Jailhouse Porting and Debug

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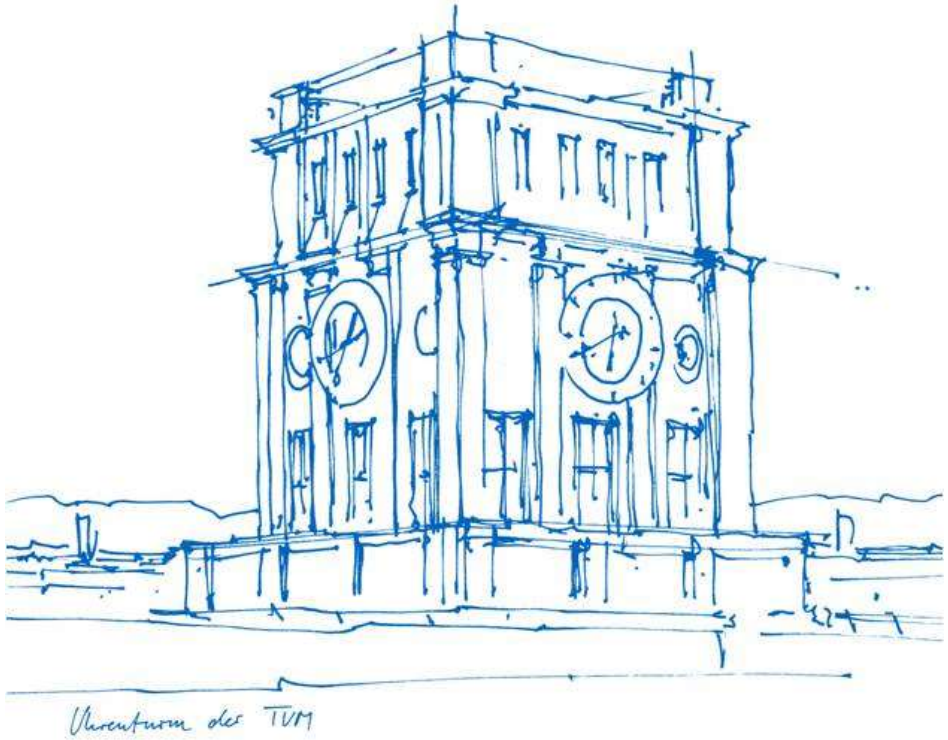
Munich, 26. June 2024



Jailhouse Porting

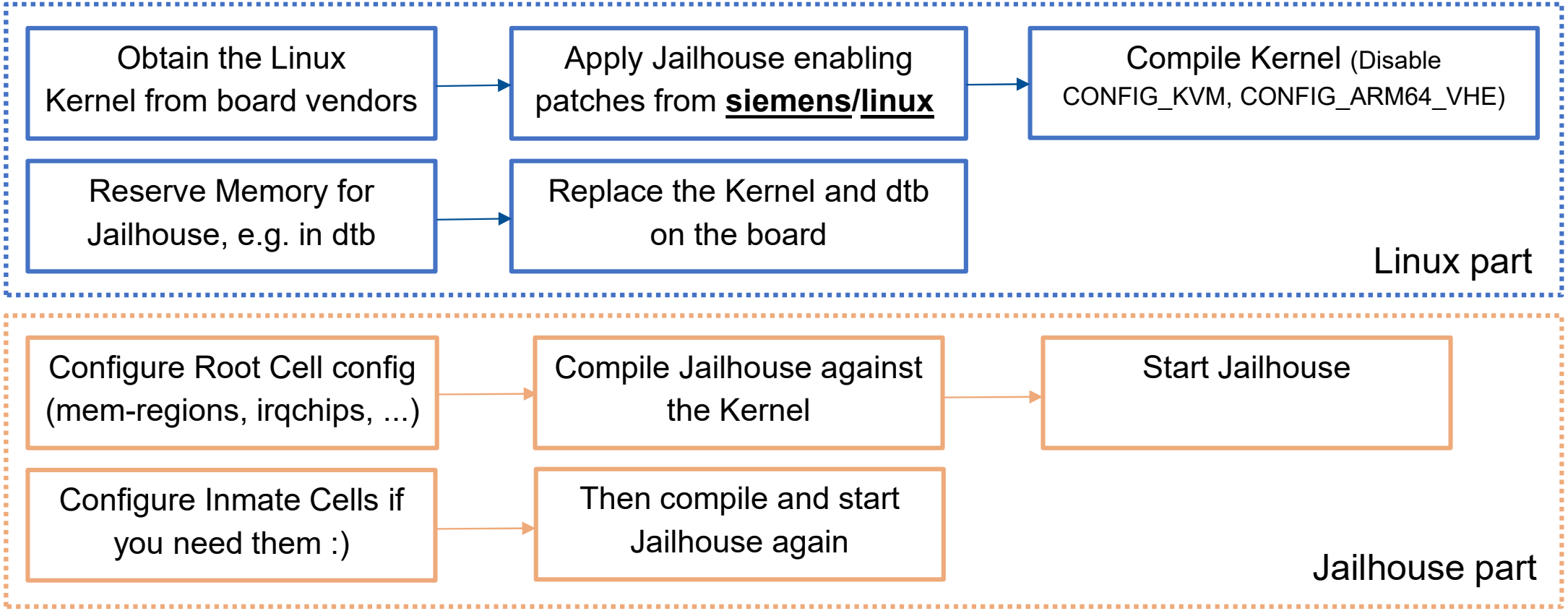
Example: Porting Jailhouse to RK3588

- Patches to the Linux Kernel 5.10
  1. Jailhouse enabling patches on ARM64
  2. Disable CONFIG_KVM
  3. Disable CONFIG_ARM64_VHE
  4. Disable CONFIG_ARM_GIC_V3_ITS

- Patches to the Jailhouse
  1. Patch to allow SMC calls to reach the firmware
  2. Skip FPEXC32_EL2 (It does not exist in A76 core!)
  3. Skip Software Delegated Exception Interface (SDEI)

- Memory reservation and address mapping

General Procedure to Port Jailhouse



Obtain the Linux Kernel from board vendors

Vendors usually have applied some patches to adapt the mainline Linux Kernel to the board.

