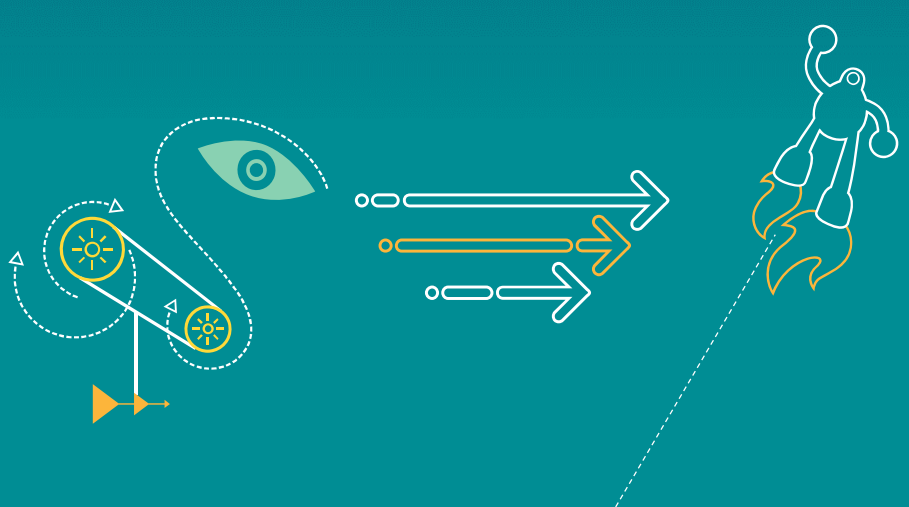
Idle XO Shutdown/VDD Minimization Overview

Qualcomm Technologies, Inc.



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Revision History

Revision	Date	Description
A	May 2015	Initial release

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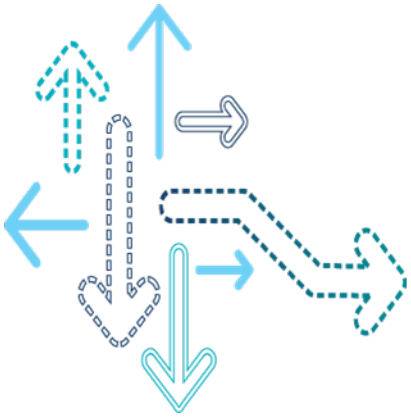
- Idle and Suspend
- GIC Interrupts vs. MPM Interrupts
- Linux IRQ Number vs. Hardware IRQ Number
- Idle XO Shutdown/VDD Minimization Debug
- Acronyms
- Questions?

Idle and Suspend



Idle and Suspend Differences

- Idle
  - No user activity
  - Display is on and static
  - Device is capable of entering XO shutdown/VDD minimization if the device is equipped with a smart panel
- Suspend
  - Triggered by specific operations, e.g., pressing the power key and the screen off timer expired
  - Display is off
  - Device is capable of entering XO shutdown/VDD minimization

Idle and Suspend Process Flow

Idle
- No user activity
- Static display
- Smart panel

Suspend
- Press power key
- Screen off timer expires

lpm_cpuidle_enter()

lpm_suspend_enter()

