Introduction to Qualcomm Specific Debugging Features

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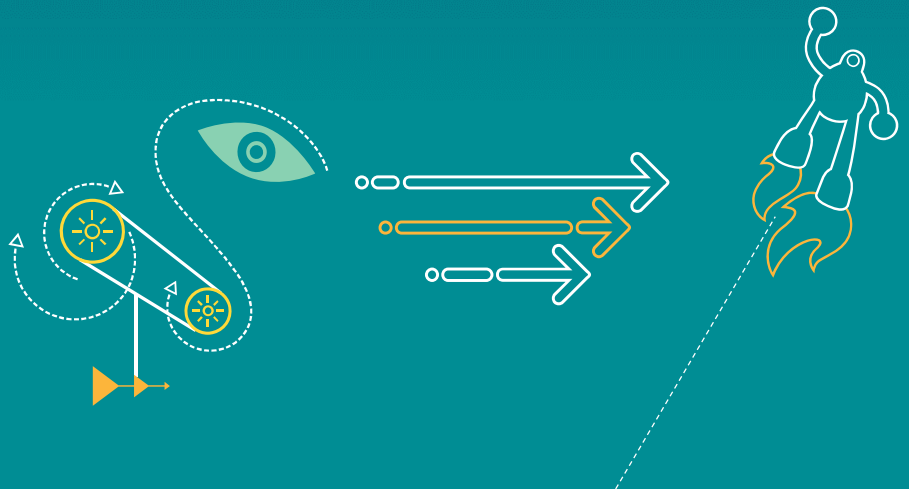

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Revision History

Revision	Date	Description
A	July 2016	Initial release

Contents

Introduction

- This presentation provides an overview of Qualcomm-specific debugging features, and is intended to be used by software engineers who are debugging stability issues.

RTB Log

- RTB log is used to log different events to a small non-cached region, and aids to debug reset issues where caches may not be properly flushed before the target resets
- Enable RTB log
  - CONFIG_MSM_RTB=y
  - CONFIG_MSM_RTB_SEPARATE_CPUS=y
  - Set msm_rtb.enabled and msm_rtb.filter in BOARD_KERNEL_CMDLINE, or change their settings in /sys/module/msm_rtb/parameters when runtime.
- Select RTB log filters
  - See following slides; also see msm_rtb.h to know how bits are mapped to events
- Get RTB logs
  - QCAP reports , or Linux Ramdump parser reports

RTB Log (cont.)

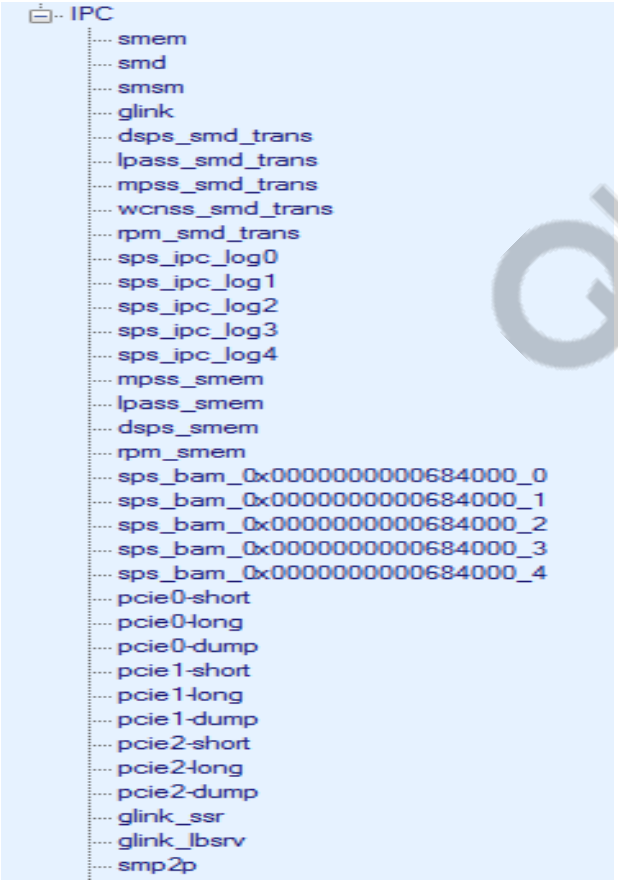
- What can be seen from RTB log
  - Timestamp is aligned to dmesg log
  - I/O memory access: LOGK_READL/WRITEL
    - Function calls into I/O memory access primitives defined in arch/arm64/include/asm/io.h
  - Context switching: LOGK_CTXID
    - Record logs before actual thread switching in switch_to()
  - IRQ happens: LOGK_IRQ
    - Record HWIRQ number read from GIC IAR
  - CPU hotplug: LOGK_HOTPLUG
    - Records logs when
      - CPU_STARTING (CPU will be running soon)
      - CPU_DYING (CPU will not be running any tasks or handling any interrupts, and will soon die)
  - L2 register read/write: LOGK_L2CPWRITE/LOGK_L2CPREAD
    - Records the register address to be accessed.