These can be found according to the guide from vendors.

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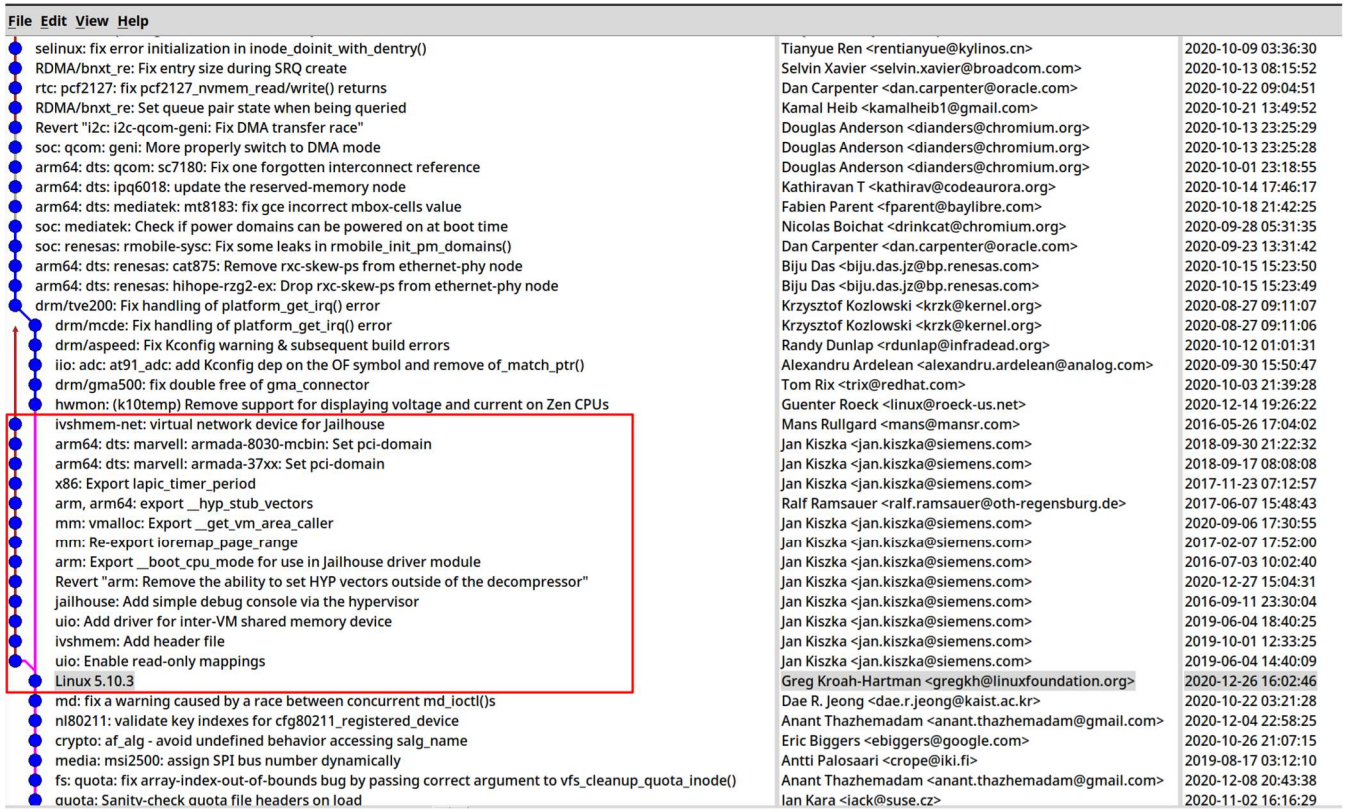
Apply Jailhouse enabling patches from **siemens/linux**

These patches enable Jailhouse to boot.

They are provided by **siemens/linux**, with different Kernel versions on different branches.

In the Linux Kernel 5.10 on the RK3588, these commits are applied by git cherry-pick onto the Kernel provided by the vendor.



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Compile Kernel (Disable CONFIG_KVM, CONFIG_ARM64_VHE)

Compile the patched Kernel with the following configs disabled:

- CONFIG_KVM
- CONFIG_ARM64_VHE
- CONFIG_ARM_GIC_V3_ITS

Depending on the board, there may be other configs that need to be turned on/off.

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Reserve Memory for Jailhouse, e.g. in dtb

Reserve memory for Jailhouse Hypervisor and inmate cells in Device Tree (.dts file).