Notify RPM

XO shutdown/VDD minimization

Idle XO Shutdown Path – Check GIC/GPIO IRQs Prevent Sleep

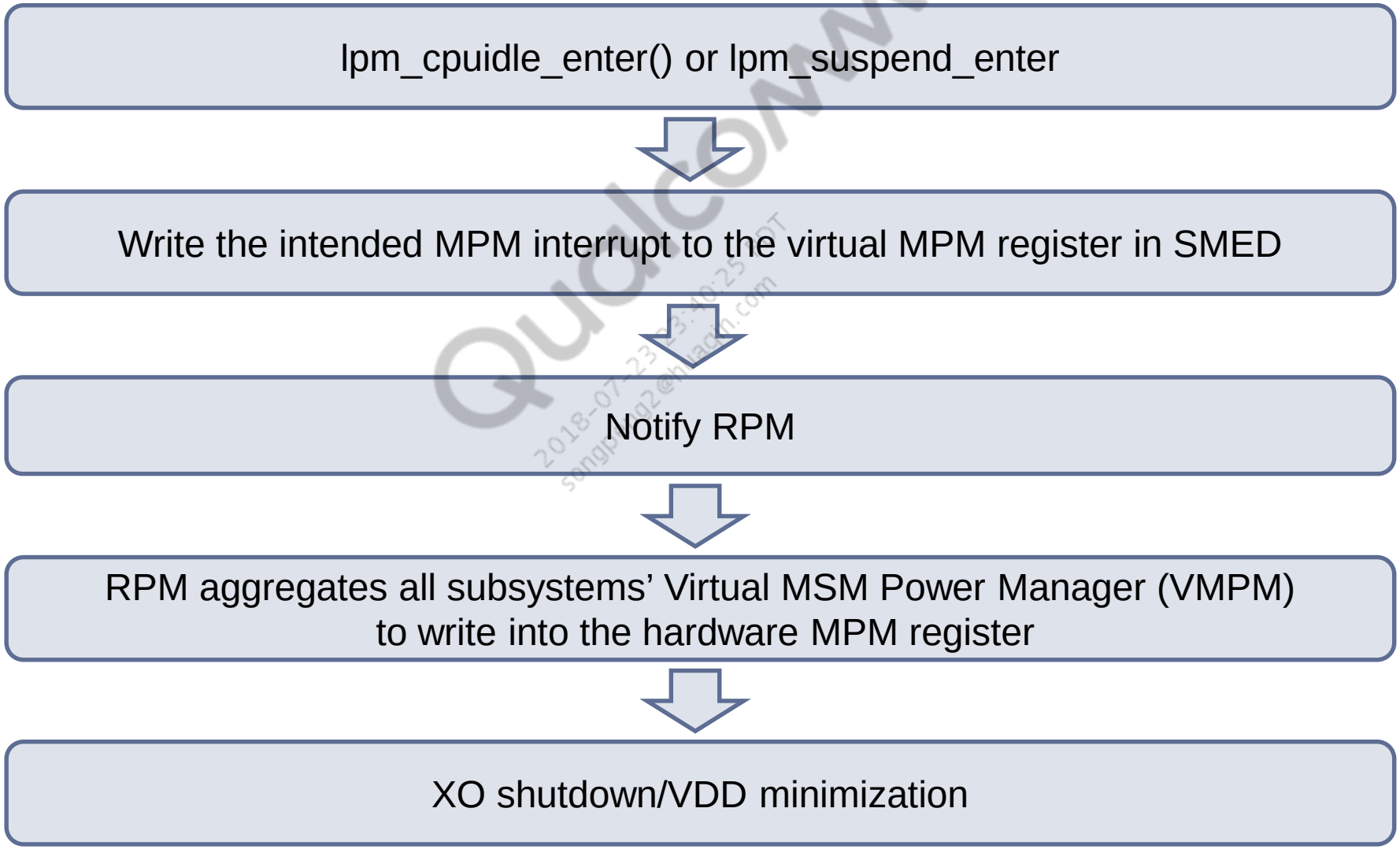
- No task runs
- CPU idle duration longer than sleep+resume latency

lpm_cpuidle_enter()