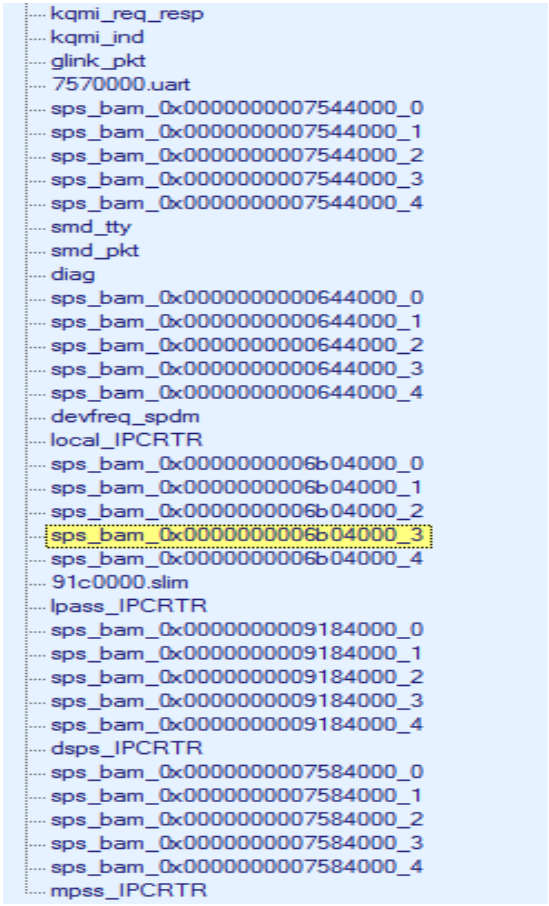
IPC Log

- IPC log consists of MSM-specific kernel log buffers, which are initially used for interprocessor communications (IPC) modules, and applied to some other modules, like PCIe
  - A similar buffer as kernel printk; it has a head structure for each record
- Enable IPC log
  - CONFIG_IPC_LOGGING
- Get IPC log
  - QCAP reports
  - Type the following command in adb shell:
    - cat /d/ipc_logging/*/log_con &

IPC Log (cont.)

- What can be seen from IPC log
  - Timestamp is aligned to dmesg log/ RTB log
  - General logs from following drivers, like smd/smem/smsm/glink/rpm_smd/sps



