Hunting and fixing bugs all over the Linux kernel

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The Linux Foundation's Core Infrastructure Initiative

Kernel Recipes
September 26, 2019
Paris, France

Who am I?

- Background in Embedded Systems.
- RTOS
- Embedded Linux.
- Volunteer at @kidsoncomputers
- Board of directors at @kidsoncomputers

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- Don’t speak Portuguese. :)

Agenda

- Coverity.
- Some bugs.
- Ancient bugs.
- Beyond bug fixing (KSPP).
- -Wimplicit-fallthrough.
- Super powers and responsibility.
- Results.
- Bonus.

Coverity

- Static code analyzer.
- Tons of false positives (This applies to all static code analyzers).

Coverity

- Static code analyzer.
- Tons of false positives (This applies to all static code analyzers).
- Helpful:

```
$ git log --shortstat --author="Gustavo A. R. Silva”
grep Coverity | wc -l
582
```

Coverity **high** impact issues

- Memory – illegal accesses (out-of-bounds access).
- Resource leaks (memory leaks).
- Uninitialized variables.

Coverity **medium** impact issues

- NULL pointer dereferences (before/after null check, explicit null dereference).
- Integer handling issues (bad bit shift operation).
- API usage errors (arguments in wrong order).
- Control flow issues.

Coverity work

- Look at every issue.
- Access to Coverity scans on mainline.
- Weekly scans every -rc.
- Now access to daily Coverity scans.
- Fix bugs in linux-next before they hit mainline.

Some Bugs

Incorrect type of variable

- commit 2b6199a1d1b70fccd62aed961ba4c2b979ae499c

```
-       while (counter < 10) {
+       while (counter < 1000) {
                value = dm_read_reg(cp110->base.ctx, addr);
                if (get_reg_field_value(
                        value,
                        FBC_STATUS,
                        FBC_ENABLE_STATUS) == enabled)
                        break;
-               msleep(10);
+               udelay(100);
                counter++;
        }
```

Fix type of variable

- commit fe78627d430435d22316fe39f2012ece31bf23c2

Diffstat

-rw-r--r-- drivers/gpu/drm/amd/display/dc/dce110/dce110_compressor.c 2

1 files changed, 1 insertions, 1 deletions

```
diff --git a/drivers/gpu/drm/amd/display/dc/dce110/dce110_compressor.c
index e2994d337044..111c4921987f 100644
--- a/drivers/gpu/drm/amd/display/dc/dce110/dce110_compressor.c
+++ b/drivers/gpu/drm/amd/display/dc/dce110/dce110_compressor.c
@@ -143,7 +143,7 @@ static void wait_for_fbc_state_changed(
        struct dce110_compressor *cp110,
        bool enabled)
 {
-       uint8_t counter = 0;
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- uint8_t → [0-255]

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- uint8_t → [0-255]
- while (**counter < 1000**) - is always true.
- uint16_t → [0-65,535]

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```

- uint8_t → [0-255]
- while (**counter < 1000**) - is always true.
- uint16_t → [0-65,535]
- while (**counter < 1000**) - can be true or false.

Inconsistent IS_ERR and PTR_ERR

- commit 52e17089d1850774d2ef583cdef2b060b84fca8c

```
@@ -1797,6 +1796,10 @@ static int imx_csi_probe(struct platform_device *pdev)
         */
        priv->dev->of_node = pdata->of_node;
        pinctrl = devm_pinctrl_get_select_default(priv->dev);
+       if (IS_ERR(pinctrl)) {
+               ret = PTR_ERR(priv->vdev);
+               goto free;
+       }

        ret = v4l2_async_register_subdev(&priv->sd);
        if (ret)
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- pinctrl != priv->vdev

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+       }

        ret = v4l2_async_register_subdev(&priv->sd);
        if (ret)
```

- pinctrl != priv->vdev
- PTR_ERR(priv→vdev) → PTR_ERR(pinctrl)

Fix inconsistent IS_ERR and PTR_ERR

- commit 2b7db29b79190f7ad5c32f63594ba08b9b9171ea

Diffstat

-rw-r--r-- drivers/staging/media/imx/imx-media-csi.c 2

1 files changed, 1 insertions, 1 deletions

```
diff --git a/drivers/staging/media/imx/imx-media-csi.c b/drivers/staging/media/ir
index 16cab40156ca..aeab05f682d9 100644
--- a/drivers/staging/media/imx/imx-media-csi.c
+++ b/drivers/staging/media/imx/imx-media-csi.c
@@ -1799,7 +1799,7 @@ static int imx_csi_probe(struct platform_device *pdev)
        priv->dev->of_node = pdata->of_node;
        pinctrl = devm_pinctrl_get_select_default(priv->dev);
        if (IS_ERR(pinctrl)) {
-               ret = PTR_ERR(priv->vdev);
+               ret = PTR_ERR(pinctrl);
                dev_dbg(priv->dev,
                        "devm_pinctrl_get_select_default() failed: %d\n", ret);
                if (ret != -ENODEV)
```

Fix inconsistent IS_ERR and PTR_ERR

- commit 2b7db29b79190f7ad5c32f63594ba08b9b9171ea

Diffstat

-rw-r--r-- drivers/staging/media/imx/imx-media-csi.c 2

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diff --git a/drivers/staging/media/imx/imx-media-csi.c b/drivers/staging/media/ir
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        pinctrl = devm_pinctrl_get_select_default(priv->dev);
        if (IS_ERR(pinctrl)) {
-               ret = PTR_ERR(priv->vdev);
+               ret = PTR_ERR(pinctrl);
                dev_dbg(priv->dev,
                        "devm_pinctrl_get_select_default() failed: %d\n", ret);
                if (ret != -ENODEV)
```

- Easily caught using Coccinelle.