Then compile the Device Tree:

```
dtc -I dts -O dtb -o output.dtb input.dts
```

```
reserved-memory {
    #address-cells = <0x02>;
    #size-cells = <0x02>;
    ranges;

    reserved-mem-jailhouses@80000000 {
        reg = <0x00 0x80000000 0x00
0x10000000>;
        no-map;
    };

    reserved-mem-inmate@90000000 {
        reg = <0x00 0x90000000 0x00
0x25000000>;
        no-map;
    };

    reserved-mem-bomb-ctrl@b5000000 {
        reg = <0x00 0xb5000000 0x00
0x10000>;
        no-map;
    };
}
```

Note: this is also addressed in Zhihang's Jailhouse Workshop slides.

Replace the Kernel and dtb on the board

On ARM64, the Linux Kernel is typically placed as `/boot/Image`.

The dtb file is also stored under `/boot/`.

Configure Root Cell config (mem-regions, irqchips, ...)

We can refer to existing configs for other boards and adapt them for our board.

Most important configurations are:

- Jailhouse hypervisor address
- Debug console
- CPUs
- Memory regions
- Generic Interrupt Controller (GIC, Arm platforms)

Compile Jailhouse against the Kernel

This is covered by Zhihang's Jailhouse Workshop slides :).

Start Jailhouse

Starting the root cell and Linux inmate cell is covered by Zhihang's Jailhouse Workshop slides :).

Starting a bare-metal inmate cell:

```
jailhouse cell create inmate-config.cell
jailhouse cell load 1 demo.bin
jailhouse cell start 1
```

Configure Inmate Cells if you need them :) → Then compile and start Jailhouse again

Like configuring the root cell, we can refer to existing configs for other boards and adapt them for our board.

Most important configurations are:

- RAM address reserved for the inmate (virtual address starts from the bottom of inmate memory, i.e. 0x0)
- Debug console
- Communication region:

```
/* communication region */ {
    .virt_start = 0x80000000,
    .size = 0x00001000,
    .flags = JAILHOUSE_MEM_READ | JAILHOUSE_MEM_WRITE |
    JAILHOUSE_MEM_COMM_REGION,
},
```

Jailhouse Debug

Porting Jailhouse is not as straight-forward as described above.

There are always some errors/bugs on the way.

Debugging Jailhouse is somehow tricky.

There are some debug possibilities, still.

Common Debug Possibilities

- Linux kernel log dmesg
- Hypervisor dump
  - Especially pc and esr

```
[ 1990.451647] rcu: INFO: rcu_sched self-detected stall on CPU
[ 1990.451662] rcu:     7-....: (125950 ticks this GP) idle=1a2/1/0x4000000000000002
softirq=3018/3018 fqs=37790
[ 1990.451671]  (t=126006 jiffies g=4517 q=39582)
[ 1990.451677] Task dump for CPU 7:
[ 1990.451682] task:kworker/7:1     state:R  running task     stack:    0 pid: 1904
ppid:     2 flags:0x0000000a
[ 1990.451702] Workqueue: events dbs_work_handler
[ 1990.451710] Call trace:
[ 1990.451719]  dump_backtrace+0x0/0x1b0
[ 1990.451727]  show_stack+0x20/0x2c
[ 1990.451735]  sched_show_task+0x118/0x150
[ 1990.451746]  dump_cpu_task+0x4c/0x5c
[ 1990.451754]  rcu_dump_cpu_stacks+0xf0/0xfc
[ 1990.451763]  rcu_sched_clock_irq+0x250/0x630
[ 1990.451773]  update_process_times+0x6c/0x98
[ 1990.451781]  tick_sched_handle+0x48/0x5c
[ 1990.451790]  tick_sched_timer+0x54/0x98
[ 1990.451800]  __hrtimer_run_queues+0x164/0x234
[ 1990.451811]  hrtimer_interrupt+0xb8/0x1c0
[ 1990.451820]  arch_timer_handler_phys+0x34/0x4c
[ 1990.451829]  handle_percpu_devid_irq+0x70/0x12c
[ 1990.451840]  generic_handle_irq_desc+0x14/0x20
[ 1990.451849]  __handle_domain_irq+0xc0/0xc8
[ 1990.451857]  gic_handle_irq+0x2b8/0x308
[ 1990.451864]  el1_irq+0xcc/0x180
[ 1990.451874]  ioread32+0xc/0x20
[ 1990.451884]  smc_send_message+0x3c/0x100
[ 1990.451892]  do_xfer+0xdc/0x2a0
[ 1990.451900]  scmi_clock_rate_get+0x78/0xe0
[ 1990.451911]  scmi_clk_recalc_rate+0x40/0x74
[ 1990.451918]  clk_recalc+0x48/0x68
[ 1990.451926]  __clk_recalc_rates+0x3c/0xa0
[ 1990.451934]  clk_core_get_rate_recalc+0x30/0x48
[ 1990.451941]  clk_get_rate+0x2c/0x50
[ 1990.451949]  dev_pm_opp_set_rate+0x12c/0x4e0
[ 1990.451958]  rockchip_cpufreq_opp_set_rate+0x58/0xe0
[ 1990.451966]  set_target+0x38/0x44
[ 1990.451976]  __cpufreq_driver_target+0x248/0x2f4
[ 1990.451987]  od_dbs_update+0xf0/0x174
[ 1990.451995]  dbs_work_handler+0x48/0x80
[ 1990.452006]  process_one_work+0x1e0/0x298
[ 1990.452016]  worker_thread+0x1e0/0x278
[ 1990.452026]  kthread+0xf4/0x104
[ 1990.452035]  ret_from_fork+0x10/0x30
```

