Maintaining a Real Time Stable Kernel

What's different than a vanilla stable kernel?

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vmware

Upstream Stable Releases

- After all mainline releases (Linus's release)
  - A stable release is maintained while the next is developed
  - for example:
    - 4.13 - released 2017-09-03
    - 4.13.1 - released 2017-09-10
      - Follows once a week or when necessary
    - 4.13.12 - released 2017-11-08
    - 4.14 - released 2017-11-12
    - Four more 4.13 stable releases (4.13.13 - 4.13.16)
      - last one released 2017-11-24
    - 4.15-rc1 released 2017-11-26
    - No more 4.13 stable kernels are released

Upstream Stable Releases

- Long Term Kernel Releases
  - 4.14 - Released 2017-11-12, PEOL - Jan 2020
  - 4.9 - Released 2016-12-11, PEOL - Jan 2019
  - 4.4 - Released 2016-01-10, PEOL - Feb 2022
  - 4.1 - Released 2015-06-21, PEOL - May 2018
  - 3.16 - Released 2014-08-03, PEOL - Apr 2020
  - 3.2 - Released 2012-01-04, PEOL - May 2018

Real Time Stable Releases

- Development Branch
  - Follows ever other Mainline release (when possible)
  - Some times it will take three releases or one release
    - 4.1, 4.4, 4.6, 4.8, 4.9, 4.11, 4.13, 4.14
  - When 4.16 comes out, that will become the new Development Branch
  - Sebastian will take over 4.16
  - Steven will convert 4.14 into the next stable RT tree.
- This talk is only about the Stable RT Process
  - RT Development may not abide by this

Real Time Stable Releases

- Development Branch
  - 4.14 - Latest development, maintained by Sebastian Siewior
- Stable releases
  - 4.9 - Maintained by Julia Cartwright
  - 4.4 - Maintained by Daniel Wagner
  - 4.1 - Maintained by Julia Carwright
  - 3.18 (*) - Maintained by Tom Zanussi
  - 3.2 - Maintained by Steven Rostedt
    - No backports, just keeping with stable releases

Real Time Stable Process

- Keeping up with mainline stable
  - Each RT stable release maps to a long term stable release
  - Should sync up at least twice a month
  - A mainline stable merge into RT stable is done without other additions
    - No RT backports
    - Increments the appended “-rt” number
      - 4.9.43-rt33 - was last development release
      - 4.9.44-rt34 - was first “stable” RT release
      - 4.9.45-rt35 - Simple merge of 4.9.45
  - Backports are done separately
    - You will see two -rt releases for the same release
      - 4.9.61-rt51 - Just merged 4.9.61
      - 4.9.61-rt52 - Backported patches from latest development RT release

Increment -rt with stable

- Originally, all new stable releases received a -rt tag
- git merge v4.9.51
- vim localversion-rt
  - change -rt40 to -rt41
- git commit -a
- git tag -s v4.9.51-rt41
- git merge v4.9.52

Increment -rt with stable

```
$ git tag |grep v4.9.5.
v4.9.50
v4.9.50-rt40
v4.9.51
v4.9.51-rt41
v4.9.52
v4.9.52-rt42
v4.9.53
v4.9.53-rt43
v4.9.54
v4.9.54-rt44
v4.9.55
v4.9.55-rt45
v4.9.56
v4.9.56-rt46
v4.9.57
v4.9.57-rt47
```

Increment -rt with stable (but not always?)

```
$ git tag |grep -e v4.9.6[89] -e v4.9.7.
v4.9.68
v4.9.68-rt60
v4.9.68-rt60-rebase
v4.9.69
v4.9.70
v4.9.71
v4.9.72
v4.9.73
v4.9.74
v4.9.75
v4.9.76
v4.9.76-rt61
v4.9.76-rt61-rebase
v4.9.77
v4.9.78
v4.9.79
```

Every stable or just when you update?

What happened?

- I was told to do it for every stable
- Julia did not see the rational for doing that
  - She only incremented the -rt for the latest stable she merged
  - If many stables were introduced, only tag the latest one you merged
- Why should we tag every stable?
  - Perhaps we don’t need to
  - But perhaps we should tag more than just the last one!
  - Compromise?

Increment -rt with stable (but not always?)

```
$ git tag |grep v4.9
[...]
v4.9.76-rt61
v4.9.76-rt61-rebase
v4.9.77
v4.9.78
v4.9.79
v4.9.80
v4.9.81
v4.9.82
v4.9.83
v4.9.84
v4.9.84-rt62
v4.9.84-rt62-rebase
```

Increment -rt with stable (but not always?)

```
$ git checkout v4.9-rt # currently at v4.9.76-rt61
$ git merge v4.9.84
CONFLICT (content): Merge conflict in kernel/workqueue.c
CONFLICT (content): Merge conflict in kernel/time/posix-timers.c
CONFLICT (content): Merge conflict in arch/x86/include/asm/thread_info.h

# Where did the conflict occur? What if we resolve it wrong?
```

Increment -rt with stable (but not always?)

```
$ git tag |grep v4.9
[...]
v4.9.76-rt61
v4.9.76-rt61-rebase
v4.9.77
v4.9.78  <- CONFLICT
v4.9.79
v4.9.80
v4.9.81  <- CONFLICT
v4.9.82  <- CONFLICT
v4.9.83
v4.9.84
v4.9.84-rt62
v4.9.84-rt62-rebase
```

