq_hash, &cfqd->cfq_hash[hashval]);
  atomic_set(&cfqq->ref, 0);
  cfqq->cfqd = cfqd;

- if (key != CFQ_KEY_ASYNC)
+ if (is_sync) {

```



```

    cfq_mark_cfqq_idle_window(cfqq);
+   cfq_mark_cfqq_sync(cfqq);
+   }

    cfq_mark_cfqq_prio_changed(cfqq);
    cfq_mark_cfqq_queue_new(cfqq);
+
    cfq_init_prio_data(cfqq);
    }

@@ -1447,6 +1397,9 @@ cfq_cic_rb_lookup(struct cfq_data *cfqd, struct io_context *ioc)
    struct cfq_io_context *cic;
    void *k, *key = cfqd;

+   if (unlikely(!ioc))
+   return NULL;
+
restart:
    n = ioc->cic_root.rb_node;
    while (n) {
@@ -1839,10 +1792,8 @@ static int cfq_may_queue(request_queue_t *q, int rw)
    {
        struct cfq_data *cfqd = q->elevator->elevator_data;
        struct task_struct *tsk = current;
+   struct cfq_io_context *cic;
        struct cfq_queue *cfqq;
-   unsigned int key;
-
-   key = cfq_queue_pid(tsk, rw, rw & REQ_RW_SYNC);

/*
 * don't force setup of a queue from here, as a call to may_queue
@@ -1850,7 +1801,11 @@ static int cfq_may_queue(request_queue_t *q, int rw)
 * so just lookup a possibly existing queue, or return 'may queue'
 * if that fails
 */
-   cfqq = cfq_find_cfq_hash(cfqd, key, tsk->ioprio);
+   cic = cfq_cic_rb_lookup(cfqd, tsk->io_context);
+   if (!cic)
+   return ELV_MQUEUE_MAY;
+
+   cfqq = cic->cfqq[rw & REQ_RW_SYNC];
    if (cfqq) {
        cfq_init_prio_data(cfqq);
        cfq_prio_boost(cfqq);
@@ -1894,7 +1849,6 @@ cfq_set_request(request_queue_t *q, struct request *rq, gfp_t
gfp_mask)
    struct cfq_io_context *cic;

```

```

const int rw = rq_data_dir(rq);
const int is_sync = rq_is_sync(rq);
- pid_t key = cfq_queue_pid(tsk, rw, is_sync);
  struct cfq_queue *cfqq;
  unsigned long flags;

@@ -1908,7 +1862,8 @@ cfq_set_request(request_queue_t *q, struct request *rq, gfp_t
gfp_mask)
  goto queue_fail;

  if (!cic->cfqq[is_sync]) {
- cfqq = cfq_get_queue(cfqd, key, tsk, gfp_mask);
+ cfqq = cfq_get_queue(cfqd, is_sync, tsk, gfp_mask);
+
  if (!cfqq)
    goto queue_fail;

@@ -2044,14 +1999,12 @@ static void cfq_exit_queue(elevator_t *e)

  cfq_shutdown_timer_wq(cfqd);

- kfree(cfqd->cfq_hash);
  kfree(cfqd);
}

static void *cfq_init_queue(request_queue_t *q)
{
  struct cfq_data *cfqd;
- int i;

  cfqd = kmalloc_node(sizeof(*cfqd), GFP_KERNEL, q->node);
  if (!cfqd)
@@ -2062,13 +2015,6 @@ static void *cfq_init_queue(request_queue_t *q)
  cfqd->service_tree = CFQ_RB_ROOT;
  INIT_LIST_HEAD(&cfqd->cic_list);

- cfqd->cfq_hash = kmalloc_node(sizeof(struct hlist_head) * CFQ_QHASH_ENTRIES,
GFP_KERNEL, q->node);
- if (!cfqd->cfq_hash)
- goto out_free;
-
- for (i = 0; i < CFQ_QHASH_ENTRIES; i++)
- INIT_HLIST_HEAD(&cfqd->cfq_hash[i]);
-
  cfqd->queue = q;

  init_timer(&cfqd->idle_slice_timer);
@@ -2092,9 +2038,6 @@ static void *cfq_init_queue(request_queue_t *q)

```

```
cfqd->cfq_slice_idle = cfq_slice_idle;

return cfqd;
-out_free:
- kfree(cfqd);
- return NULL;
}
```

```
static void cfq_slab_kill(void)
```

```
--
Jens Axboe
```

---

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Subject: Re: [PATCH] cfq: get rid of cfqq hash  
Posted by [Vasily Tarasov](#) on Wed, 25 Apr 2007 07:32:34 GMT  
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From: Vasily Tarasov <vtaras@openvz.org>

```
>> - if (key != CFQ_KEY_ASYNC)
>> + if (!is_sync)
>>   cfq_mark_cfqq_idle_window(cfqq);
>> + else
>> +   cfq_mark_cfqq_sync(cfqq);
>
> Woops, should be
>
>   if (is_sync) {
>       cfq_mark_cfqq_idle_window(cfqq);
>       cfq_mark_cfqq_sync(cfqq);
>   }
>
> of course.
```

Ugh!.. My fault, sorry.

Vasily

---