Kernel log

```
FATAL: forbidden access (exception class 0x20)
Cell state before exception:
 pc: ffffffc0010f43bc   lr: ffffffc0010f43bc spsr: 20400085     EL1
 sp: ffffffc00a17be90  elr: ffffffc0010f43bc  esr: 20 1 0000085
 x0: 0000000000000000   x1: 0000000000000000   x2: 0000000000000000
 x3: 0000000000000000   x4: 0000000000000000   x5: 0000000000000000
 x6: 0000000000000000   x7: 0000000000000000   x8: 0000000000000000
 x9: 0000000000000000  x10: 0000000000000000  x11: 0000000000000000
x12: 0000000000000000  x13: 0000000000000000  x14: 0000000000000000
x15: 0000000000000000  x16: 0000000000000000  x17: 0000000000000000
x18: 0000000000000000  x19: ffffffc0010f8e90  x20: 0000000000000000
x21: 0000000000000000  x22: 0000000000000000  x23: ffffffc009f0a3b0
x24: 0000000000000000  x25: ffffffc00945659f  x26: ffffffc00a17c000
x27: 0000000000000000  x28: ffffff80030e8000  x29: ffffffc00a17be90

Parking CPU 4 (Cell: "orangepi5p")

FATAL: Unhandled HYP exception: synchronous abort from EL2
 pc: 0000ffffc0203e60   lr: 0000ffffc0203e0c spsr: 604003c9     EL2
 sp: 0000ff0000010e60  elr: 0000ffffc0203e60  esr: 00 1 0000000
 x0: 0000000000300000   x1: 0000000000000000   x2: 0000000000000100
 x3: 000000000000100   x4: 000000000000003f   x5: 0000ffffc021e000
 x6: 0000ffffc021c0c0   x7: 000000000000000a   x8: 0000000000000000
 x9: 0000000000000000  x10: 0000000000000020  x11: 0000000000000000
x12: 0000000000000000  x13: 0000000000000000  x14: 0000000000000000
x15: 0000000000000000  x16: 0000ffffc020dc5c  x17: 0000000000000000
x18: 0000000000000000  x19: 0000000000000000  x20: 0000000000000000
x21: 0000000000000000  x22: 0000000000000000  x23: ffffffc009f0a3b0
x24: 0000000000000000  x25: ffffffc00945659f  x26: ffffffc00a17c000
x27: 0000000000000000  x28: ffffff80030e8000  x29: 0000ff0000010e60

Hypervisor stack before exception (0x0000ff0000010e60 - 0x0000ff0000011000):
0e60: 00010e90 0000ff00 c0200888 0000ffff c021b000 0000ffff 00012000 0000ff00
0e80: 00000000 00000000 00000001 00000000 00010ea0 0000ff00 c020b798 0000ffff
0ea0: 00010ec0 0000ff00 c020891c 0000ffff 010f8e90 ffffffc0 00000000 00000000
0ec0: 00000000 00000000 c0204fc8 0000ffff 00000000 00000000 00010f08 0000ff00
0ee0: 010f43bc ffffffc0 82000085 00000000 20400085 00000000 0a17be90 ffffffc0
0f00: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f20: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f40: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f60: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f80: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0fa0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0fc0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

Hypervisor dump

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Debug Jailhouse Example 1

Failing due to Improper Memory Translation Setup

esr_el1: 0x20 0x1 0x0000085

```
FATAL: forbidden access (exception class 0x20)
Cell state before exception:
 pc: ffffffc0010f43bc   lr: ffffffc0010f43bc spsr: 20400085     EL1
 sp: ffffffc00a17be90  elr: ffffffc0010f43bc  esr: 20 1 0000085
 x0: 0000000000000000   x1: 0000000000000000   x2: 0000000000000000
 x3: 0000000000000000   x4: 0000000000000000   x5: 0000000000000000
 x6: 0000000000000000   x7: 0000000000000000   x8: 0000000000000000
 x9: 0000000000000000  x10: 0000000000000000  x11: 0000000000000000
x12: 0000000000000000  x13: 0000000000000000  x14: 0000000000000000
x15: 0000000000000000  x16: 0000000000000000  x17: 0000000000000000
x18: 0000000000000000  x19: ffffffc0010f8e90  x20: 0000000000000000
x21: 0000000000000000  x22: 0000000000000000  x23: ffffffc009f0a3b0
x24: 0000000000000000  x25: ffffffc00945659f  x26: ffffffc00a17c000
x27: 0000000000000000  x28: ffffff80030e8000  x29: ffffffc00a17be90

Parking CPU 4 (Cell: "orangepi5p")

FATAL: Unhandled HYP exception: synchronous abort from EL2
 pc: 0000ffffc0203e60   lr: 0000ffffc0203e0c spsr: 604003c9     EL2
 sp: 0000ff0000010e60  elr: 0000ffffc0203e60  esr: 00 1 0000000
 x0: 0000000000300000   x1: 0000000000000000   x2: 0000000000000100
 x3: 0000000000000100   x4: 000000000000003f   x5: 0000ffffc021e000
 x6: 0000ffffc021c0c0   x7: 000000000000000a   x8: 0000000000000000
 x9: 0000000000000000  x10: 0000000000000020  x11: 0000000000000000
x12: 0000000000000000  x13: 0000000000000000  x14: 0000000000000000
x15: 0000000000000000  x16: 0000ffffc020dc5c  x17: 0000000000000000
x18: 0000000000000000  x19: 0000000000000000  x20: 0000000000000000
x21: 0000000000000000  x22: 0000000000000000  x23: ffffffc009f0a3b0
x24: 0000000000000000  x25: ffffffc00945659f  x26: ffffffc00a17c000
x27: 0000000000000000  x28: ffffff80030e8000  x29: 0000ff0000010e60