Increment -rt with stable (What we agreed on)

```
$ git tag |grep v4.9
[...]
v4.9.76-rt61
v4.9.76-rt61-rebase
v4.9.77
v4.9.78-rt62 # resolve conflicts
v4.9.79
v4.9.80
v4.9.81-rt63 # resolve conflicts
v4.9.82-rt64 # resolve conflicts
v4.9.83
v4.9.84
v4.9.84-rt65
v4.9.84-rt65-rebase

# Of course we wont change the current tags (but this is for the future)
```

Increment -rt with stable (Should we?)

```
$ git tag |grep v4.9
[...]
v4.9.76-rt61
v4.9.76-rt61-rebase
v4.9.77-rt62
v4.9.78-rt63 # resolve conflicts
v4.9.79
v4.9.80-rt64
v4.9.81-rt65 # resolve conflicts
v4.9.82-rt66 # resolve conflicts
v4.9.83
v4.9.84
v4.9.84-rt67
v4.9.84-rt67-rebase
```

Merging Mainline Stable into RT Stable

- If it has been a while, catch up first
  - Each stable release with conflicts gets its own -rt tag (or will in the future)
  - git merge v4.9.78
  - Solve conflicts
  - git commit
  - Increment “localversion-rt” file (-rt62)
  - git commit
  - git merge v4.9.80
  - etc
- When you catch up. Run the tests
  - This release will have a “rebase” (explained next)

The Rebase Branch

- After catching up to stable
- Run the tests, if it passes, then release
- To make a patch queue and tarball
  - Merging branches changes the original commits (because of conflicts)
  - Can’t just cherry pick from the stable tree
  - Must keep the added patches at the end of the queue for the release
- v4.9-rt1 is equal to v4.9-rt1-rebase
- But let’s look at v4.9.11-rt9
  - git cherry v4.9.11 v4.9.11-rt9 > /tmp/list
  - Convert the /tmp/list (of sha1s) into a quilt queue
  - Try to apply it!

From the Development Branch

```
From: Sebastian Andrzej Siewior <bigeasy@linutronix.de>
Date: Wed, 14 Dec 2016 14:44:18 +0100
Subject: [PATCH] btrfs: drop trace_btrfs_all_work_done() from
 normal_work_helper()

For btrfs_scrubparity_helper() the ->func() is set to
scrub_parity_bio_endio_worker(). This functions invokes invokes
scrub_free_parity() which kfrees() the worked object. All is good as
long as trace events are not enabled because we boom with a backtrace
like this:
  Workqueue: btrfs-endio btrfs_endio_helper
  RIP: 0010:[<ffffffff812f81ae>]  [<ffffffff812f81ae>] trace_event_raw_event_btrfs__work__done+0x4e/0xa0
  Call Trace:
   [<ffffffff8136497d>] btrfs_scrubparity_helper+0x59d/0x780
   [<ffffffff81364c49>] btrfs_endio_helper+0x9/0x10
   [<ffffffff8108af8e>] process_one_work+0x26e/0x7b0
   [<ffffffff8108b516>] worker_thread+0x46/0x560
   [<ffffffff81091c4e>] kthread+0xee/0x110
   [<ffffffff818e166a>] ret_from_fork+0x2a/0x40

So in order to avoid this, I remove the trace point.

Signed-off-by: Sebastian Andrzej Siewior <bigeasy@linutronix.de>
---
 fs/btrfs/async-thread.c | 2 --
 1 file changed, 2 deletions(-)

diff --git a/fs/btrfs/async-thread.c b/fs/btrfs/async-thread.c
index e0f071f6b5a7..d0dfc3d2e199 100644
--- a/fs/btrfs/async-thread.c
+++ b/fs/btrfs/async-thread.c
@@ -318,8 +318,6 @@ static void normal_work_helper(struct btrfs_work *work)
                    set_bit(WORK_DONE_BIT, &work->flags);
                    run_ordered_work(wq);
          }
-         if (!need_order)
-                   trace_btrfs_all_work_done(work);
 }

 void btrfs_init_work(struct btrfs_work *work, btrfs_work_func_t uniq_func,
--
```

From the Development Branch

```
diff --git a/fs/btrfs/async-thread.c b/fs/btrfs/async-thread.c
index e0f071f6b5a7..d0dfc3d2e199 100644
--- a/fs/btrfs/async-thread.c
+++ b/fs/btrfs/async-thread.c
@@ -318,8 +318,6 @@ static void normal_work_helper(struct btrfs_work *work)
            set_bit(WORK_DONE_BIT, &work->flags);
            run_ordered_work(wq);
      }
-     if (!need_order)
-           trace_btrfs_all_work_done(work);
 }

 void btrfs_init_work(struct btrfs_work *work, btrfs_work_func_t uniq_func,
--
```

From the Mainline Stable

```
@@ -333,7 +340,7 @@ static void normal_work_helper(struct btrfs_work *work)
                run_ordered_work(wq);
        }
        if (!need_order)
-               trace_btrfs_all_work_done(work);
+               trace_btrfs_all_work_done(wq->fs_info, wtag);
 }

 void btrfs_init_work(struct btrfs_work *work, btrfs_work_func_t uniq_func,
```