potential integer overflows

- commit 6f3472a993e7cb63cde5d818dcabc8e42fc03744

Diffstat

-rw-r--r-- drivers/gpu/drm/amd/display/dc/dce/dce_clock_source.c 10

1 files changed, 5 insertions, 5 deletions

```
diff --git a/drivers/gpu/drm/amd/display/dc/dce/dce_clock_source.c b/drivers/gpu
index 88b09dd758ba..ca137757a69e 100644
--- a/drivers/gpu/drm/amd/display/dc/dce/dce_clock_source.c
+++ b/drivers/gpu/drm/amd/display/dc/dce/dce_clock_source.c
@@ -133,7 +133,7 @@ static bool calculate_fb_and_fractional_fb_divider(
        uint64_t feedback_divider;

        feedback_divider =
-               (uint64_t)(target_pix_clk_khz * ref_divider * post_divider);
+               (uint64_t)target_pix_clk_khz * ref_divider * post_divider;
        feedback_divider *= 10;
        /* additional factor, since we divide by 10 afterwards */
        feedback_divider *= (uint64_t)(calc_pll_cs->fract_fb_divider_factor);

 @@ -203,8 +203,8 @@ static bool calc_fb_divider_checking_tolerance(
                        &fract_feedback_divider);

         /*Actual calculated value*/
 -       actual_calc_clk_khz = (uint64_t)(feedback_divider *
 -                                       calc_pll_cs->fract_fb_divider_factor) +
 +       actual_calc_clk_khz = (uint64_t)feedback_divider *
 +                                       calc_pll_cs->fract_fb_divider_factor +
                                                fract_feedback_divider;
         actual_calc_clk_khz *= calc_pll_cs->ref_freq_khz;
         actual_calc_clk_khz =
```

use-after-free

- commit 594619497f3d6d4b8d8440e6d380e8da9dcc9eeb

Diffstat

-rw-r--r-- drivers/net/ethernet/mellanox/mlx5/core/fpga/ipsec.c 3

1 files changed, 2 insertions, 1 deletions

```
diff --git a/drivers/net/ethernet/mellanox/mlx5/core/fpga/ipsec.c b/drivers
index 4f1568528738..0f5da499a223 100644
--- a/drivers/net/ethernet/mellanox/mlx5/core/fpga/ipsec.c
+++ b/drivers/net/ethernet/mellanox/mlx5/core/fpga/ipsec.c
@@ -1061,8 +1061,9 @@ static int fpga_ipsec_fs_create_fte(struct mlx5_core_

        rule->ctx = mlx5_fpga_ipsec_fs_create_sa_ctx(dev, fte, is_egress);
        if (IS_ERR(rule->ctx)) {
+               int err = PTR_ERR(rule->ctx);
                kfree(rule);
-               return PTR_ERR(rule->ctx);
+               return err;
        }

        rule->fte = fte;
```

Incorrect bitwise operator

- commit e146471f588e4b8dcd7994036c1b47cc52325f00
- Introduced on Jul 14, 2019.
- Fixed on Jul 18, 2019.
- Never hit mainline.

```
diff --git a/drivers/net/ethernet/marvell/mvpp2/mvpp2_debugfs.c b/drivers/net/et
index 02dfef13cccd..f9744a61e5dd 100644
--- a/drivers/net/ethernet/marvell/mvpp2/mvpp2_debugfs.c
+++ b/drivers/net/ethernet/marvell/mvpp2/mvpp2_debugfs.c
@@ -245,7 +245,7 @@ static int mvpp2_dbgfs_flow_c2_enable_show(struct seq_file *

        mvpp2_cls_c2_read(port->priv, MVPP22_CLS_C2_RSS_ENTRY(port->id), &c2);

-       enabled = !!(c2.attr[2] | MVPP22_CLS_C2_ATTR2_RSS_EN);
+       enabled = !!(c2.attr[2] & MVPP22_CLS_C2_ATTR2_RSS_EN);

        seq_printf(s, "%d\n", enabled);
```

- #define MVPP22_CLS_C2_ATTR2_RSS_EN BIT(30)
- The use of the bitwise OR operator '|' always leads to true.

Fix “missing return” in switch

- commit c5b974bee9d2ceae4c441ae5a01e498c2674e100

Diffstat

-rw-r--r-- drivers/iio/accel/sca3000.c 1

1 files changed, 1 insertions, 0 deletions

```
diff --git a/drivers/iio/accel/sca3000.c b/drivers/iio/accel/sca3000.c
index 4dceb75e3586..4964561595f5 100644
--- a/drivers/iio/accel/sca3000.c
+++ b/drivers/iio/accel/sca3000.c
@@ -797,6 +797,7 @@ static int sca3000_write_raw(struct iio_dev *indio_dev,
                mutex_lock(&st->lock);
                ret = sca3000_write_3db_freq(st, val);
                mutex_unlock(&st->lock);
+               return ret;
        default:
                return -EINVAL;
        }
```

resource leaks

- commit 3b4acbb92dbda4829e021e5c6d5410658849fa1c

perf script: Fix memory leaks in list_scripts()

```
In case memory resources for *buf* and *paths* were allocated, jump to
*out* and release them before return.

diff --git a/tools/perf/ui/browsers/scripts.c b/tools/perf/ui/browsers/scri
index f2fd9f0d7ab5..50e0c03171f2 100644
--- a/tools/perf/ui/browsers/scripts.c
+++ b/tools/perf/ui/browsers/scripts.c
@@ -133,8 +133,10 @@ static int list_scripts(char *script_name, bool *custc
                int key = ui_browser__input_window("perf script command",
                                   "Enter perf script command line (without pe
                                   script_args, "", 0);
-               if (key != K_ENTER)
-                       return -1;
+               if (key != K_ENTER) {
+                       ret = -1;
+                       goto out;
+               }
                sprintf(script_name, "%s script %s", perf, script_args);
        } else if (choice < num + max_std) {
                strcpy(script_name, paths[choice]);
```

Ancient Bugs

Incorrect bitwise operator

- commit 489338a717a0dfbbd5a3fabccf172b78f0ac9015

```
diff --git a/tools/perf/tests/evsel-tp-sched.c b/tools/perf/tests/evsel-tp-sched
index 5f8501c68da4..5cbba70bcdd0 100644
--- a/tools/perf/tests/evsel-tp-sched.c
+++ b/tools/perf/tests/evsel-tp-sched.c
@@ -17,7 +17,7 @@ static int perf_evsel__test_field(struct perf_evsel *evsel, co
                return -1;
        }

-       is_signed = !!(field->flags | TEP_FIELD_IS_SIGNED);
+       is_signed = !!(field->flags & TEP_FIELD_IS_SIGNED);
        if (should_be_signed && !is_signed) {
                pr_debug("%s: \"%s\" signedness(%d) is wrong, should be %d\n",
                         evsel->name, name, is_signed, should_be_signed);
```

- The use of the bitwise OR operator '|' always leads to true.