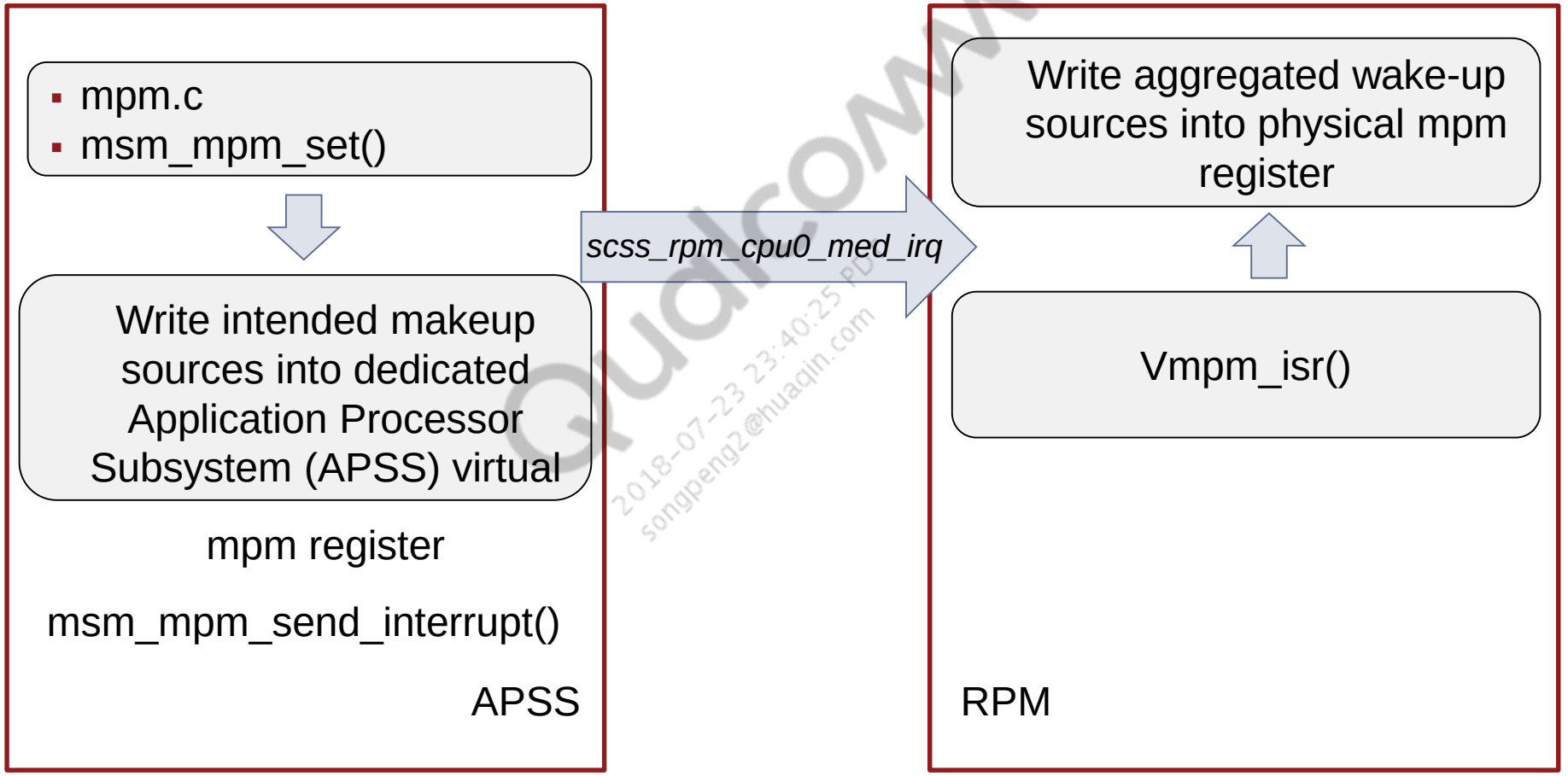
msm_mpm_interrupts_detectable()
- Device cannot enter XO shutdown/VDD minimization if:
  - Any GIC/GPIO IRQ is enabled
  - The enabled IRQ is not in the bypass list (defined in DTSI)

Notify RPM

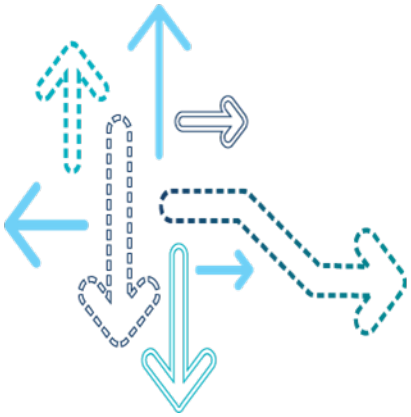
Handover MPM Configuration to RPM



Handover MPM Configuration to RPM (cont.)