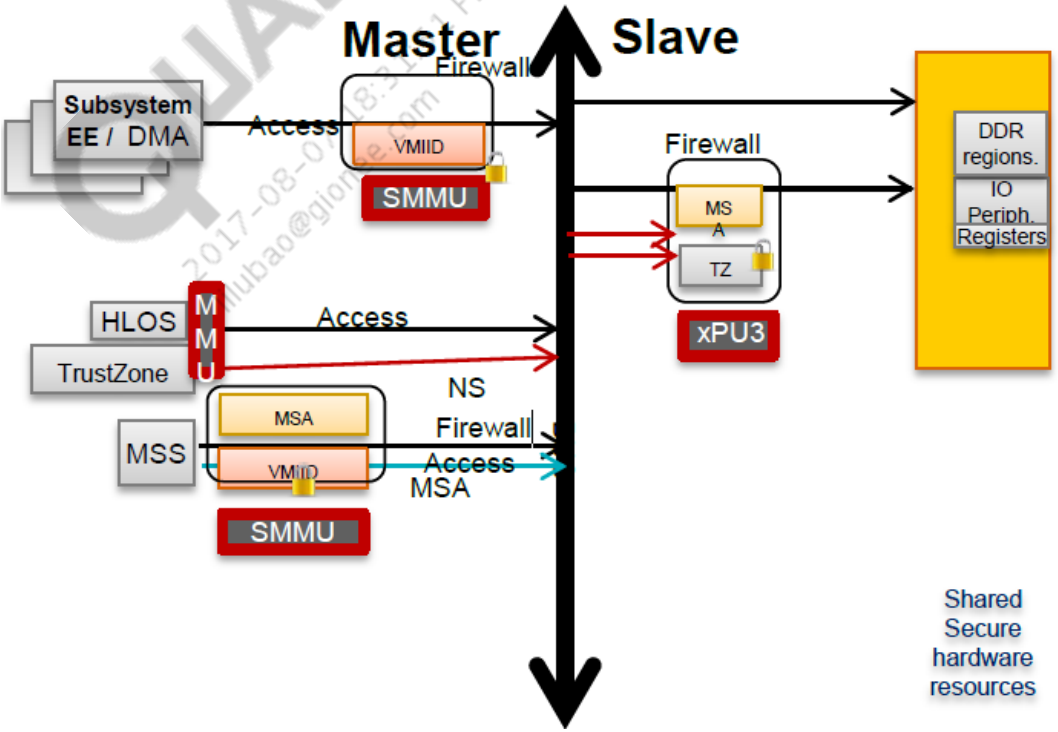


TZBSP Diag Buffer

- TZBSP diag buffer is a circular buffer saved in IMEM, logged by TZBSP
- Enable TZBSP
  - Enabled by default
- Get TZBSP diag log
  - QCAP report -- From crash dump
  - Cat /d/tzdbg/log -- During runtime
- Source code from both TZ side and HLOS side
- What can be seen from TZBSP diag buffer
  - SMMU failure, XPU violation (QuAC, Qualcomm Access Control)
  - NOC error
  - Non-secure dog bite
  - Secure dog triggered from non-secure world (from Hypervisor)

Qualcomm Access Control (QuAC)

- Inside the SoC, if one master wants to access certain slaves
  - SMMU unit checks the access permission for any memory access
  - xPUs are present at the slave sides; also controls the access using VMID generated by the master



NOC Error

- Inside the SoC, if one master was trying to access non-clock registers, or accessing DDR that had been in a bad or self-refresh state, an NOC error would be generated (see following example)