Incorrect bitwise operator

- commit 489338a717a0dfbbd5a3fabccf172b78f0ac9015
- 7-year-old bug (Tue Sep 18 11:56:28 2012).

```
diff --git a/tools/perf/tests/evsel-tp-sched.c b/tools/perf/tests/evsel-tp-sched
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        if (should_be_signed && !is_signed) {
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```

- The use of the bitwise OR operator '|' always leads to true.

(!x & y) strikes again

- commit 07c69f1148da7de3978686d3af9263325d9d60bd

Diffstat

-rw-r--r-- drivers/usb/gadget/udc/net2272.c 2

1 files changed, 1 insertions, 1 deletions

```
diff --git a/drivers/usb/gadget/udc/net2272.c b/drivers/usb/gadget/udc/net2272.c
index 660878a19505..b77f3126580e 100644
--- a/drivers/usb/gadget/udc/net2272.c
+++ b/drivers/usb/gadget/udc/net2272.c
@@ -2083,7 +2083,7 @@ static irqreturn_t net2272_irq(int irq, void *_dev)
 #if defined(PLX_PCI_RDK2)
        /* see if PCI int for us by checking irqstat */
        intcsr = readl(dev->rdk2.fpga_base_addr + RDK2_IRQSTAT);
-       if (!intcsr & (1 << NET2272_PCI_IRQ)) {
+       if (!(intcsr & (1 << NET2272_PCI_IRQ))) {
                spin_unlock(&dev->lock);
                return IRQ_NONE;
        }
```

(!x & y) strikes again

- commit 07c69f1148da7de3978686d3af9263325d9d60bd
- 8-year-old bug (Mon Jun 6 19:42:44 2011).

Diffstat

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        intcsr = readl(dev->rdk2.fpga_base_addr + RDK2_IRQSTAT);
-       if (!intcsr & (1 << NET2272_PCI_IRQ)) {
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                spin_unlock(&dev->lock);
                return IRQ_NONE;
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(!x & y) strikes again

Gustavo A. R. Silva @embeddedgus · Feb 1

(!x & y) strikes again:
git.kernel.org/pub/scm/linux/...

This bug has been out there since 2011.

1 6

Kieran Bingham
@kieranbingham

Replying to @embeddedgus

I wonder what effect these bugs had on the devices to go unnoticed for so long. In a years time someone's going to suddenly see something work correctly :-)

2:50 PM · Feb 1, 2019 · Twitter for Android

Beyond bug fixing

Kernel Self Protection Project

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- Variable Length Arrays (VLA) removal.

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- Defense-in-depth with struct_size() helper.

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- Variable Length Arrays (VLA) removal.
- Defense-in-depth with struct_size() helper.
- Switch case fall-through

Variable Length Arrays

- Exhaust the stack: write to things following it.
- Jump over guard pages.
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- Jump over guard pages.
- Easy to find with compiler flag: *-Wvla*
- Eradicated from the kernel in Linux v4.20. :)

Defense-in-depth & struct_size()

Defense-in-depth & struct_size()

```
287 /*
288  * Compute a*b+c, returning SIZE_MAX on overflow. Internal helper for
289  * struct_size() below.
290  */
291 static inline __must_check size_t __ab_c_size(size_t a, size_t b, size_t c)
292 {
293         size_t bytes;
294
295         if (check_mul_overflow(a, b, &bytes))
296                 return SIZE_MAX;
297         if (check_add_overflow(bytes, c, &bytes))
298                 return SIZE_MAX;
299
300         return bytes;
301 }
302
303 /**
304  * struct_size() - Calculate size of structure with trailing array.
305  * @p: Pointer to the structure.
306  * @member: Name of the array member.
307  * @n: Number of elements in the array.
308  *
309  * Calculates size of memory needed for structure @p followed by an
310  * array of @n @member elements.
311  *
312  * Return: number of bytes needed or SIZE_MAX on overflow.
313  */
314 #define struct_size(p, member, n)                                       \
315         __ab_c_size(n,                                                  \
316                     sizeof(*(p)->member) + __must_be_array((p)->member),\
317                     sizeof(*(p)))
318
319 #endif /* __LINUX_OVERFLOW_H */
"include/linux/overflow.h" 319 lines --99%--
```

Defense-in-depth & struct_size()

- Bluetooth: mgmt: Use struct_size() helper
- Commit 72bb169e024a20203e6044a81d5e41ae6ee0645b

Bluetooth: mgmt: Use struct_size() helper

```
One of the more common cases of allocation size calculations is finding
the size of a structure that has a zero-sized array at the end, along
with memory for some number of elements for that array. For example:

struct mgmt_rp_get_connections {
        ...
        struct mgmt_addr_info addr[0];
} __packed;

Make use of the struct_size() helper instead of an open-coded version
in order to avoid any potential type mistakes.

So, replace the following form:

sizeof(*rp) + (i * sizeof(struct mgmt_addr_info));

with:

struct_size(rp, addr, i)

Also, notice that, in this case, variable rp_len is not necessary,
hence it is removed.

This code was detected with the help of Coccinelle.

Signed-off-by: Gustavo A. R. Silva <gustavo@embeddedor.com>
Signed-off-by: Marcel Holtmann <marcel@holtmann.org>
```

Defense-in-depth & struct_size()

- Bluetooth: mgmt: Use struct_size() helper
- Commit 72bb169e024a20203e6044a81d5e41ae6ee0645b

```
diff --git a/net/bluetooth/mgmt.c b/net/bluetooth/mgmt.c
index 150114e33b20..acb7c6d5643f 100644
--- a/net/bluetooth/mgmt.c
+++ b/net/bluetooth/mgmt.c
@@ -2588,7 +2588,6 @@ static int get_connections(struct sock *sk, str
 {
        struct mgmt_rp_get_connections *rp;
        struct hci_conn *c;
-       size_t rp_len;
        int err;
        u16 i;

@@ -2608,8 +2607,7 @@ static int get_connections(struct sock *sk, str
                        i++;
        }