From the Mainline Stable

```
@@ -333,7 +340,7 @@ static void normal_work_helper(struct btrfs_work *work)
                run_ordered_work(wq);
        }
        if (!need_order)
-               trace_btrfs_all_work_done(work);
+               trace_btrfs_all_work_done(wq->fs_info, wtag);
 }

 void btrfs_init_work(struct btrfs_work *work, btrfs_work_func_t uniq_func,
```

```
@@ -318,8 +318,6 @@ static void normal_work_helper(struct btrfs_work *work)
            set_bit(WORK_DONE_BIT, &work->flags);
            run_ordered_work(wq);
      }
-     if (!need_order)
-           trace_btrfs_all_work_done(work);
 }

 void btrfs_init_work(struct btrfs_work *work, btrfs_work_func_t uniq_func,
```

From the Mainline Stable

```
$ quilt push -a
[...]
Applying patch patches/0001-locking-percpu-rwsem-use-swait-for-the-wating-writer.patch
patching file include/linux/percpu-rwsem.h
patching file kernel/locking/percpu-rwsem.c

Applying patch patches/0001-btrfs-drop-trace_btrfs_all_work_done-from-normal_wor.patch
patching file fs/btrfs/async-thread.c
Hunk #1 FAILED at 318.
1 out of 1 hunk FAILED -- rejects in file fs/btrfs/async-thread.c
Patch patches/0001-btrfs-drop-trace_btrfs_all_work_done-from-normal_wor.patch can be reverse-
applied
```

The Rebase Branch

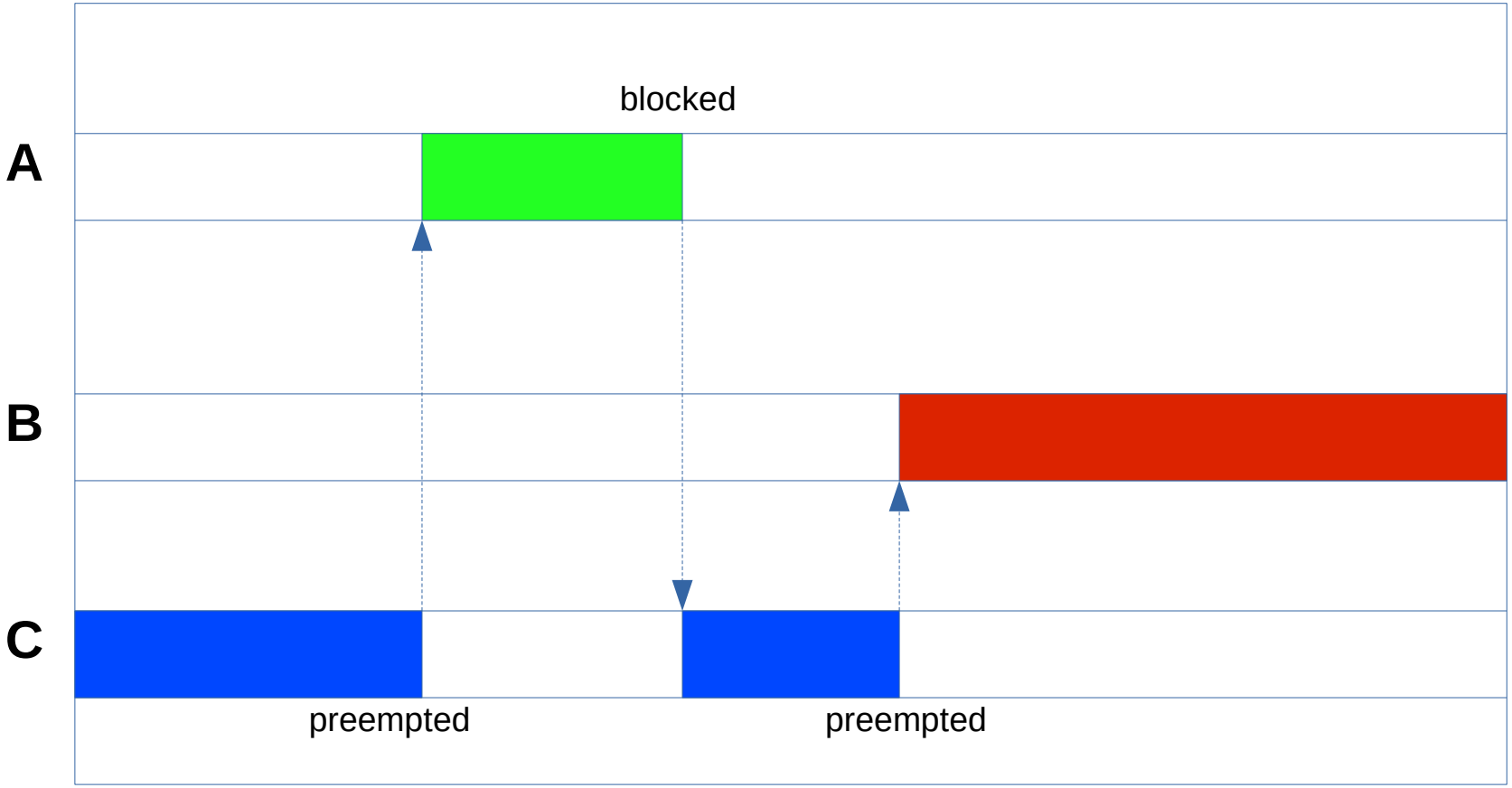
- git checkout v4.9-rt
- git rebase -i v4.9.11
  - Make sure you are on the right branch!
- Fix all conflicts
- Tag with “-rebase” appended
- Make sure v4.9.11-rt9 is the same as v4.9.11-rt9-rebase
  - git diff v4.9.11-rt9 v4.9.11-rt9-rebase
- Create the patch tarball from the rebase branch