Hypervisor stack before exception (0x0000ff0000010e60 - 0x0000ff0000011000):
0e60: 00010e90 0000ff00 c0200888 0000ffff c021b000 0000ffff 00012000 0000ff00
0e80: 00000000 00000000 00000001 00000000 00010ea0 0000ff00 c020b798 0000ffff
0ea0: 00010ec0 0000ff00 c020891c 0000ffff 010f8e90 ffffffc0 00000000 00000000
0ec0: 00000000 00000000 c0204fc8 0000ffff 00000000 00000000 00010f08 0000ff00
0ee0: 010f43bc ffffffc0 82000085 00000000 20400085 00000000 0a17be90 ffffffc0
0f00: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f20: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f40: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f60: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f80: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0fa0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0fc0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0fe0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
Stopping CPU 4 (Cell: "orangepi5p")
```

Hypervisor dump

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Debug Jailhouse Example 1

Failing due to Improper Memory Translation Setup

esr_el1: 0x20 0x1 0x0000085

Check the ESR_EL1 in the manual.

-> EC (Exception Class) = 0x20 = 0b100000

D19.2.37 ESR_EL1, Exception Syndrome Register (EL1)

The ESR_EL1 characteristics are:

Purpose

Holds syndrome information for an exception taken to EL1.

Configurations

AArch64 System register ESR_EL1 bits [31:0] are architecturally mapped to AArch32 System register DFSR[31:0].

Attributes

ESR_EL1 is a 64-bit register.

Field descriptions

ESR_EL1 is made UNKNOWN as a result of an exception return from EL1.

When an UNPREDICTABLE instruction is treated as UNDEFINED, and the exception is taken to EL1, the value of ESR_EL1 is UNKNOWN. The value written to ESR_EL1 must be consistent with a value that could be created as a result of an exception from the same Exception level that generated the exception as a result of a situation that is not UNPREDICTABLE at that Exception level, in order to avoid the possibility of a privilege violation.

Description of ESR_EL1 from Arm Architecture Reference Manual for A-profile architecture

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Debug Jailhouse Example 1

Failing due to Improper Memory Translation Setup

esr_el1: 0x20 0x1 0x0000085

Check the ESR_EL1 in the manual.

-> EC (Exception Class) = 0x20 = 0b100000

-> MMU faults

-> This indicates that probably the memory translation in Jailhouse is not properly set up.

EC == 0b100000

Instruction Abort from a lower Exception level.

Used for MMU faults generated by instruction accesses and synchronous External aborts, including synchronous parity or ECC errors. Not used for debug-related exceptions.

See ISS encoding for an exception from an Instruction Abort.

Description of EC from Arm Architecture Reference Manual for A-profile architecture

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Debug Jailhouse Example 2

Failing at ITS (Interrupt Translation Service)

pc: 0xffffffc0086590f4

This address seems to be in the Linux Kernel, because it is so high (starting with 0xfffff...).

```
FATAL: unhandled trap (exception class 0x24)
Cell state before exception:
 pc: ffffffc0086590f4   lr: ffffffc00865b324 spsr: a0c00085     EL1
 sp: ffffffc00a37bb10  elr: ffffffc0086590f4  esr: 24 1 1800006
 x0: ffffffc00a140090   x1: 0000000000000000   x2: ffffff81000f0000
 x3: 0000000000000000   x4: 0000000000000000   x5: 0000000000000007
 x6: ffffffc00a37bb70   x7: 0000000000000000   x8: 0000000000000000
 x9: ffffffc00865b324  x10: 00000000000000a2  x11: ffffffc009dcf7b0
x12: ffffffc3f4794000  x13: ffffff8100394c40  x14: ffffff8100293f10
x15: ffffff810040d7f0  x16: 0000000000000000  x17: 0000000000000000
x18: 0000000000000000  x19: ffffff81000f4a00  x20: ffffff83fc50e800
x21: 00000000000f4240  x22: 0000000000000080  x23: ffffffc00a37bbd8
x24: 0000000000000001  x25: ffffff8106a35800  x26: 0000000000000000
x27: ffffffc009cd4000  x28: ffffff8106a35818  x29: ffffffc00a37bb10

Parking CPU 1 (Cell: "orangepi5p")
```

Hypervisor dump

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Debug Jailhouse Example 2

Failing at ITS (Interrupt Translation Service)

pc: 0xffffffc0086590f4

Check the disassembly of the Linux Kernel.

aarch64-none-linux-gnu-objdump -D vmlinux > vmlinux_disassembly.txt

This address is within the function its_allocate_entry.

However, ITS is not supported in Jailhouse.

-> Disable it in the Kernel config