-       rp_len = sizeof(*rp) + (i * sizeof(struct mgmt_addr_info));
-       rp = kmalloc(rp_len, GFP_KERNEL);
+       rp = kmalloc(struct_size(rp, addr, i), GFP_KERNEL);
        if (!rp) {
                err = -ENOMEM;
                goto unlock;
```

Defense-in-depth & struct_size()

- One day I found something interesting...

Defense-in-depth & struct_size()

- One day I found something interesting...
- Commit cffaaf0c816238c45cd2d06913476c83eb50f682

author	Julia Cartwright <julia@ni.com>	2019-02-20 16:46:31 +0000
committer	Joerg Roedel <jroedel@suse.de>	2019-02-26 11:24:37 +0100
commit	cffaaf0c816238c45cd2d06913476c83eb50f682 (patch)	
tree	7f4a28accfcf07e1aa0e2c21bee93aaad48e821f	
parent	8950dcd83ae7d62bdc2a60507949acebd85399f2 (diff)	
download	linux-cffaaf0c816238c45cd2d06913476c83eb50f682.tar.gz	

iommu/dmar: Fix buffer overflow during PCI bus notification

```
Commit 57384592c433 ("iommu/vt-d: Store bus information in RMRR PCI
device path") changed the type of the path data, however, the change in
path type was not reflected in size calculations.  Update to use the
correct type and prevent a buffer overflow.
```

```
diff --git a/drivers/iommu/dmar.c b/drivers/iommu/dmar.c
index dc9f14811e0f..58dc70bffd5b 100644
--- a/drivers/iommu/dmar.c
+++ b/drivers/iommu/dmar.c
@@ -144,7 +144,7 @@ dmar_alloc_pci_notify_info(struct pci_dev *dev, unsigned lon
                for (tmp = dev; tmp; tmp = tmp->bus->self)
                        level++;

-       size = sizeof(*info) + level * sizeof(struct acpi_dmar_pci_path);
+       size = sizeof(*info) + level * sizeof(info->path[0]);
        if (size <= sizeof(dmar_pci_notify_info_buf)) {
                info = (struct dmar_pci_notify_info *)dmar_pci_notify_info_buf;
        } else {
```

Defense-in-depth & struct_size()

- Commit 57384592c43375d2c9a14d82aebbdc95fdda9e9d

```
diff --git a/drivers/iommu/dmar.c b/drivers/iommu/dmar.c
index 8ed55b0a1ce4..68da1ab0f2cd 100644
--- a/drivers/iommu/dmar.c
+++ b/drivers/iommu/dmar.c
@@ -155,6 +155,7 @@ dmar_alloc_pci_notify_info(struct pci_dev *dev, unsigne
        if (event == BUS_NOTIFY_ADD_DEVICE) {
                for (tmp = dev; tmp; tmp = tmp->bus->self) {
                        level--;
+                       info->path[level].bus = tmp->bus->number;
                        info->path[level].device = PCI_SLOT(tmp->devfn);
                        info->path[level].function = PCI_FUNC(tmp->devfn);
                        if (pci_is_root_bus(tmp->bus))
diff --git a/include/linux/dmar.h b/include/linux/dmar.h
index 1deece46a0ca..593fff99e6bf 100644
--- a/include/linux/dmar.h
+++ b/include/linux/dmar.h
@@ -56,13 +56,19 @@ struct dmar_drhd_unit {
        struct intel_iommu *iommu;
 };

+struct dmar_pci_path {
+       u8 bus;
+       u8 device;
+       u8 function;
+};
+
 struct dmar_pci_notify_info {
        struct pci_dev                  *dev;
        unsigned long                   event;
        int                             bus;
        u16                             seg;
        u16                             level;
-       struct acpi_dmar_pci_path       path[];
+       struct dmar_pci_path            path[];
 }  __attribute__((packed));
```

Defense-in-depth & struct_size()

- Commit 57384592c43375d2c9a14d82aebbdc95fdda9e9d

```
diff --git a/drivers/iommu/dmar.c b/drivers/iommu/dmar.c
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@@ -155,6 +155,7 @@ dmar_alloc_pci_notify_info(struct pci_dev *dev, unsigne
        if (event == BUS_NOTIFY_ADD_DEVICE) {
                for (tmp = dev; tmp; tmp = tmp->bus->self) {
                        level--;
+                       info->path[level].bus = tmp->bus->number;
                        info->path[level].device = PCI_SLOT(tmp->devfn);
                        info->path[level].function = PCI_FUNC(tmp->devfn);
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--- a/include/linux/dmar.h
+++ b/include/linux/dmar.h
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        struct intel_iommu *iommu;
 };

+struct dmar_pci_path {
+       u8 bus;
+       u8 device;
+       u8 function;
+};
+
 struct dmar_pci_notify_info {
        struct pci_dev                  *dev;
        unsigned long                   event;
        int                             bus;
        u16                             seg;
        u16                             level;
-       struct acpi_dmar_pci_path       path[];
+       struct dmar_pci_path            path[];
 }  __attribute__((packed));
```

```
541
542 struct acpi_dmar_pci_path {
543         u8 device;
544         u8 function;
545 };
"include/acpi/actbl1.h" 1631 lines --32%--
```

Defense-in-depth & struct_size()

- Commit 57384592c43375d2c9a14d82aebbdc95fdda9e9d

```
diff --git a/drivers/iommu/dmar.c b/drivers/iommu/dmar.c
index 8ed55b0a1ce4..68da1ab0f2cd 100644
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        if (event == BUS_NOTIFY_ADD_DEVICE) {
                for (tmp = dev; tmp; tmp = tmp->bus->self) {
                        level--;
+                       info->path[level].bus = tmp->bus->number;
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                        info->path[level].function = PCI_FUNC(tmp->devfn);
                        if (pci_is_root_bus(tmp->bus))
diff --git a/include/linux/dmar.h b/include/linux/dmar.h
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+++ b/include/linux/dmar.h
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        struct intel_iommu *iommu;
 };

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+       u8 bus;
+       u8 device;
+       u8 function;
+};
+
 struct dmar_pci_notify_info {
        struct pci_dev                  *dev;
        unsigned long                   event;
        int                             bus;
        u16                             seg;
        u16                             level;
-       struct acpi_dmar_pci_path       path[];
+       struct dmar_pci_path            path[];
 }  __attribute__((packed));
```

```
541
542 struct acpi_dmar_pci_path {
543         u8 device;
544         u8 function;
545 };
"include/acpi/actbl1.h" 1631 lines --32%--
```

- New structure **dmar_pci_path** contains an extra field: **u8 bus;**

Defense-in-depth & struct_size()

- Commit 57384592c43375d2c9a14d82aebbdc95fdda9e9d