RT overview

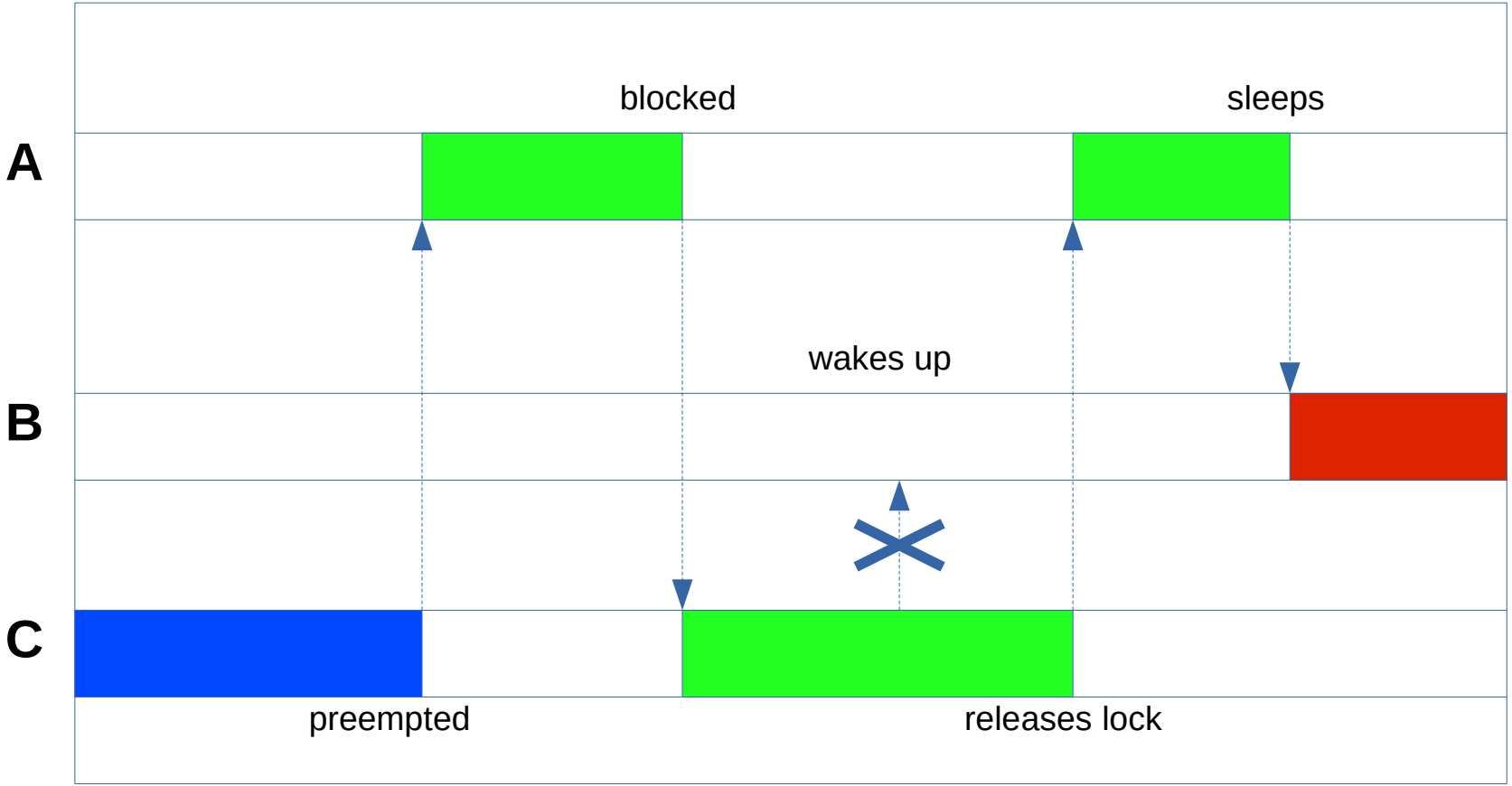
What makes Linux into an RTOS?