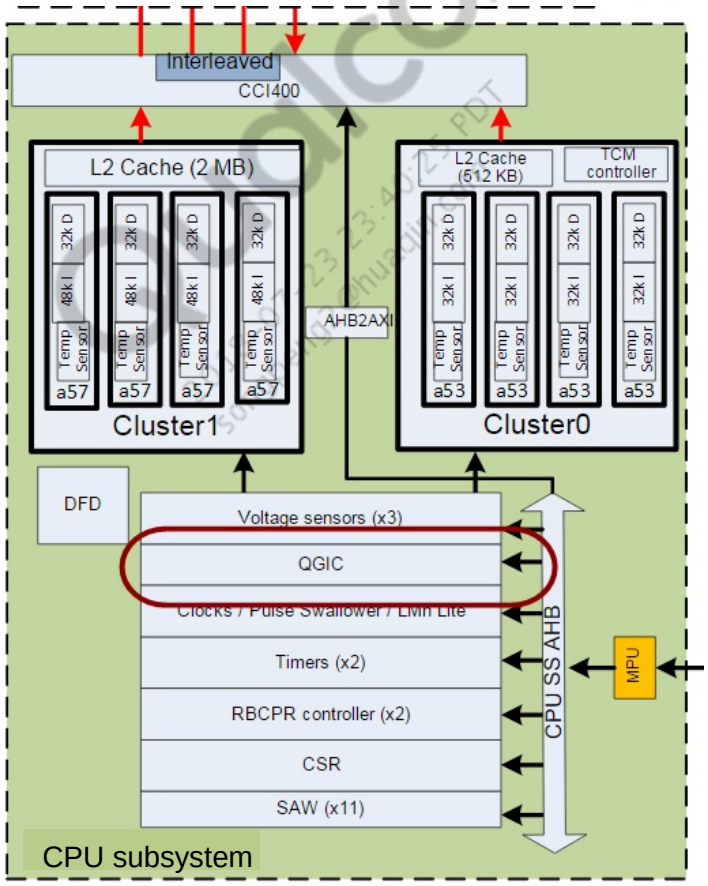


GIC Interrupts vs. MPM Interrupts



GIC Interrupts vs. MPM Interrupts

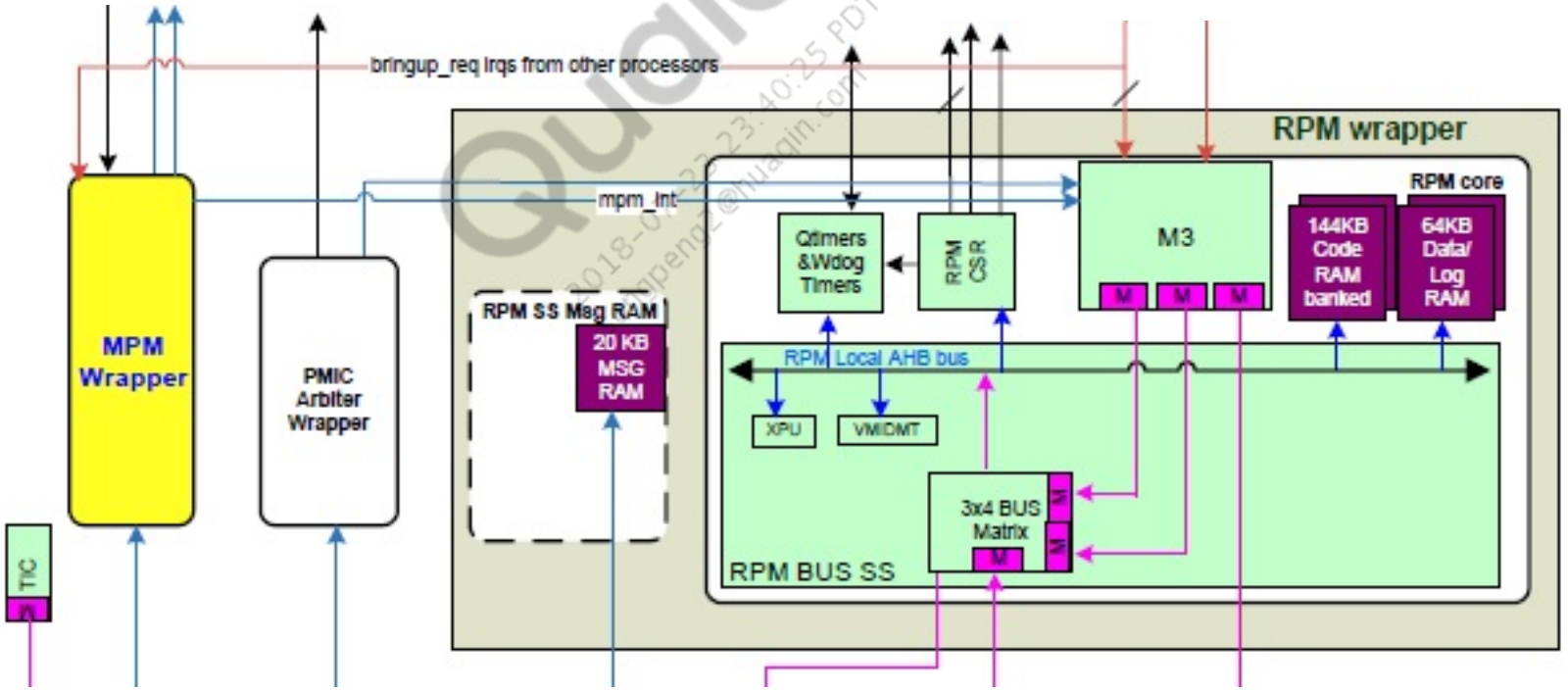
- GIC interrupts
  - Controlled by the APSS subsystem
  - Not capable of waking up the device from XO shutdown/VDD minimization