```
diff --git a/drivers/iommu/dmar.c b/drivers/iommu/dmar.c
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+                       info->path[level].bus = tmp->bus->number;
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+       u8 bus;
+       u8 device;
+       u8 function;
+};
+
 struct dmar_pci_notify_info {
        struct pci_dev                  *dev;
        unsigned long                   event;
        int                             bus;
        u16                             seg;
        u16                             level;
-       struct acpi_dmar_pci_path       path[];
+       struct dmar_pci_path            path[];
 }  __attribute__((packed));
```

```
541
542 struct acpi_dmar_pci_path {
543         u8 device;
544         u8 function;
545 };
"include/acpi/actbl1.h" 1631 lines --32%--
```

- New structure **dmar_pci_path** contains an extra field: **u8 bus;**

- Overflow: info → **path[level].bus** = tmp → bus → number;

Defense-in-depth & struct_size()

- Commit 57384592c43375d2c9a14d82aebbdc95fdda9e9d

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diff --git a/drivers/iommu/dmar.c b/drivers/iommu/dmar.c
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+
 struct dmar_pci_notify_info {
        struct pci_dev                  *dev;
        unsigned long                   event;
        int                             bus;
        u16                             seg;
        u16                             level;
-       struct acpi_dmar_pci_path       path[];
+       struct dmar_pci_path            path[];
 }  __attribute__((packed));
```

```
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542 struct acpi_dmar_pci_path {
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545 };
"include/acpi/actbl1.h" 1631 lines --32%--
```

- New structure **dmar_pci_path** contains an extra field: **u8 bus;**

- Overflow: info → **path[level].bus** = tmp → bus → number;

```
-       size = sizeof(*info) + level * sizeof(struct acpi_dmar_pci_path);
+       size = sizeof(*info) + level * sizeof(info->path[0]);
```

Defense-in-depth & struct_size()

- Commit 57384592c43375d2c9a14d82aebbdc95fdda9e9d

```
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 struct dmar_pci_notify_info {
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        unsigned long                   event;
        int                             bus;
        u16                             seg;
        u16                             level;
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```
541
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545 };
"include/acpi/actbl1.h" 1631 lines --32%--
```

- New structure **dmar_pci_path** contains an extra field: **u8 bus;**

- Overflow: info → **path[level].bus** = tmp → bus → number;

```
-       size = sizeof(*info) + level * sizeof(struct acpi_dmar_pci_path);
+       size = sizeof(*info) + level * sizeof(info->path[0]);
```

- 4-year-old+ bug (Thu Oct 2 11:50:25 2014)

Defense-in-depth & struct_size()

- iommu/vt-d: Use struct_size() helper
- Commit 553d66cb1e8667aadb57e3804775c5ce1724a49b

```
diff --git a/drivers/iommu/dmar.c b/drivers/iommu/dmar.c
index 9c49300e9fb7..6d969a172fbb 100644
--- a/drivers/iommu/dmar.c
+++ b/drivers/iommu/dmar.c
@@ -145,7 +145,7 @@ dmar_alloc_pci_notify_info(struct pci_dev *dev, unsigned long
                for (tmp = dev; tmp; tmp = tmp->bus->self)
                        level++;

-       size = sizeof(*info) + level * sizeof(info->path[0]);
+       size = struct_size(info, path, level);
        if (size <= sizeof(dmar_pci_notify_info_buf)) {
                info = (struct dmar_pci_notify_info *)dmar_pci_notify_info_buf;
        } else {
```

Defense-in-depth & struct_size()

- iommu/vt-d: Use struct_size() helper
- Commit 553d66cb1e8667aadb57e3804775c5ce1724a49b
- Could have prevented: 57384592c43375d2c9a14d82aebbdc95fdda9e9d

```
diff --git a/drivers/iommu/dmar.c b/drivers/iommu/dmar.c
index 9c49300e9fb7..6d969a172fbb 100644
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        if (size <= sizeof(dmar_pci_notify_info_buf)) {
                info = (struct dmar_pci_notify_info *)dmar_pci_notify_info_buf;
        } else {
```

Defense-in-depth & struct_size()

- Commit 76497732932f15e7323dc805e8ea8dc11bb587cf

cxgb3/l2t: Fix undefined behaviour

```
The use of zero-sized array causes undefined behaviour when it is not
the last member in a structure. As it happens to be in this case.

Also, the current code makes use of a language extension to the C90
standard, but the preferred mechanism to declare variable-length
types such as this one is a flexible array member, introduced in
C99:

struct foo {
        int stuff;
        struct boo array[];
};

diff --git a/drivers/net/ethernet/chelsio/cxgb3/l2t.h b/drivers/net/e
index c2fd323c4078..ea75f275023f 100644
--- a/drivers/net/ethernet/chelsio/cxgb3/l2t.h
+++ b/drivers/net/ethernet/chelsio/cxgb3/l2t.h
@@ -75,8 +75,8 @@ struct l2t_data {
        struct l2t_entry *rover;        /* starting point for next al
        atomic_t nfree;         /* number of free entries */
        rwlock_t lock;
-       struct l2t_entry l2tab[0];
        struct rcu_head rcu_head;       /* to handle rcu cleanup */
+       struct l2t_entry l2tab[];
 };
```

Defense-in-depth & struct_size()

- Commit 76497732932f15e7323dc805e8ea8dc11bb587cf
- 8-year-old bug (Tue Sep 6 13:59:13 2011).

cxgb3/l2t: Fix undefined behaviour

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-       struct l2t_entry l2tab[0];
        struct rcu_head rcu_head;       /* to handle rcu cleanup */
+       struct l2t_entry l2tab[];
 };
```

Defense-in-depth & struct_size()

- Commit 76497732932f15e7323dc805e8ea8dc11bb587cf
- 8-year-old bug (Tue Sep 6 13:59:13 2011).
- Bugfix backported all the way down to LTS Linux v3.16.74

cxgb3/l2t: Fix undefined behaviour

```
The use of zero-sized array causes undefined behaviour when it is not
the last member in a structure. As it happens to be in this case.