- Spin locks into mutex
  - Allow to preempt (sleep) in “spin lock” critical sections
  - raw_spin_locks are still spin locks
- Threaded interrupts
  - Interrupt handlers contain “spin locks”
- Priority Inheritance
  - All sleeping locks are given Priority Inheritance

Priority Inversion



Priority Inheritance



Priority Inheritance is Hard

- Can get really complex
- Can not handle Multiple owners (think reader writer locks)
- Do one of three (or two)
  - Make readers serialize (turn multi owner into single owner lock)
  - Do not convert rwlocks to use priority inheritance (buyer beware)
  - Implement Multiple owner Priority Inheritance algorithm
    - Becomes exponentially more complex
    - Lots of race conditions
    - But hey! It *can* be done

Disabling Preemption

- Preemption is disabled by spin locks
  - PREEMPT_RT lets spin locks sleep, and keeps preemption enabled
- Per CPU critical sections
  - Preemption is disabled for modifying local data to the CPU
  - RT adds “local_locks”
    - Keeps preemption enabled
    - Adds a mutex to the critical section
    - Disables migration (task stays on CPU)
- Watch out for “local_locks” in modified stable code
  - New ones may be needed

Disabling Interrupts

- If per CPU data shared with interrupts is performed
- Interrupts may be disabled
- PREEMPT_RT runs interrupt handlers as threads
- local_lock is good enough
- Either have “local_lock_irqsave()” or local_irq_disable_nort()
  - local_irq_disable_nort() only disables interrupts when PREEMPT_RT is not configured

Dealing with Conflicts (during stable merges)

- Merge of mainline stable release into RT stable
  - git merge v4.9.35
- Conflict occurs (This is good, we know a problem exists)
  - No conflicts does not mean a good merge
  - Remember, preempt_disable and local_irq_save may have been added
- Here's what to do

Dealing with Conflicts (Easy)

```
$ git merge v4.9.35
Auto-merging kernel/time/timekeeping.c
Auto-merging kernel/signal.c
CONFLICT (content): Merge conflict in kernel/signal.c
Auto-merging fs/exec.c
Auto-merging drivers/usb/gadget/function/f_fs.c
Automatic merge failed; fix conflicts and then commit the result.
$ git diff
diff --cc kernel/signal.c
index c884647951f7,deb04d5983ed..000000000000
--- a/kernel/signal.c
+++ b/kernel/signal.c
@@@ -583,7 -526,13 +584,17 @@@ static void collect_signal(int sig, str
  still_pending:
                list_del_init(&first->list);
                copy_siginfo(info, &first->info);
++<<<<<<< HEAD
 +              sigqueue_free_current(first);
++=======
+
+               *resched_timer =
+                       (first->flags & SIGQUEUE_PREALLOC) &&
+                       (info->si_code == SI_TIMER) &&
+                       (info->si_sys_private);
+
+               __sigqueue_free(first);
++>>>>>>> v4.9.35
        } else {
                /*
                 * Ok, it wasn't in the queue.  This must be
@@@ -616,10 -565,9 +627,11 @@@ static int __dequeue_signal(struct sigp
   */
  int dequeue_signal(struct task_struct *tsk, sigset_t *mask, siginfo_t *info)
  {
+       bool resched_timer = false;
        int signr;

 +      WARN_ON_ONCE(tsk != current);
 +
        /* We only dequeue private signals from ourselves, we don't let
         * signalfd steal them
         */
```

Dealing with Conflicts (Easy)

```
--- a/kernel/signal.c
+++ b/kernel/signal.c
@@ -583,7 -526,13 +584,17 @@ static void collect_signal(int sig, str
  still_pending:
                list_del_init(&first->list);
                copy_siginfo(info, &first->info);
++<<<<<<< HEAD
 +              sigqueue_free_current(first);
++=======
+
+               *resched_timer =
+                       (first->flags & SIGQUEUE_PREALLOC) &&
+                       (info->si_code == SI_TIMER) &&
+                       (info->si_sys_private);
+
+               __sigqueue_free(first);
++>>>>>>> v4.9.35
        } else {
                /*
                 * Ok, it wasn't in the queue.  This must be
@@ -616,10 -565,9 +627,11 @@ static int __dequeue_signal(struct sigp
   */
  int dequeue_signal(struct task_struct *tsk, sigset_t *mask, siginfo_t *info)
  {
+       bool resched_timer = false;
        int signr;

 +      WARN_ON_ONCE(tsk != current);
 +
        /* We only dequeue private signals from ourselves, we don't let
         * signalfd steal them
         */
```

Dealing with Conflicts (Easy)

```
$ git diff v4.9.34 v4.9.34-rt24 kernel/signal.c
@@ -525,7 +583,7 @@ static void collect_signal(int sig, struct sigpending *list,
siginfo_t *info)
 still_pending:
                list_del_init(&first->list);
                copy_siginfo(info, &first->info);
-               __sigqueue_free(first);
+               sigqueue_free_current(first);
        } else {
                /*
                 * Ok, it wasn't in the queue.  This must be
@@ -560,6 +618,8 @@ int dequeue_signal(struct task_struct *tsk, sigset_t *mask,
siginfo_t *info)
 {
        int signr;

+       WARN_ON_ONCE(tsk != current);
+
        /* We only dequeue private signals from ourselves, we don't let
         * signalfd steal them
         */
```