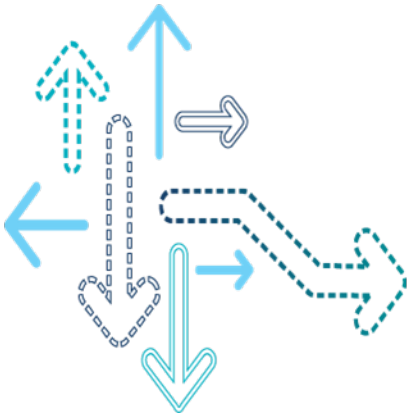
MSM8994 V2 Chip Block Diagram

GIC Interrupts vs. MPM Interrupts (cont.)

- MPM interrupts
  - Controlled by the RPM
  - Capable of waking up the device from XO shutdown/VDD minimization



Linux IRQ Number vs. Hardware IRQ Number



Linux IRQ Number vs. Hardware IRQ Number Device Tree

```
#interrupt-cells = <1>;
interrupt-map-mask = <0xffffffff>;
interrupt-map = <0 &intc 0 271 0
        1 &intc 0 272 0
        2 &intc 0 273 0
        3 &intc 0 274 0
        4 &intc 0 275 0
        5 &intc 0 276 0
        6 &intc 0 277 0
        7 &intc 0 278 0
        8 &intc 0 279 0
        9 &intc 0 280 0
        10 &intc 0 281 0
        11 &intc 0 282 0>;
                1 2 3
interrupt-names = "int_msi", "int_a"
```

- 1 – Interrupt type
  - 0 – SPI
  - 1 – PPI
- 2 – Interrupt number of interrupt type
- 3 – Trigger type
  - 1 – Low-to-high edge triggered
  - 2 – High-to-low edge triggered
  - 4 – Active high-level sensitive
  - 8 – Active low-level sensitive

hwirq = GIC_PPI_START/GIC_SPI_START + interrupt number

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ref: /LA.BR.1/kernel/arch/arm/mach-msm/include/mach/irqs.h

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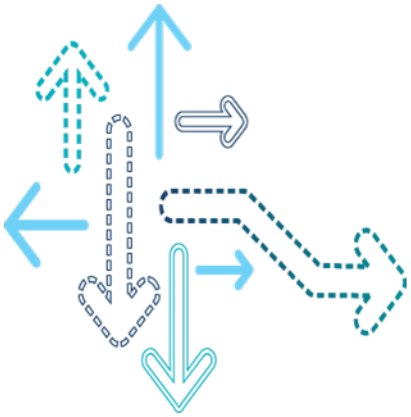
only in /LA.BR.1/kernel/arch/arm/mach-msm/include/mach/