```
ffffffc0086590c0 <its_allocate_entry>:
ffffffc0086590c0:       d503201f        nop
ffffffc0086590c4:       d503201f        nop
ffffffc0086590c8:       d503233f        paciasp
ffffffc0086590cc:       a9bd7bfd        stp     x29, x30, [sp, #-48]!
ffffffc0086590d0:       910003fd        mov     x29, sp
ffffffc0086590d4:       a90153f3        stp     x19, x20, [sp, #16]
ffffffc0086590d8:       aa0003f4        mov     x20, x0
ffffffc0086590dc:       f90013f5        str     x21, [sp, #32]
ffffffc0086590e0:       52884815        mov     w21, #0x4240
ffffffc0086590e4:       72a001f5        movk    w21, #0xf, lsl #16
ffffffc0086590e8:       f9403280        ldr     x0, [x20, #96]
ffffffc0086590ec:       a947ce82        ldp     x2, x19, [x20, #120]
ffffffc0086590f0:       91024000        add     x0, x0, #0x90
ffffffc0086590f4:       b9400000        ldr     w0, [x0]
ffffffc0086590f8:       cb020261        sub     x1, x19, x2
ffffffc0086590fc:       9345fc21        asr     x1, x1, #5
ffffffc008659100:       11000421        add     w1, w1, #0x1
ffffffc008659104:       12002821        and     w1, w1, #0x7ff
ffffffc008659108:       6b40143f        cmp     w1, w0, lsr #5
ffffffc00865910c:       540001a0        b.eq    ffffffc008659140 <its_allocate
ffffffc008659110:       91008260        add     x0, x19, #0x20
ffffffc008659114:       91404041        add     x1, x2, #0x10, lsl #12
ffffffc008659118:       eb01001f        cmp     x0, x1
ffffffc00865911c:       9a821000        csel    x0, x0, x2, ne  // ne = any
ffffffc008659120:       f9004280        str     x0, [x20, #128]
ffffffc008659124:       a9007e7f        stp     xzr, xzr, [x19]
ffffffc008659128:       a9017e7f        stp     xzr, xzr, [x19, #16]
ffffffc00865912c:       14000012        b       ffffffc008659174 <its_allocate
ffffffc008659130:       d503203f        yield
ffffffc008659134:       d28218e0        mov     x0, #0x10c7
:
```

Linux Kernel Disassembly Snippet

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Debug Jailhouse Example 3

Failing at accessing FPEXC32_EL2

pc: 0x0000ffffc020460c

This address is not that high, so it does not seem to be within the Kernel. It could be within the Jailhouse.

```
FATAL: Unhandled HYP exception: synchronous abort from EL2
 pc: 0000ffffc020460c   lr: 0000ffffc02045b8 spsr: 604003c9     EL2
 sp: 0000ff0000010e40  elr: 0000ffffc020460c  esr: 00 1 0000000
 x0: 0000000000300000   x1: 0000000000000000   x2: 0000000000000100
 x3: 0000000000000100   x4: 0000ffffc02039a0   x5: 0000000000000000
 x6: 0000000000000000   x7: 0000000000000000   x8: 0000000000000000
 x9: ffffffc008c55054  x10: 0000000000000ae0  x11: 0000000000000008
x12: ffffffc3f485e000  x13: ffffff81002f2dc0  x14: ffffff81001a3d10
x15: ffffff81044b1c60  x16: 0000000000000000  x17: 0000000000000000
x18: 0000000000000000  x19: 0000000000000000  x20: 0000000000000000
x21: 0000000000000000  x22: ffffffc009768638  x23: 0000000000000080
x24: ffffffc009cc49f8  x25: 0000000000000000  x26: 0000000000000000
x27: 0000000000000000  x28: 0000000000000000  x29: 0000ff0000010e40

Hypervisor stack before exception (0x0000ff0000010e40 - 0x0000ff0000011000):
0e40: 00010e70 0000ff00 c0200890 0000ffff 00010f08 0000ff00 00010ed8 0000ff00
0e60: 09cc4988 ffffffc0 c0209bac 0000ffff 00010e80 0000ff00 c02039a4 0000ffff
0e80: 00010ea0 0000ff00 c0203e5c 0000ffff 00010f08 0000ff00 00010ed8 0000ff00
0ea0: 00010ec0 0000ff00 c0209bac 0000ffff 08fe28e8 ffffffc0 00000007 00000000
0ec0: 00000000 00000000 c02057c8 0000ffff 00000000 00000000 00010f08 0000ff00
0ee0: 0802799c ffffffc0 5e000000 00000000 60c003c5 00000000 0a32bea0 ffffffc0
0f00: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f20: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f40: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f60: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0f80: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0fa0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0fc0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0fe0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
Stopping CPU 7 (Cell: "orangepi5p")
```

Hypervisor dump

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Debug Jailhouse Example 3

Failing at accessing FPEXC32_EL2

pc: 0x0000ffffc020460c

Check the disassembly of the Jailhouse.

aarch64-none-linux-gnu-objdump -D hypervisor.o

> hypervisor_disassembly.txt

This address corresponds to reading fpexc32_el2.

However, fpexc32_el2 does not exist on Cortex-A76.

-> Skip reading fpexc32_el2; we don't need it now.