Dealing with Conflicts (Easy)

```
$ git diff v4.9.34 v4.9.35 kernel/signal.c
-static void collect_signal(int sig, struct sigpending *list, siginfo_t *info)
+static void collect_signal(int sig, struct sigpending *list, siginfo_t *info,
+                           bool *resched_timer)
 {
        struct sigqueue *q, *first = NULL;

@@ -525,6 +526,12 @@ static void collect_signal(int sig, struct sigpending *list, siginfo_t *info)
 still_pending:
                list_del_init(&first->list);
                copy_siginfo(info, &first->info);
+
+               *resched_timer =
+                       (first->flags & SIGQUEUE_PREALLOC) &&
+                       (info->si_code == SI_TIMER) &&
+                       (info->si_sys_private);
+
                __sigqueue_free(first);
        } else {
                /*
@@ -558,15 +565,16 @@ static int __dequeue_signal(struct sigpending *pending, sigset_t *mask,
  */
 int dequeue_signal(struct task_struct *tsk, sigset_t *mask, siginfo_t *info)
 {
+       bool resched_timer = false;
        int signr;

        /* We only dequeue private signals from ourselves, we don't let
         * signalfd steal them
         */
-       signr = __dequeue_signal(&tsk->pending, mask, info);
+       signr = __dequeue_signal(&tsk->pending, mask, info, &resched_timer);
        if (!signr) {
                signr = __dequeue_signal(&tsk->signal->shared_pending,
```

Dealing with Conflicts (Easy)

```
$ git diff v4.9.34 v4.9.35-rt25 kernel/signal.c
-static void collect_signal(int sig, struct sigpending *list, siginfo_t *info)
+static void collect_signal(int sig, struct sigpending *list, siginfo_t *info,
+                           bool *resched_timer)
 {
        struct sigqueue *q, *first = NULL;

@@ -525,7 +584,13 @@ static void collect_signal(int sig, struct sigpending *list, siginfo_t *info)
 still_pending:
                list_del_init(&first->list);
                copy_siginfo(info, &first->info);
-               __sigqueue_free(first);
+
+               *resched_timer =
+                       (first->flags & SIGQUEUE_PREALLOC) &&
+                       (info->si_code == SI_TIMER) &&
+                       (info->si_sys_private);
+
+               sigqueue_free_current(first);
        } else {
                /*
                 * Ok, it wasn't in the queue.  This must be
@@ -558,15 +623,18 @@ static int __dequeue_signal(struct sigpending *pending, sigset_t *mask,
  */
 int dequeue_signal(struct task_struct *tsk, sigset_t *mask, siginfo_t *info)
 {
+       bool resched_timer = false;
        int signr;

+       WARN_ON_ONCE(tsk != current);
+
        /* We only dequeue private signals from ourselves, we don't let
         * signalfd steal them
         */
-       signr = __dequeue_signal(&tsk->pending, mask, info);
+       signr = __dequeue_signal(&tsk->pending, mask, info, &resched_timer);
```

Dealing with Conflicts (non-trivial)

```
$ git merge v4.9.61
Auto-merging fs/namei.c
Auto-merging drivers/pci/access.c
CONFLICT (content): Merge conflict in drivers/pci/access.c
Automatic merge failed; fix conflicts and then commit the result.
$ git diff
diff --cc drivers/pci/access.c
index 223bbb9acb03,7b5cf6d1181a..000000000000
--- a/drivers/pci/access.c
+++ b/drivers/pci/access.c
@@@ -672,8 -672,9 +672,13 @@@ void pci_cfg_access_unlock(struct pci_d
        WARN_ON(!dev->block_cfg_access);

        dev->block_cfg_access = 0;
++<<<<<<< HEAD
 +      wake_up_all_locked(&pci_cfg_wait);
++=======
++>>>>>>> v4.9.61
        raw_spin_unlock_irqrestore(&pci_lock, flags);
+
+       wake_up_all(&pci_cfg_wait);
  }
  EXPORT_SYMBOL_GPL(pci_cfg_access_unlock);
```

Dealing with Conflicts (non-trivial)

```
$ git diff v4.9.61 v4.9.61-rt50 drivers/pci/access.c
@@ -672,7 +672,7 @@ void pci_cfg_access_unlock(struct pci_dev *dev)
        WARN_ON(!dev->block_cfg_access);

        dev->block_cfg_access = 0;
-       wake_up_all(&pci_cfg_wait);
+       wake_up_all_locked(&pci_cfg_wait);
        raw_spin_unlock_irqrestore(&pci_lock, flags);
 }
 EXPORT_SYMBOL_GPL(pci_cfg_access_unlock);
```

Dealing with Conflicts (non-trivial)

```
$ git diff v4.9.61 v4.9.62 drivers/pci/access.c
@@ -672,8 +672,9 @@ void pci_cfg_access_unlock(struct pci_dev *dev)
        WARN_ON(!dev->block_cfg_access);

        dev->block_cfg_access = 0;
-       wake_up_all(&pci_cfg_wait);
        raw_spin_unlock_irqrestore(&pci_lock, flags);
+
+       wake_up_all(&pci_cfg_wait);
 }
 EXPORT_SYMBOL_GPL(pci_cfg_access_unlock);
```

Dealing with Conflicts (non-trivial)

Obvious answer:

```
$ git diff v4.9.61 v4.9.62 drivers/pci/access.c
@@ -672,8 +672,9 @@ void pci_cfg_access_unlock(struct pci_dev *dev)
        WARN_ON(!dev->block_cfg_access);

        dev->block_cfg_access = 0;
-       wake_up_all(&pci_cfg_wait);
        raw_spin_unlock_irqrestore(&pci_lock, flags);
+
+       wake_up_all_locked(&pci_cfg_wait);
 }
 EXPORT_SYMBOL_GPL(pci_cfg_access_unlock);
```

Dealing with Conflicts (non-trivial)

Obvious answer:

WRONG!

```
$ git diff v4.9.61 v4.9.62 drivers/pci/access.c
@@ -672,8 +672,9 @@ void pci_cfg_access_unlock(struct pci_dev *dev)
        WARN_ON(!dev->block_cfg_access);

        dev->block_cfg_access = 0;
-       wake_up_all(&pci_cfg_wait);
        raw_spin_unlock_irqrestore(&pci_lock, flags);
+
+       wake_up_all_locked(&pci_cfg_wait);
 }
 EXPORT_SYMBOL_GPL(pci_cfg_access_unlock);
```

wake_up_all_locked?