  - **TZ diag log:**

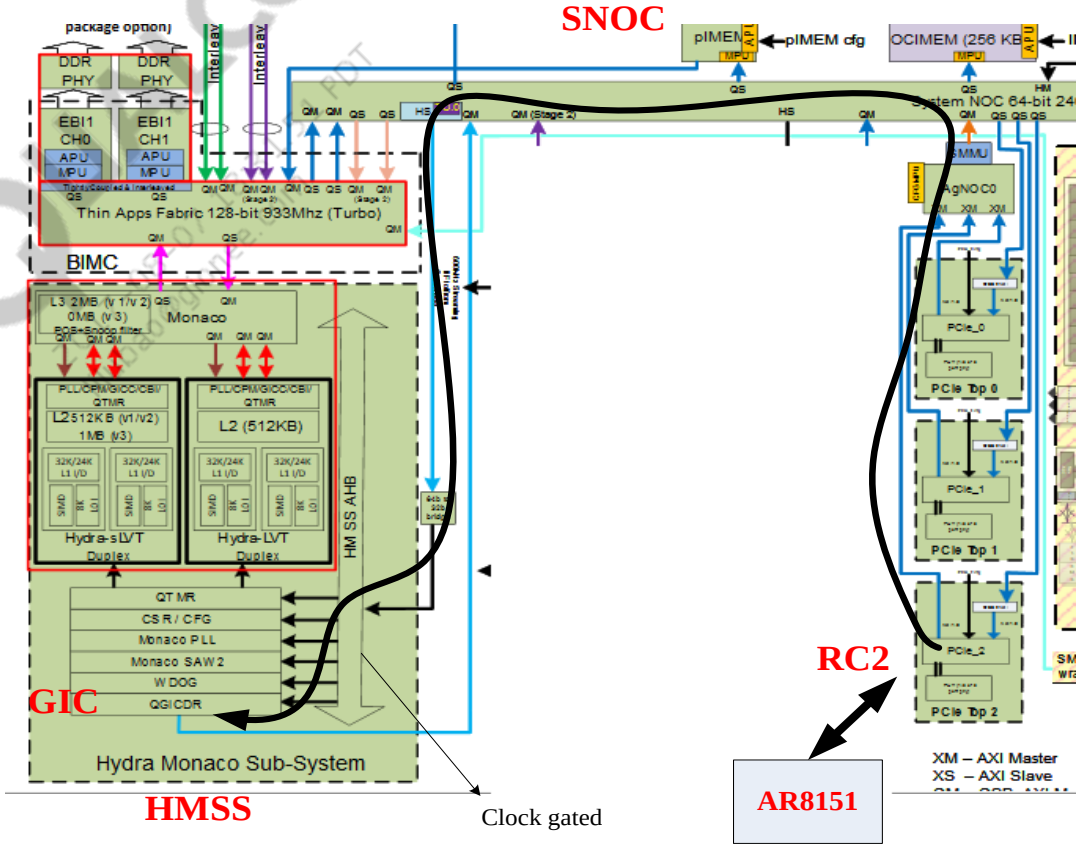
    Target = 8996v3
    NoC = SNOC
    ERRLOG0 = 0x80030308
    ERRLOG1 = 0x84054001
    ERRLOG2 = 0x0
    ERRLOG3 = 0x3d0040
    ERRLOG4 = 0x0

  - **Decoded logs :**

    opcode = 0x4 = Write
    errcode = **0x3 = Unclocked access**

    InitFlow = 0x4 = qxm_aggr0_noc
    TargFlow = 0x4 = qhs0_hmss_0
    BID = 0x5
    PID = 0x2
    MID = 0x0
    BID/PID/MID = ANOC0 PCIE 2

    Address offset = 0x003d0040
    Address base = 0x09800000
    Address = **0x09bd0040**



Non-Secure Dog Bite

- Case #1: Linux kernel ought to pet dog periodically, but if it fails, dog bark (IRQ) occurs; if kernel is able to handle the IRQ, kernel intentionally triggers non-secure dog bite
  - Kernel prints when last pet happens and current time
  - Pet/bark time is configurable in device tree

- Case #2: If kernel is not able to handle dog bark IRQ in time, dog would automatically bite (FIQ); TZ would service it and save the context
  - TZ log says non-secure dog bite happens

Note: All non-secure dog bites would finally trigger secure dog bite, because always relying on secure dog bite to reset chip

Secure Dog Bite

- Case #3: If a Hypervisor runs into fatal errors, it can make SMC call and trigger secure dog bite
  - Hyp log identifies the fatal error type
  - TZ log states that secure dog triggered from non-secure world

- Case #4: After entering TZ, TZ pets secure dog when it barks, but if TZ fails to do so, secure dog biting finally happens and chip resets
  - There is no useful log from TZ diag log
  - Time when bark/bite happens for secure dog is also configurable
    - See Oem_config.xml: OEM_sec_wdog_bark_time, OEM_sec_wdog_bite_time.