```
0000ffffc0204570 <arm_cpu_reset>:
    ffffc0204570:       a9bd7bfd        stp     x29, x30, [sp, #-48]!
    ffffc0204574:       910003fd        mov     x29, sp
    ffffc0204578:       a90153f3        stp     x19, x20, [sp, #16]
    ffffc020457c:       aa0003f4        mov     x20, x0
    ffffc0204580:       d2810000        mov     x0, #0x800
    ffffc0204584:       f2a61a00        movk    x0, #0x30d0, lsl #16
    ffffc0204588:       f90013f5        str     x21, [sp, #32]
    ffffc020458c:       2a0103f5        mov     w21, w1
    ffffc0204590:       d5181000        msr     sctlr_el1, x0
    ffffc0204594:       d2800013        mov     x19, #0x0
    ffffc0204598:       d518e113        msr     cntkctl_el1, x19
    ffffc020459c:       d51b9c13        msr     pmcr_el0, x19
    ffffc02045a0:       d281e000        mov     x0, #0xf00
    ffffc02045a4:       d2802002        mov     x2, #0x100
    ffffc02045a8:       f2a00020        movk    x0, #0x1, lsl #16
    ffffc02045ac:       52800001        mov     w1, #0x0
    ffffc02045b0:       f2dfe000        movk    x0, #0xff00, lsl #32
    ffffc02045b4:       9400217e        bl      ffffc020cbac <memset>
    ffffc02045b8:       d5184113        msr     sp_el0, x19
    ffffc02045bc:       d51c4113        msr     sp_el1, x19
    ffffc02045c0:       d5184013        msr     spsr_el1, x19
    ffffc02045c4:       d5185113        msr     afsr0_el1, x19
    ffffc02045c8:       d5185133        msr     afsr1_el1, x19
    ffffc02045cc:       d518a313        msr     amair_el1, x19
    ffffc02045d0:       d518d033        msr     contextidr_el1, x19
    ffffc02045d4:       d2a00600        mov     x0, #0x300000
    ffffc02045d8:       d5181040        msr     cpacr_el1, x0
    ffffc02045dc:       d51a0013        msr     csselr_el1, x19
    ffffc02045e0:       d5185213        msr     esr_el1, x19
    ffffc02045e4:       d5186013        msr     far_el1, x19
    ffffc02045e8:       d518a213        msr     mair_el1, x19
    ffffc02045ec:       d5187413        msr     par_el1, x19
    ffffc02045f0:       d5182053        msr     tcr_el1, x19
    ffffc02045f4:       d51bd073        msr     tpidrro_el0, x19
    ffffc02045f8:       d51bd053        msr     tpidr_el0, x19
    ffffc02045fc:       d518d093        msr     tpidr_el1, x19
    ffffc0204600:       d5182013        msr     ttbr0_el1, x19
    ffffc0204604:       d5182033        msr     ttbr1_el1, x19
    ffffc0204608:       d518c013        msr     vbar_el1, x19
    ffffc020460c:       d53c5300        mrs     x0, fpexc32_el2
    ffffc0204610:       b2620000        orr     x0, x0, #0x40000000
    ffffc0204614:       d51c5300        msr     fpexc32_el2, x0
    ffffc0204618:       d51be233        msr     cntp_ctl_el0, x19
    ffffc020461c:       d51be253        msr     cntp_cval_el0, x19
    ffffc0204620:       d51be213        msr     cntp_tval_el0, x19
    ffffc0204624:       d51be333        msr     cntv_ctl_el0, x19
```

Jailhouse Disassembly Snippet

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Debug Jailhouse Example 4

CPU stalling at smc calls

The Linux Kernel has detected a CPU stall.

The smc_send_message before the interrupt handler (that periodically checks whether the CPU is making progress) seems suspicious.

```
[ 1990.451647] rcu: INFO: rcu_sched self-detected stall on CPU
[ 1990.451662] rcu:     7-....: (125950 ticks this GP) idle=1a
fqs=37790
[ 1990.451671]  (t=126006 jiffies g=4517 q=39582)
[ 1990.451677] Task dump for CPU 7:
[ 1990.451682] task:kworker/7:1     state:R  running task
0x0000000a
[ 1990.451702] Workqueue: events dbs_work_handler
[ 1990.451710] Call trace:
[ 1990.451719]  dump_backtrace+0x0/0x1b0
[ 1990.451727]  show_stack+0x20/0x2c
[ 1990.451735]  sched_show_task+0x118/0x150
[ 1990.451746]  dump_cpu_task+0x4c/0x5c
[ 1990.451754]  rcu_dump_cpu_stacks+0xf0/0xfc
[ 1990.451763]  rcu_sched_clock_irq+0x250/0x630
[ 1990.451773]  update_process_times+0x6c/0x98
[ 1990.451781]  tick_sched_handle+0x48/0x5c
[ 1990.451790]  tick_sched_timer+0x54/0x98
[ 1990.451800]  __hrtimer_run_queues+0x164/0x234
[ 1990.451811]  hrtimer_interrupt+0xb8/0x1c0
[ 1990.451820]  arch_timer_handler_phys+0x34/0x4c
[ 1990.451829]  handle_percpu_devid_irq+0x70/0x12c
[ 1990.451840]  generic_handle_irq_desc+0x14/0x20
[ 1990.451849]  __handle_domain_irq+0xc0/0xc8
[ 1990.451857]  gic_handle_irq+0x2b8/0x308
[ 1990.451864]  el1_irq+0xcc/0x180
[ 1990.451874]  ioread32+0xc/0x20
[ 1990.451884]  smc_send_message+0x3c/0x100
[ 1990.451892]  do_xfer+0xdc/0x2a0
[ 1990.451900]  scmi_clock_rate_get+0x78/0xe0
[ 1990.451911]  scmi_clk_recalc_rate+0x40/0x74
[ 1990.451918]  clk_recalc+0x48/0x68
[ 1990.451926]  __clk_recalc_rates+0x3c/0xa0
[ 1990.451934]  clk_core_get_rate_recalc+0x30/0x48
[ 1990.451941]  clk_get_rate+0x2c/0x50
[ 1990.451949]  dev_pm_opp_set_rate+0x12c/0x4e0
[ 1990.451958]  rockchip_cpufreq_opp_set_rate+0x58/0xe0
[ 1990.451966]  set_target+0x38/0x44
[ 1990.451976]  __cpufreq_driver_target+0x248/0x2f4
[ 1990.451987]  od_dbs_update+0xf0/0x174
[ 1990.451995]  dbs_work_handler+0x48/0x80
[ 1990.452006]  process_one_work+0x1e0/0x298
[ 1990.452016]  worker_thread+0x1e0/0x278
[ 1990.452026]  kthread+0xf4/0x104
[ 1990.452035]  ret_from_fork+0x10/0x30
```

Kernel log

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Debug Jailhouse Example 4

CPU stalling at smc calls

If we search for smc_send_message before in the Linux source code, it is in drivers/firmware/arm_scmi/smc.c.

Further investigation shows that it is stuck at a spin lock

in shmem_tx_prepare of drivers/firmware/arm_scmi/shmem.c.