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--- a/drivers/net/ethernet/chelsio/cxgb3/l2t.h
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        atomic_t nfree;         /* number of free entries */
        rwlock_t lock;
-       struct l2t_entry l2tab[0];
        struct rcu_head rcu_head;       /* to handle rcu cleanup */
+       struct l2t_entry l2tab[];
 };
```

Switch case fall-through

Switch case fall-through

- Common Weakness Enumeration.
  CWE-484:*Omitted Break Statement in Switch:*

“The program omits a break statement within a switch or similar construct, causing code associated with multiple conditions to execute. This can cause problems when the programmer only intended to execute code associated with one condition.”

Switch case fall-through

- Common Weakness Enumeration.
  CWE-484:*Omitted Break Statement in Switch:*

“The program omits a break statement within a switch or similar construct, causing code associated with multiple conditions to execute. This can cause problems when the programmer only intended to execute code associated with one condition.”

- Prone to error.

Switch case fall-through

- Common Weakness Enumeration.
  CWE-484:Omitted Break Statement in Switch:

“The program omits a break statement within a switch or similar construct, causing code associated with multiple conditions to execute. This can cause problems when the programmer only intended to execute code associated with one condition.”

- Prone to error.

- “To enable -Wimplicit-fallthrough in Firefox,
  I had to annotate 287 intentional fallthroughs.”
  - Chris Peterson. TPM on Mozilla’s Firefox team.

-Wimplicit-fallthrough

-Wimplicit-fallthrough

- Commit 7607a121f4617840fe645c65f090af6403738031

dmaengine: fsldma: Mark expected switch fall-through

```
Mark switch cases where we are expecting to fall through.

Fix the following warning (Building: powerpc-ppa8548_defconfig powerpc):

drivers/dma/fsldma.c: In function ‘fsl_dma_chan_probe’:
drivers/dma/fsldma.c:1165:26: warning: this statement may fall through [-Wimplicit-fallthrough=]
   chan->toggle_ext_pause = fsl_chan_toggle_ext_pause;
   ~~~~~~~~~~~~~~~~~~~~~~~^~~~~~~~~~~~~~~~~~~~~~~~~~~
drivers/dma/fsldma.c:1166:2: note: here
  case FSL_DMA_IP_83XX:
  ^~~~
```

Diffstat

-rw-r--r-- drivers/dma/fsldma.c 1

1 files changed, 1 insertions, 0 deletions

```
diff --git a/drivers/dma/fsldma.c b/drivers/dma/fsldma.c
index 23e0a356f167..ad72b3f42ffa 100644
--- a/drivers/dma/fsldma.c
+++ b/drivers/dma/fsldma.c
@@ -1163,6 +1163,7 @@ static int fsl_dma_chan_probe(struct fsldma_device
        switch (chan->feature & FSL_DMA_IP_MASK) {
        case FSL_DMA_IP_85XX:
                chan->toggle_ext_pause = fsl_chan_toggle_ext_pause;
+               /* Fall through */
        case FSL_DMA_IP_83XX:
                chan->toggle_ext_start = fsl_chan_toggle_ext_start;
                chan->set_src_loop_size = fsl_chan_set_src_loop_size;
```

-Wimplicit-fallthrough

- Tons of warnings (2300+).

-Wimplicit-fallthrough

- Tons of warnings (2300+). **Just on x86.**

-Wimplicit-fallthrough

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- Where do I even begin?

-Wimplicit-fallthrough

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- Where do I even begin?
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- x86 gate keeper:

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- What could possibly go wrong?
- First patch (2017) :) - **Flamed :/**
- **Abort.** Rethink strategy.
- Warnings finally addressed in 2019.

Unintentional fall-through bugs

Unintentional fall-through bugs

Gustavo A. R. Silva
@embeddedgus

A bugfix for a 12-year-old bug has been finally pulled and will be merged into mainline soon: git.kernel.org/pub/scm/linux/... 🐧

Yep; this bug has been out there since 2007. Briefly explained: the problem is that the code always returns "success" even on failure.

8:18 AM · May 8, 2019 · Twitter Web Client

Unintentional fall-through bugs

- commit 1cbd7a64959d33e7a2a1fa2bf36a62b350a9fcbd
- Recently applied to LTS Linux v3.16.74 (a couple of days ago).

```
diff --git a/drivers/platform/x86/sony-laptop.c b/drivers/platform/x8
index 4bfbfa3f78e6..2058445fc456 100644
--- a/drivers/platform/x86/sony-laptop.c
+++ b/drivers/platform/x86/sony-laptop.c
@@ -4424,14 +4424,16 @@ sony_pic_read_possible_resource(struct acpi_r
                        }
                        return AE_OK;
                }
+
+       case ACPI_RESOURCE_TYPE_END_TAG:
+               return AE_OK;
+
        default:
                dprintk("Resource %d isn't an IRQ nor an IO port\n",
                        resource->type);
+               return AE_CTRL_TERMINATE;

-       case ACPI_RESOURCE_TYPE_END_TAG:
-               return AE_OK;
        }
-       return AE_CTRL_TERMINATE;
 }
```

Unintentional fall-through bugs

Gustavo A. R. Silva
@embeddedgus

Bugs, bugs, ancient bugs!
Another years-old bug found while working on the -Wimplicit-fallthrough stuff: lore.kernel.org/patchwork/patc…

This one was introduced in January 2012.

4:45 PM · Feb 18, 2019 · Twitter Web Client

Unintentional fall-through bugs

- commit cc5034a5d293dd620484d1d836aa16c6764a1c8c

```
diff --git a/drivers/gpu/drm/radeon/evergreen_cs.c b/drivers/gpu/drm/rade
index f471537c852f..1e14c6921454 100644
--- a/drivers/gpu/drm/radeon/evergreen_cs.c
+++ b/drivers/gpu/drm/radeon/evergreen_cs.c
@@ -1299,6 +1299,7 @@ static int evergreen_cs_handle_reg(struct radeon_cs
                        return -EINVAL;
                }
                ib[idx] += (u32)((reloc->gpu_offset >> 8) & 0xffffffff);
+               break;
        case CB_TARGET_MASK:
                track->cb_target_mask = radeon_get_ib_value(p, idx);
                track->cb_dirty = true;
```

Unintentional fall-through bugs

- commit cc5034a5d293dd620484d1d836aa16c6764a1c8c
- 7-year-old bug.

```
diff --git a/drivers/gpu/drm/radeon/evergreen_cs.c b/drivers/gpu/drm/rade
index f471537c852f..1e14c6921454 100644
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+++ b/drivers/gpu/drm/radeon/evergreen_cs.c
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                track->cb_dirty = true;
```