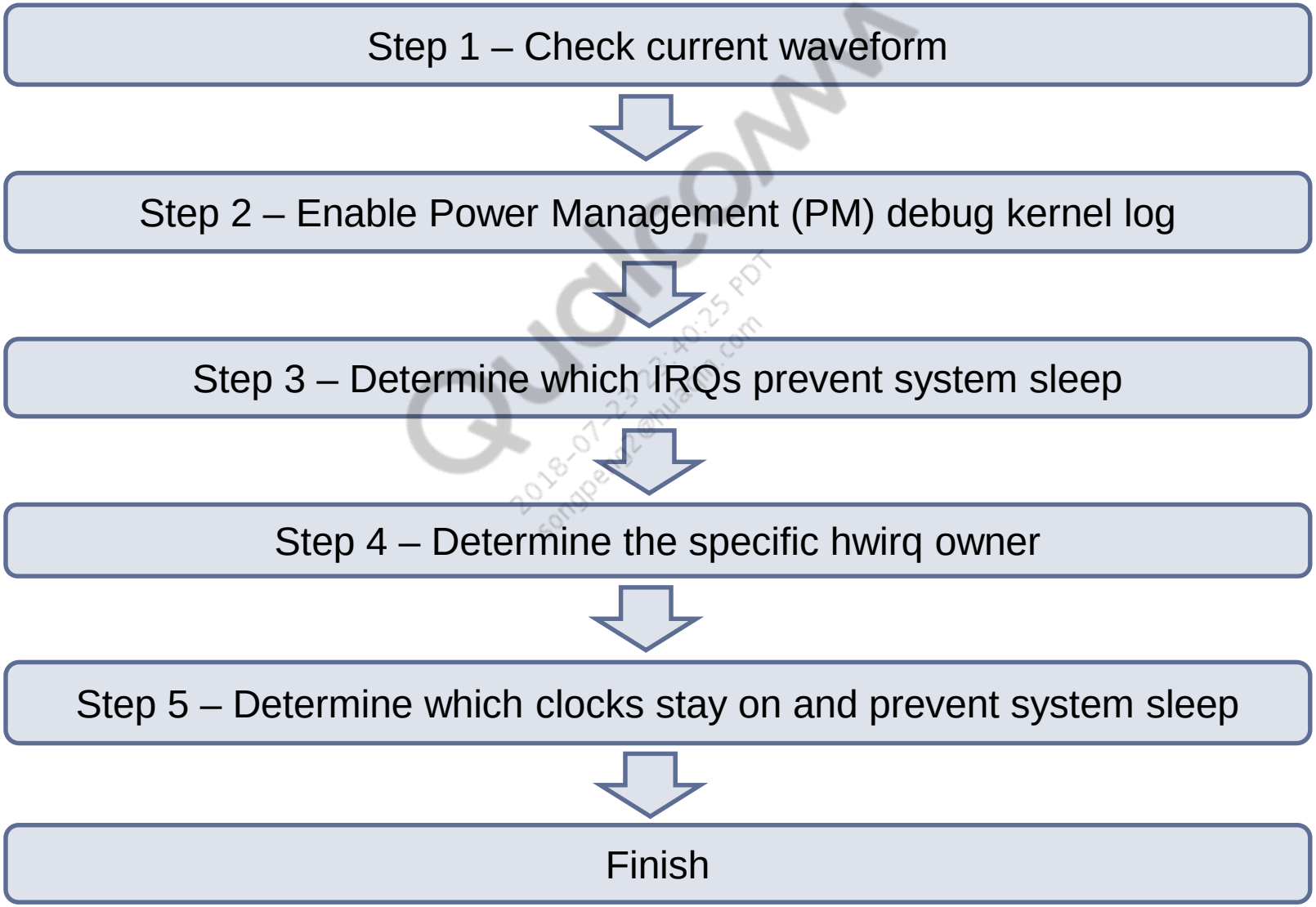
```
21  * 0-15:   STI/SGI (software triggered/generated interrupts)
22  * 16-31: PPI (private peripheral interrupts)
23  * 32+:   SPI (shared peripheral interrupts)
24  */
25 #define GIC_PPI_START 16
26 #define GIC_SPI_START 32
```