```
[ 1990.451647] rcu: INFO: rcu_sched self-detected stall on CPU
[ 1990.451662] rcu:     7-....: (125950 ticks this GP) idle=1a
fqs=37790
[ 1990.451671]  (t=126006 jiffies g=4517 q=39582)
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[ 1990.451746]  dump_cpu_task+0x4c/0x5c
[ 1990.451754]  rcu_dump_cpu_stacks+0xf0/0xfc
[ 1990.451763]  rcu_sched_clock_irq+0x250/0x630
[ 1990.451773]  update_process_times+0x6c/0x98
[ 1990.451781]  tick_sched_handle+0x48/0x5c
[ 1990.451790]  tick_sched_timer+0x54/0x98
[ 1990.451800]  __hrtimer_run_queues+0x164/0x234
[ 1990.451811]  hrtimer_interrupt+0xb8/0x1c0
[ 1990.451820]  arch_timer_handler_phys+0x34/0x4c
[ 1990.451829]  handle_percpu_devid_irq+0x70/0x12c
[ 1990.451840]  generic_handle_irq_desc+0x14/0x20
[ 1990.451849]  __handle_domain_irq+0xc0/0xc8
[ 1990.451857]  gic_handle_irq+0x2b8/0x308
[ 1990.451864]  el1_irq+0xcc/0x180
[ 1990.451874]  ioread32+0xc/0x20
[ 1990.451884]  smc_send_message+0x3c/0x100
[ 1990.451892]  do_xfer+0xdc/0x2a0
[ 1990.451900]  scmi_clock_rate_get+0x78/0xe0
[ 1990.451911]  scmi_clk_recalc_rate+0x40/0x74
[ 1990.451918]  clk_recalc+0x48/0x68
[ 1990.451926]  __clk_recalc_rates+0x3c/0xa0
[ 1990.451934]  clk_core_get_rate_recalc+0x30/0x48
[ 1990.451941]  clk_get_rate+0x2c/0x50
[ 1990.451949]  dev_pm_opp_set_rate+0x12c/0x4e0
[ 1990.451958]  rockchip_cpufreq_opp_set_rate+0x58/0xe0
[ 1990.451966]  set_target+0x38/0x44
[ 1990.451976]  __cpufreq_driver_target+0x248/0x2f4
[ 1990.451987]  od_dbs_update+0xf0/0x174
[ 1990.451995]  dbs_work_handler+0x48/0x80
[ 1990.452006]  process_one_work+0x1e0/0x298
[ 1990.452016]  worker_thread+0x1e0/0x278
[ 1990.452026]  kthread+0xf4/0x104
[ 1990.452035]  ret_from_fork+0x10/0x30
```

Kernel log

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Debug Jailhouse Example 4

CPU stalling at smc calls

The smc call was not passed to the firmware, so the spin lock is never unlocked, and therfore, it gets stuck at the spin lock.

-> A patch that allows the smc call to pass through is applied.

```
[ 1990.451647] rcu: INFO: rcu_sched self-detected stall on CPU
[ 1990.451662] rcu:     7-....: (125950 ticks this GP) idle=1a
fqs=37790
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[ 1990.451763]  rcu_sched_clock_irq+0x250/0x630
[ 1990.451773]  update_process_times+0x6c/0x98
[ 1990.451781]  tick_sched_handle+0x48/0x5c
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[ 1990.451800]  __hrtimer_run_queues+0x164/0x234
[ 1990.451811]  hrtimer_interrupt+0xb8/0x1c0
[ 1990.451820]  arch_timer_handler_phys+0x34/0x4c
[ 1990.451829]  handle_percpu_devid_irq+0x70/0x12c
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[ 1990.451849]  __handle_domain_irq+0xc0/0xc8
[ 1990.451857]  gic_handle_irq+0x2b8/0x308
[ 1990.451864]  el1_irq+0xcc/0x180
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[ 1990.451918]  clk_recalc+0x48/0x68
[ 1990.451926]  __clk_recalc_rates+0x3c/0xa0
[ 1990.451934]  clk_core_get_rate_recalc+0x30/0x48
[ 1990.451941]  clk_get_rate+0x2c/0x50
[ 1990.451949]  dev_pm_opp_set_rate+0x12c/0x4e0
[ 1990.451958]  rockchip_cpufreq_opp_set_rate+0x58/0xe0
[ 1990.451966]  set_target+0x38/0x44
[ 1990.451976]  __cpufreq_driver_target+0x248/0x2f4
[ 1990.451987]  od_dbs_update+0xf0/0x174
[ 1990.451995]  dbs_work_handler+0x48/0x80
[ 1990.452006]  process_one_work+0x1e0/0x298
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[ 1990.452026]  kthread+0xf4/0x104
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```

Kernel log