Unintentional fall-through bugs

Gustavo A. R. Silva
@embeddedgus

Friday night, casually building ARCH=sh for the first time, I found a 10-year-old bug thanks to -Wimplicit-fallthrough:
lore.kernel.org/patchwork/patc... 🐧

This is the perfect way to officially start my weekend. Cheers! 🍻

2:05 AM · Aug 10, 2019 · Twitter Web App

Unintentional fall-through bugs

- commit 1ee1119d184bb06af921b48c3021d921bbd85bac

```
diff --git a/arch/sh/kernel/hw_breakpoint.c b/arch/sh/k
index 3bd010b4c55f..f10d64311127 100644
--- a/arch/sh/kernel/hw_breakpoint.c
+++ b/arch/sh/kernel/hw_breakpoint.c
@@ -157,6 +157,7 @@ int arch_bp_generic_fields(int sh_l
        switch (sh_type) {
        case SH_BREAKPOINT_READ:
                *gen_type = HW_BREAKPOINT_R;
+               break;
        case SH_BREAKPOINT_WRITE:
                *gen_type = HW_BREAKPOINT_W;
                break;
```

Unintentional fall-through bugs

- commit 1ee1119d184bb06af921b48c3021d921bbd85bac
- 10-year-old bug.

```
diff --git a/arch/sh/kernel/hw_breakpoint.c b/arch/sh/k
index 3bd010b4c55f..f10d64311127 100644
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```

Unintentional fall-through bugs

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```
diff --git a/arch/sh/kernel/hw_breakpoint.c b/arch/sh/k
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                *gen_type = HW_BREAKPOINT_W;
                break;
```

Ancient bugs

Kieran Bingham
@kieranbingham

Replying to @embeddedgus

I wonder what effect these bugs had on the devices to go unnoticed for so long. In a years time someone's going to suddenly see something work correctly :-)

2:50 PM · Feb 1, 2019 · Twitter for Android

-Wimplicit-fallthrough

Gustavo A. R. Silva
@embeddedgus

After almost two years of work, -Wimplicit-fallthrough will be finally globally enabled in Linux v5.3. I'll go grab a beer. Have a great weekend everybody. 🐧
git.kernel.org/pub/scm/linux/...

author	Linus Torvalds <torvalds@linux-foundation.org> 2019-07-27 11:04:18 -0700
committer	Linus Torvalds <torvalds@linux-foundation.org> 2019-07-27 11:04:18 -0700
commit	88c5083442454e5e8a505b11fa16f32d2879651e (patch)
tree	54774b7dc8cb3bf3d9cb661f63bc40fd5190fa54
parent	43e317c1bbdfe1d4d6d19d28f925f400898d41b9 (diff)
parent	a035d552a93bb9ef6048733bb9f2a0dc857ff869 (diff)
download	linux-88c5083442454e5e8a505b11fa16f32d2879651e.tar.gz

Merge tag 'Wimplicit-fallthrough-5.3-rc2' of git://git.kernel.org/pub/scm/linux/kern

```
Pull Wimplicit-fallthrough enablement from Gustavo A. R. Silva:
 "This marks switch cases where we are expecting to fall through, and
  globally enables the -Wimplicit-fallthrough option in the main
  Makefile.

  Finally, some missing-break fixes that have been tagged for -stable:

   - drm/amdkfd: Fix missing break in switch statement

   - drm/amdgpu/gfx10: Fix missing break in switch statement
```

Worth it

```
On Tue, Aug 13, 2019 at 09:38:51PM +0800, Jonathan Cameron wrote:
> This got caught by the implicit fall through detection but is
> a bug rather than missing marking.
>
> Reported-by: 0-DAY kernel test infrastructure
> Signed-off-by: Jonathan Cameron <Jonathan.Cameron@huawei.com>
> Fixes: 741172d18e8a ("iio: light: noa1305: Add support for NOA1305")
> ---
>  drivers/iio/light/noa1305.c | 1 +
>  1 file changed, 1 insertion(+)
>
> diff --git a/drivers/iio/light/noa1305.c b/drivers/iio/light/noa1305.c
> index 7b859ae1044d..5ebfbc52f541 100644
> --- a/drivers/iio/light/noa1305.c
> +++ b/drivers/iio/light/noa1305.c
> @@ -85,6 +85,7 @@ static int noa1305_scale(struct noa1305_priv *priv, int
>       case NOA1305_INTEGR_TIME_400MS:
>               *val = 100;
>               *val2 = 77 * 4;
> +             break;
>       case NOA1305_INTEGR_TIME_200MS:
>               *val = 100;
>               *val2 = 77 * 2;
> --
> 2.20.1
>

Gustavo, your work caught a bug _before_ it hit Linus's tree this time :)

I'll go queue this up now, thanks for the fast response Jonathan.

greg k-h
```

Super powers and responsibility

My own tree

My own tree

- Why?

My own tree

- Why?
- Stuck at 90%.

My own tree

- Why?
- Stuck at 90%.
- Patches deliberately ignored.

My own tree

- Why?
- Stuck at 90%.
- Patches deliberately ignored.
- Forced to bypass people to get the job done.

Results

Contributions

Contributions

200+ commits upstream (KR2017)

Contributions

200+ commits upstream (KR2017)

750+ commits upstream (KR2018)

Contributions

200+ commits upstream (KR2017)

750+ commits upstream (KR2018)

1400+ commits upstream (KR2019)

Categories (10+)

- NULL pointer dereferences.
- Spectre vulnerabilities.
- API usage errors.
- Code maintainability issues.
- Constification.
- Control flow issues.
- Uninitialized variables.
- Incorrect expression.
- Integer handling issues.
- Miscellaneous

Types (38+)

- Variable Length Arrays (VLA)
- Integer overflows
- Bad memory allocation
- Dereference after null check.
- Dereference before null check.
- Dereference null return value.
- Explicit null dereference.
- Missing null check on return value.
- Arguments in wrong order.
- Ignored error return code.
- Unused value.
- Unused code.
- Unnecessary static on local variable.
- Missing return in switch
- Logical vs. bitwise operator
- Wrong operator used
- Spectre V1
- Memory leaks
- ‘Constant’ variable guards dead code.
- Missing break in switch.
- Uninitialized scalar variable.
- Array compared against 0.
- Identical code for different branches.
- Self assignment.
- Macro compares unsigned to 0.
- Code refactoring.
- Print error message on failure.
- Unnecessary cast on kmalloc.
- Use sizeof(*var) in kmalloc.
- Double free
- Copy-paste errors
- Read from pointer after free