start index of PPI and SPI

Idle XO Shutdown/VDD Minimization Debug

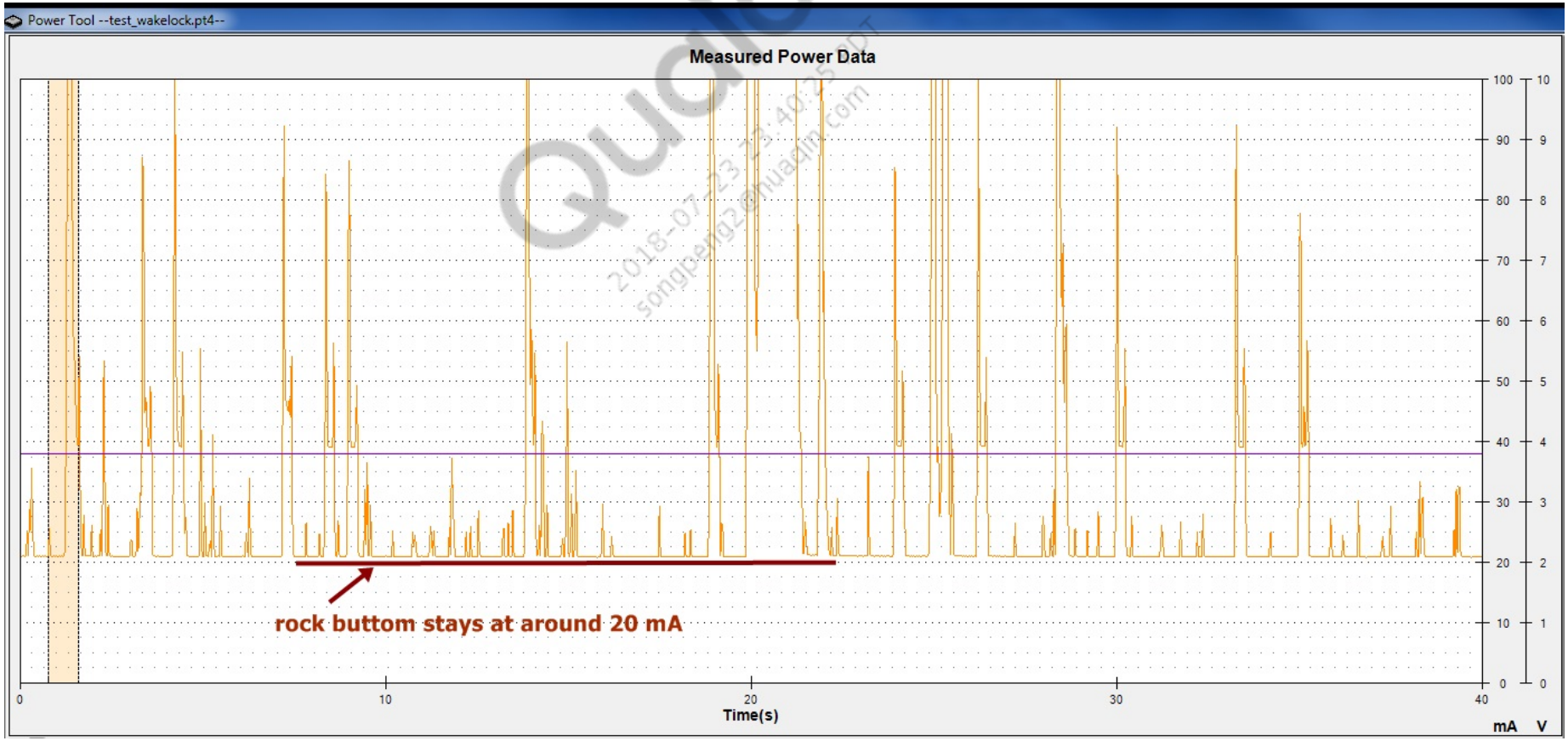


Handover MPM Configuration to RPM



Step 1 – Check Current Waveform

- Rock bottom of VDD minimization should be 2 mA to 3 mA.
- Rock bottom of static display fails if it stays at around 20 mA; this indicates that something negates the XO shutdown and VDD minimization.



Step 2 – Enable PM Debug Kernel Log

- echo 32 > /sys/module/msm_pm/parameters/debug_mask

```
enum {
     MSM_PM_DEBUG_SUSPEND = BIT(0),
     MSM_PM_DEBUG_POWER_COLLAPSE = BIT(1),
     MSM_PM_DEBUG_SUSPEND_LIMITS = BIT(2),
     MSM_PM_DEBUG_CLOCK = BIT(3),
     MSM_PM_DEBUG_RESET_VECTOR = BIT(4),
     MSM_PM_DEBUG_IDLE_CLK = BIT(5),
     MSM_PM_DEBUG_IDLE = BIT(6),
     MSM_PM_DEBUG_IDLE_LIMITS = BIT(7),
     MSM_PM_DEBUG_HOTPLUG = BIT(8),
     };
```

- echo 8 > /sys/module/mpm_of/parameters/debug_mask

```
enum {
     MSM_MPM_DEBUG_NON_DETECTABLE_IRQ = BIT(0),
     MSM_MPM_DEBUG_PENDING_IRQ = BIT(1),
     MSM_MPM_DEBUG_WRITE = BIT(2),
     MSM_MPM_DEBUG_NON_DETECTABLE_IRQ_IDLE = BIT(3),
     };
```


Step 3 – Determine Which IRQs Prevent System Sleep

- Log example

```
<6>[ 1695.567203] [0: kworker/u:0: 6] msm_mpm_interrupts_detectable(): gic
preventing system sleep modes during idle
<6>[ 1695.567252] [0: kworker/u:0: 6] hwirq: 65 -> kgsl-3d0
<6>[ 1695.567277] [0: kworker/u:0: 6] hwirq: 157 -> mmc1
<6>[ 1695.567303] [0: kworker/u:0: 6] hwirq: 159 -> mmc2
<6>[ 1695.567328] [0: kworker/u:0: 6] hwirq: 253 -> msm_sdcc.2
<6>[ 1695.567354] [0: kworker/u:0: 6] hwirq: 256 -> msm_sdcc.3
```