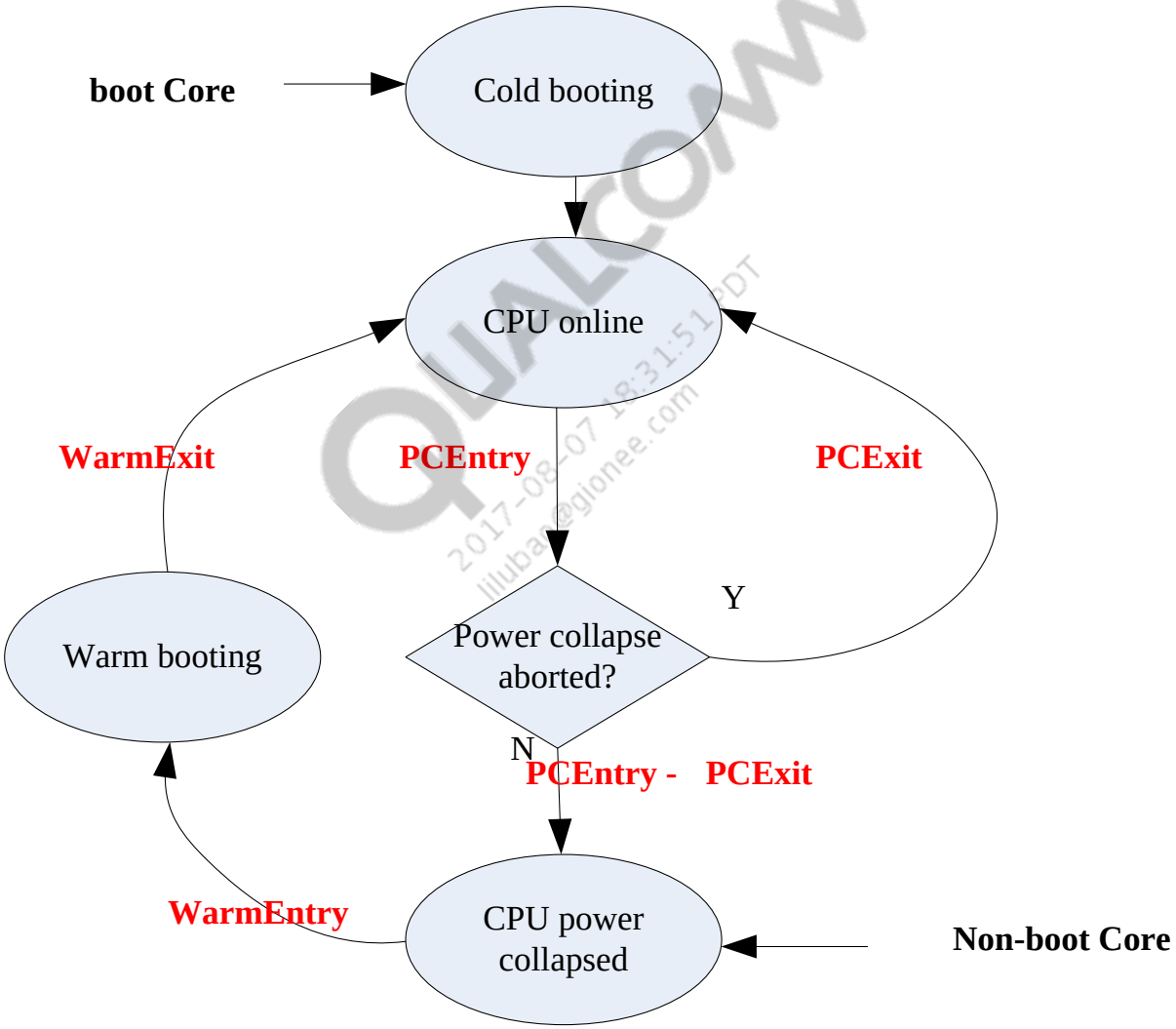
TZ Counters

- TZ counters are saved in IMEM, and increased when cores entering and exiting power collapse
- TZ counters are in QCAP logs