- In mainline, but nice for RT
- If the wait queue is protected by a lock
  - No need to grab the wait queue lock
- Mainline uses this for optimization
  - Why grab another lock if one is already taken?
- RT uses this for wait queues in raw_spin_locks

wake_up_all_locked usage

```
void pci_cfg_access_unlock(struct pci_dev *dev)
{
        unsigned long flags;

        raw_spin_lock_irqsave(&pci_lock, flags);

        /* This indicates a problem in the caller, but we don't need
         * to kill them, unlike a double-block above. */
        WARN_ON(!dev->block_cfg_access);

        dev->block_cfg_access = 0;
        wake_up_all_locked(&pci_cfg_wait);
        raw_spin_unlock_irqrestore(&pci_lock, flags);
}
```


Dealing with Conflicts (non-trivial)

Correct answer:

```
$ git diff v4.9.61 v4.9.62 drivers/pci/access.c
@@ -672,8 +672,9 @@ void pci_cfg_access_unlock(struct pci_dev *dev)
        WARN_ON(!dev->block_cfg_access);

        dev->block_cfg_access = 0;
-       wake_up_all(&pci_cfg_wait);
        raw_spin_unlock_irqrestore(&pci_lock, flags);
+
+       wake_up_all(&pci_cfg_wait);
 }
 EXPORT_SYMBOL_GPL(pci_cfg_access_unlock);
```

Dealing with No Conflicts (Hard)

```
$ git merge v4.9.66
Auto-merging kernel/sched/sched.h
Auto-merging kernel/sched/rt.c
CONFLICT (content): Merge conflict in kernel/sched/rt.c
[..]
$ git diff
diff --cc kernel/sched/rt.c
index b0691f4e7d49,9c131168d933..000000000000
--- a/kernel/sched/rt.c
+++ b/kernel/sched/rt.c
@@@ -96,14 -91,6 +92,17 @@@ void init_rt_rq(struct rt_rq *rt_rq
        rt_rq->rt_nr_migratory = 0;
        rt_rq->overloaded = 0;
        plist_head_init(&rt_rq->pushable_tasks);
++<<<<<<< HEAD
 +
 +#ifdef HAVE_RT_PUSH_IPI
 +      rt_rq->push_flags = 0;
 +      rt_rq->push_cpu = nr_cpu_ids;
 +      raw_spin_lock_init(&rt_rq->push_lock);
 +      init_irq_work(&rt_rq->push_work, push_irq_work_func);
 +      rt_rq->push_work.flags |= IRQ_WORK_HARD_IRQ;
 +#endif
++=======
++>>>>>>> v4.9.66
  #endif /* CONFIG_SMP */
```

Dealing with No Conflicts (hard)

```
$ git diff v4.9.65 v4.9.66 kernel/sched/
--- a/kernel/sched/core.c
+++ b/kernel/sched/core.c
@@ -5878,6 +5877,12 @@ static int init_rootdomain(struct root_domain *rd)
        if (!zalloc_cpumask_var(&rd->rto_mask, GFP_KERNEL))
                goto free_dlo_mask;

+#ifdef HAVE_RT_PUSH_IPI
+       rd->rto_cpu = -1;
+       raw_spin_lock_init(&rd->rto_lock);
+       init_irq_work(&rd->rto_push_work, rto_push_irq_work_func);
+#endif
+
        init_dl_bw(&rd->dl_bw);
        if (cpudl_init(&rd->cpudl) != 0)
                goto free_dlo_mask;
--- a/kernel/sched/rt.c
+++ b/kernel/sched/rt.c
@@ -95,13 +91,6 @@ void init_rt_rq(struct rt_rq *rt_rq)
        rt_rq->rt_nr_migratory = 0;
        rt_rq->overloaded = 0;
        plist_head_init(&rt_rq->pushable_tasks);
-
-#ifdef HAVE_RT_PUSH_IPI
-       rt_rq->push_flags = 0;
-       rt_rq->push_cpu = nr_cpu_ids;
-       raw_spin_lock_init(&rt_rq->push_lock);
-       init_irq_work(&rt_rq->push_work, push_irq_work_func);
-#endif
 #endif /* CONFIG_SMP */
        /* We start is dequeued state, because no RT tasks are queued */
        rt_rq->rt_queued = 0;
```

Dealing with No Conflicts (hard)

```
$ git diff v4.9.65 v4.9.65-rt57 kernel/sched/
--- a/kernel/sched/rt.c
+++ b/kernel/sched/rt.c
@@ -101,6 +102,7 @@ void init_rt_rq(struct rt_rq *rt_rq)
        rt_rq->push_cpu = nr_cpu_ids;
        raw_spin_lock_init(&rt_rq->push_lock);
        init_irq_work(&rt_rq->push_work, push_irq_work_func);
+       rt_rq->push_work.flags |= IRQ_WORK_HARD_IRQ;
 #endif
 #endif /* CONFIG_SMP */
        /* We start is dequeued state, because no RT tasks are queued */
```

Why was that Hard?