- Analysis – Search hwirq to determine which IRQs prevent system sleep
- Solution 1 – Drivers should disable the IRQ if it is *not* required
- Solution 2 – Add the IRQ to the bypass list in DTSI

```
qcom,gic-parent = <&intc>;
qcom,gic-map = <2 216>, /* tsens_upper_lower_int */
               <47 165>, /* usb30_hs_phy_irq */
               <50 172>, /* usb1_hs_async_wakeup_irq */
                <53 104>, /* mdss_irq */
                <62 222>, /* ee0_krait_hlos_spmi_periph_irq */
                <0xff 57>,  /* mss_to_apps_irq(0) */
                <0xff 58>,  /* mss_to_apps_irq(1) */
                <0xff 59>,  /* mss_to_apps_irq(2) */
```

Step 4 – Determine the Specific hwirq Owner

- Cat/proc/interrupt

```
270:          2          0          0          0       GIC  sps
273:          0          0          0          0       GIC  msm_iommu_nonsecure_irq
274:          0          0          0          0       GIC  msm_iommu_nonsecure_irq
280:          0          0          0          0       GIC  mobicore
288:          6          0          0          0       qpnp-int  qpnp_kpdpwr_status
```

- Determine which function enables the specific IRQ that causes sleep fail

```
--- a/arch/arm/mach-msm/mpm-of.c
+++ b/arch/arm/mach-msm/mpm-of.c
@@ -252,6 +252,11 @@ static int msm_mpm_enable_irq_exclusive(
irq_apps = wakeset ? unlisted_irqs[i].wakeup_irqs :
unlisted_irqs[i].enabled_irqs;

+ if (d->hwirq == 280 && enable) {
+ pr_err ("!!!hwirq 280 registered, wakeset %d\n", wakeset);
+ dump_stack();
+ }
+
if (enable)
  __set_bit(d->hwirq, irq_apps);
  else
```


Step 4 – Determine the Specific hwirq Owner (cont.)

- Dump result sample

```
[<c017ccd8>] msm_mpm_enable_irq_exclusive+0x164
[<c017cdcc>] __msm_mpm_enable_irq+0x38
[<c0115600>] gic_unmask_irq+0x38
[<c01f6fb8>] irq_enable+0x28
[<c01f59f4>] __enable_irq+0x9c
[<c01f5a78>] enable_irq+0x60
[<c05a5258>] qup_i2c_xfer+0x28c
[<c05a0ea0>] i2c_transfer+0xb8
[<c05948c4>] gtp_i2c_read+0x60
```

Step 5 – Determine Which Clocks Stay On and Prevent System Sleep

- Log example

```
<6>[ 1353.995631] c0 0 Enabled clock count: 32
<6>[ 1353.996721] c0 0 Enabled clocks:
<6>[ 1353.996731] c0 0 cxo_clk_src:1:1 [19200000]
<6>[ 1353.996743] c0 0 pnoc_clk:1:1 [9600000]
<6>[ 1353.996756] c0 0 pnoc_a_clk:1:1 [19200000]
<6>[ 1353.996767] c0 0 bimc_clk:1:1 [9600000]
<6>[ 1353.996778] c0 0 bimc_a_clk:1:1 [459931648]
<6>[ 1353.996789] c0 0 snoc_clk:1:1 [9600000]
<6>[ 1353.996799] c0 0 snoc_a_clk:1:1 [100000000]
<6>[ 1353.996812] c0 0 bimc_msmbus_clk:1:1 [9600000] -> bimc_clk:1:1 [9600000]
```

- Search “Enabled clocks” to determine which clocks prevent XO shutdown and VDD minimization
- The serial console is enabled by default in the engineering build; if the engineering build causes an idle XO shutdown fail, disable the serial console to fix it

```
kernel/arch/arm/configs/msm8994_defconfig
#CONFIG_SERIAL_MSM_HSL=y
#CONFIG_SERIAL_MSM_HSL_CONSOLE=y
```

Acronyms

Acronyms	
Term	**Definition**
hwirq	Hardware Interrupt Request
PM	Power Management
VMPM	Virtual MSM Power Manager

Questions?

https://support.cdmatech.com