Boot Status / TZ Counter

CPU	WarmEntry	WarmExit	PCEntry	PCExit	Warm JumpAddr	JumpInstr	PSCIEntry	PSCIExit
0	0x00B7257C	0x00B7257C	0x00CC43C6	0x00151E4A	0x0000000000000000	0x00000000	0x00CD59B2	0x00163436
1	0x0098D42D	0x0098D42D	0x00A7AC4C	0x000ED820	0x0000000000000000	0x00000000	0x00A84FCD	0x000F7BA1
2	0x00868808	0x00868808	0x00931EDA	0x000C96D2	0x0000000000000000	0x00000000	0x00937E06	0x000CF5FE
3	0x007C500F	0x007C500F	0x0086DFCC	0x000A8FBD	0x0000000000000000	0x00000000	0x00872884	0x000AD875
4	0x0037E9CC	0x0037E9CC	0x0086C318	0x004ED94D	0x0000000000000000	0x00000000	0x00877C4A	0x004F927F
5	0x00034AC9	0x00034AC9	0x00041C34	0x0000D16B	0x0000000000000000	0x00000000	0x0004307A	0x0000E5B1
6	0x000046A0	0x000046A0	0x0000529D	0x00000BFD	0x0000000000000000	0x00000000	0x0000534B	0x00000CAB
7	0x00003AF4	0x00003AF4	0x000044D9	0x000009E5	0x0000000000000000	0x00000000	0x0000455D	0x00000A69

CPU State Machine and TZ counters



How to Check TZ Counters

- What can be learned from TZ counters
  - Core may be stuck in warm boot
    - If WarmEntry = WarmExit counter, then it enters and exits TZ the same number of times; if there is a mismatch, the core is still in TZ
  - Core may be stuck in power collapse
    - For boot core , if PCEntry - (PCExit +WarmEntry) = 0 , then the core is online; if PCEntry - (PCExit+WarmEntry) = 1 , core 0 is power collapsed
    - For non-boot core , if PCEntry - (PCExit+ (WarmEntry-1)) = 0, the core is online;

      [For non-boot cores, their first powering up is implemented as a warm boot]

boot core (logical core0)	warmEntry = WarmExit	PCEntry - (PCExit +WarmEntry) = 0	Not stuck in warm boot, core online
		PCEntry - (PCExit+WarmEntry) = 1	Not stuck in warm boot, core power collapsed
	warmEntry = WarmExit+1	no need to check	stuck in warm boot
non-boot core	WarmEntry = WarmExit	PCEntry - (PCExit+ (WarmEntry-1)) = 0	Not stuck in warm boot, core online
		PCEntry -(PCExit+(WarmEntry-1)) = 1	Not stuck in warm boot, core power collapsed
	warmEntry = WarmExit+1	no need to check	stuck in warm boot

RPM Log

- RPM log is a circular buffer saved in DataRAM, logged by RPM subsystem in ULog format
- Get RPM log
  - QCAP report -- From crash dump
  - Hansei

    rpm_proc\core\bsp\rpm\scripts\hansei\
    - See 80-NA157-9 for usage
- What can be seen from RPM log
  - RPM fatal error, caused by APPS NON SECURE WD BITE
  - RPM fatal error, caused by other reasons
  - If device is entering vdd-min or exiting vdd-min when crash happens

Note: To know whether AP cores are offline, RPM dump needs to be loaded via T32 simulator

rpm.ees[master_id].subsystem_status

References

Title	Number
Qualcomm Technologies, Inc.	
RPM Debug Overview	80-NA157-9

Acronym or term	Definition
ITC	interprocessor communications
NOC	Network On a Chip
RTB	Register Trace Buffer
RPM	Remote Power Manager
SoC	System on Chip
TZBSP	TrustZone Boot Services Platform

Questions?

https://createpoint.qti.qualcomm.com