Subsystems & Components impacted (38+)

- alsa-devel
- linux-arm-msm
- linux-mediatek
- linux-samsung-soc
- ath10k
- linux-block
- linux-mmc
- linux-scsi
- ceph-devel
- linux-clk
- linux-nfs
- linux-wireless
- linux-media
- cifs-client
- linux-crypto
- linux-omap
- linux-wpan
- dri-devel
- linux-dmaengine
- linux-parisc
- platform-driver-x86
- intel-gfx
- linux-fbdev
- linux-pci
- spi-devel-general
- linux-arm-kernel
- kvm
- linux-fpga
- linux-pm
- target-devel
- linux-acpi
- linux-iio
- linux-rdma
- tpmdd-devel
- linux-rockchip
- linux-input
- linux-renesas-soc
- xen-devel

Stable trees impacted (20)

- 5.3.y
- 5.2.y
- 5.1.y
- 5.0.y
- 4.20.y
- 4.19.y (LTS)
- 4.18.y
- 4.17.y
- 4.16.y
- 4.15.y
- 4.14.y (LTS)
- 4.13.y
- 4.12.y
- 4.11.y
- 4.10.y
- 4.9.y (LTS)
- 4.4.y (LTS)
- 4.1.y
- 3.18.y
- 3.16.y (LTS)

Stable trees impacted (20)

- 5.3.y
- 5.2.y
- 5.1.y
- 5.0.y
- 4.20.y
- 4.19.y (LTS)
- 4.18.y
- 4.17.y
- 4.16.y
- 4.15.y
- 4.14.y (LTS)
- 4.13.y
- **4.12.y**[1]
- 4.11.y
- 4.10.y
- 4.9.y (LTS)
- 4.4.y (LTS)
- 4.1.y
- 3.18.y
- 3.16.y (LTS)

[1] Kick-off. First bugfixes. May 2017.

Stable trees impacted (20)

- 5.3.y
- 5.2.y
- 5.1.y
- 5.0.y
- **4.20.y**[2]
- 4.19.y (LTS)
- 4.18.y
- 4.17.y
- 4.16.y
- 4.15.y
- 4.14.y (LTS)
- 4.13.y
- **4.12.y**[1]
- 4.11.y
- 4.10.y
- 4.9.y (LTS)
- 4.4.y (LTS)
- 4.1.y
- 3.18.y
- 3.16.y (LTS)

[1] Kick-off. First bugfixes. May 2017.
[2] VLAs erradicated from kernel. December 2018.

Stable trees impacted (20)

- **5.3.y[3]**
- 5.2.y
- 5.1.y
- 5.0.y
- **4.20.y[2]**
- 4.19.y (LTS)
- 4.18.y
- 4.17.y
- 4.16.y
- 4.15.y
- 4.14.y (LTS)
- 4.13.y
- **4.12.y[1]**
- 4.11.y
- 4.10.y
- 4.9.y (LTS)
- 4.4.y (LTS)
- 4.1.y
- 3.18.y
- 3.16.y (LTS)

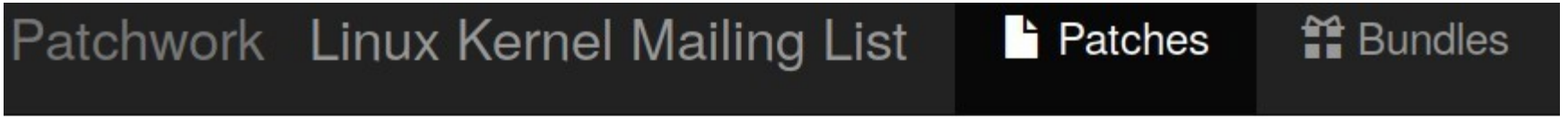
[1] Kick-off. First bugfixes. May 2017.
[2] VLAs erradicated from kernel. December 2018.
[3] -Wimplicit-fallthrough globally enabled by default. September 2019

Bonus

Code of Conduct

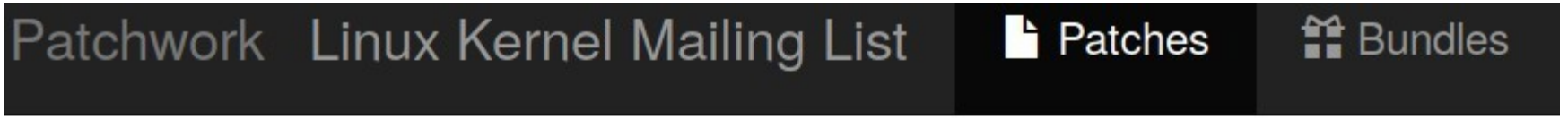
My experience with CoC

My experience with CoC



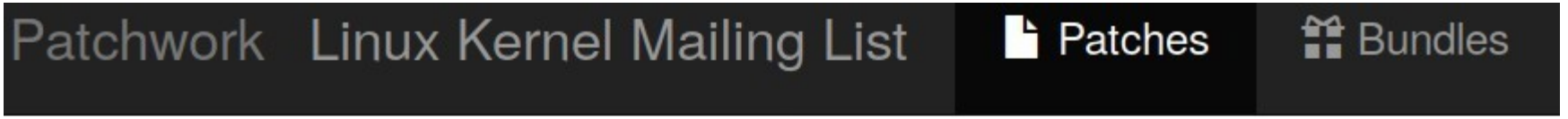
- 1480 files changed, 3920 (+), 2961 (-)

My experience with CoC



- 1480 files changed, 3920 (+), 2961 (-)
- 1846 interactions in general.

My experience with CoC



- 1480 files changed, 3920 (+), 2961 (-)
- 1846 interactions in general.
- Some interesting “feedback”:
  - “This crap… !!”
  - “I hate when… !!”
  - Contempt.

Flexibility and persistence.

KSPP moto suggested by Alexander Popov.

Thank you!

Gustavo A. R. Silva
gustavo@embeddedor.com
@embeddedgus