- It wasn't, because there was a conflict
- This patch was backported to 3.18-rt (for RHEL)
- It introduced the irq_work
- That irq_work required adding the IRQ_WORK_HARD_IRQ flag
- If not, the system would not behave properly (but would still boot!)
- How do you catch these?
  - You need to know how PREEMPT_RT works!

Backporting RT patches

- Stable is the easy part
- When a new development RT comes out
  - Need to look at what was added
  - Must haves will be tagged: Cc: stable-rt@vger.kernel.org
  - But there may be some that are required
  - If not the next stable, even “stable-rt” commits may not be applicable

Backporting RT patches

	A	B	C	D	E	F
1	**Patches**	**Upstream commit**	**4.9**	**4.4**	**4.1**	**3.18**
2	Revert "fs, jbd: pull your plug when waiting for space"	3b5cf23e6b87a	N/A	N/A	Review	Review
3	timer/hrtimer: check properly for a running timer	f2249ccab4856	Original	Applied		N/A
4	rtmutex: Make lock_killable work	9edcb2cd71f	Original	Applied		Applied
5	random: avoid preempt_disable()ed section	21ca6915e696	Original	Applied		Applied
6	sched: Prevent task state corruption by spurious lock wakeup	2f9f24e15088	Original	Applied		Applied
7	sched/migrate disable: handle updated task-mask mg-dis	1dc89be37874	Original	Applied	N/A	N/A
8	kernel/locking: use an exclusive wait_q for sleepers	2d8a1c7a3780	Original	Applied		N/A
9	fs: convert two more BH_Uptodate_Lock related bitspinlocks	a043e49ad549	Applied	Applied		Applied
10	md/raid5: do not disable interrupts	4b8ad020f0c0	Applied	Applied		Applied
11	locking/rt-mutex: fix deadlock in device mapper / block-IO	3a390af127e4	Applied	Applied		Applied
12	Revert "fs: jbd2: pull your plug when waiting for space"	d5bc2c7b2cc0	Applied	Applied		Applied
13	cpu_pm: replace raw_notifier to atomic_notifier	df0fba5ba4c6	Applied	Applied		Applied
14	kernel/hrtimer: migrate deferred timer on CPU down	b3c08bffdcdd	Applied	Applied		Applied
15	kernel/hrtimer: don't wakeup a process while holding the	ce577cb1bba1	Applied	Applied		N/A
16	kernel/hrtimer/hotplug: don't wake ktimersoftd while holding	f53c46477839	Applied	Applied		Applied
17	Bluetooth: avoid recursive locking in hci_send_to_channel()	a785161d39be	Applied	Applied		N/A
18	rt/locking: allow recursive local_trylock()	40cf995cde2a	Applied	Applied		Applied
19	net: use trylock in icmp_sk	80836b63c32c	Applied	Applied		Applied

Backporting RT patches

- Have a branch with last rt-devel pull (let's say v4.14.15-rt13)
- git checkout -b temp last_rt_devel (branch)
- Want to update to latest rt-devel (let's say v4.14.24-rt19)
- git merge v4.14.24 (make it match the same mainline stable release)
  - Force fixing of commits (really doesn't matter here)
- git cherry -v --abbrev=12 HEAD v4.14.24-rt19
- Examine the commits that are new

git cherry

```
$ git cherry -v --abbrev=12 HEAD v4.14.24-rt19
+ 56e250a796bc v4.14.18-rt14
+ 4eb01a8a3d90 brd: remove unused brd_mutex
+ 0ab208e3c1d2 tracing: Update the "tracing: Inter-event (e.g. latency) support" patch
+ 51331ec00036 v4.14.18-rt15
+ 8f7c88961b2e v4.14.20-rt16
+ 96867e66ef1d RCU: skip the "schedule() in RCU section" warning on UP, too
+ d3a66ffd1c4f net: use task_struct instead of CPU number as the queue owner on -RT
+ f5a5c5e7d006 v4.14.20-rt17
+ 79d03355044c v4.14.20-rt18
+ 932c5783d443 Revert "rt,ntp: Move call to schedule_delayed_work() to helper thread"
+ ee6c0574c45a v4.14.24-rt19
```

git cherry

```
$ git cherry -v --abbrev=12 HEAD v4.14.24-rt19
+ 56e250a796bc v4.14.18-rt14
+ 4eb01a8a3d90 brd: remove unused brd_mutex
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+ d3a66ffd1c4f net: use task_struct instead of CPU number as the queue owner on -RT
+ f5a5c5e7d006 v4.14.20-rt17
+ 79d03355044c v4.14.20-rt18
+ 932c5783d443 Revert "rt,ntp: Move call to schedule_delayed_work() to helper thread"
+ ee6c0574c45a v4.14.24-rt19
```

Thank You

vmware