Arm® SBSA Architecture Compliance

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User Guide

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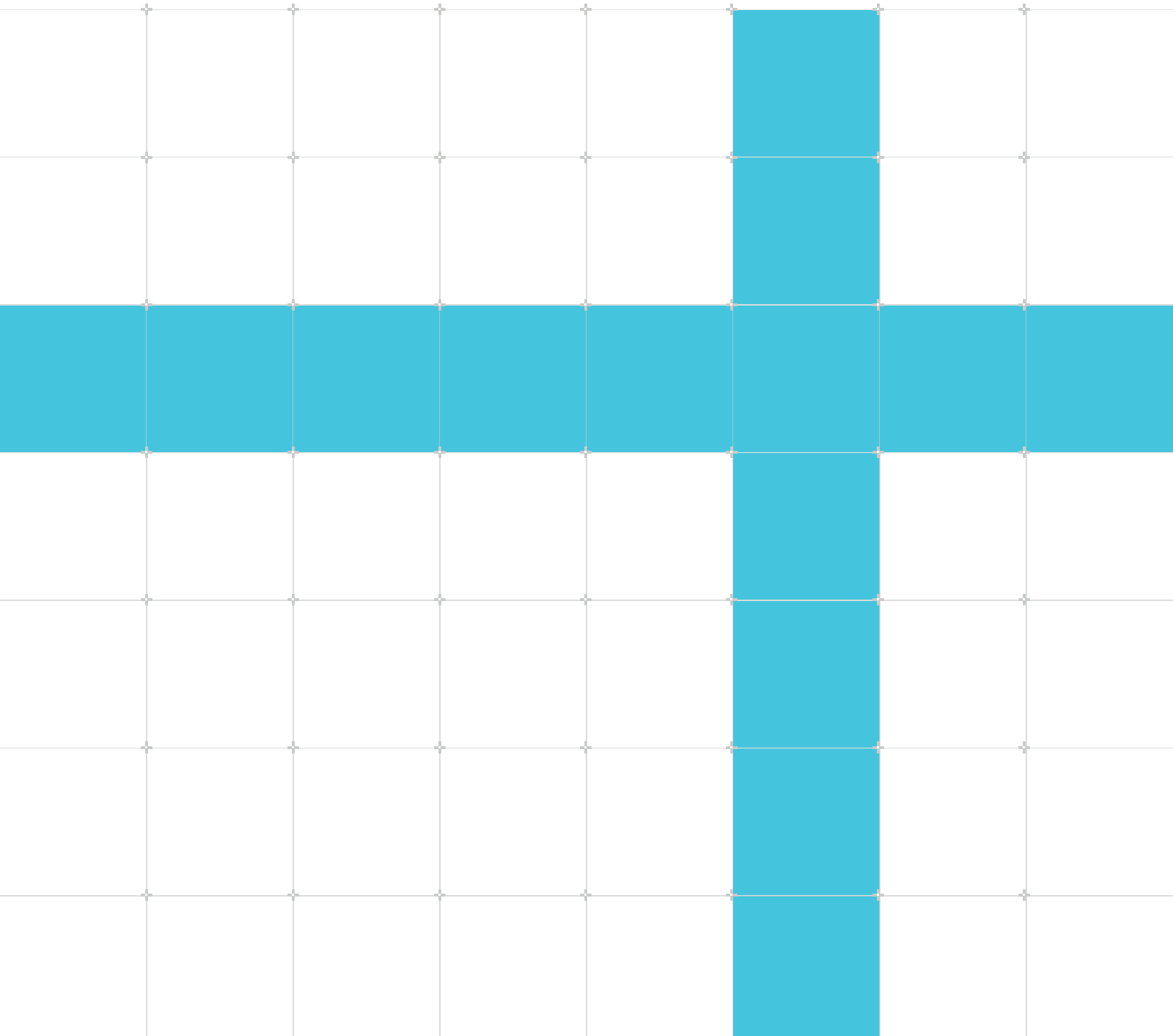

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User Guide

Release Information

Document history

Issue	Date	Confidentiality	Change
A	30 November 2016	Non-Confidential	Alpha release
B	31 March 2017	Non-Confidential	Beta release
C	13 July 2017	Non-Confidential	REL 1.0
D	11 May 2018	Non-Confidential	REL 2.0
0200-01	27 December 2018	Non-Confidential	REL 2.1. The document now follows a new numbering format.
0200-02	26 April 2019	Non-Confidential	REL 2.2
0200-03	18 September 2019	Non-Confidential	REL 2.3
0200-04	20 March 2020	Non-Confidential	REL 2.4
0300-01	30 September 2020	Non-Confidential	REL 3.0
0301-01	27 September 2021	Non-Confidential	REL 3.1
0302-01	26 July 2022	Non-Confidential	REL 3.2

Proprietary Notice

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1. Introduction

1.1 Conventions

The following subsections describe conventions used in Arm documents.

Glossary

The Arm® Glossary is a list of terms used in Arm documentation, together with definitions for those terms. The Arm Glossary does not contain terms that are industry standard unless the Arm meaning differs from the generally accepted meaning.

See the Arm Glossary for more information: developer.arm.com/glossary.

Typographic conventions

Convention	Use
italic	Citations.
bold	Highlights interface elements, such as menu names. Also used for terms in descriptive lists, where appropriate.
`monospace`	Denotes text that you can enter at the keyboard, such as commands, file and program names, and source code.
`monospace`	Denotes a permitted abbreviation for a command or option. You can enter the underlined text instead of the full command or option name.
`monospace italic`	Denotes arguments to monospace text where the argument is to be replaced by a specific value.
`<and>`	Encloses replaceable terms for assembler syntax where they appear in code or code fragments. For example: `MRC p15, 0, <Rd>, <CRn>, <CRm>, <Opcode_2>`
SMALL CAPITALS	Used in body text for a few terms that have specific technical meanings, that are defined in the *Arm® Glossary*. For example, **IMPLEMENTATION DEFINED**, **IMPLEMENTATION SPECIFIC**, **UNKNOWN**, and **UNPREDICTABLE**.

1.2 Additional reading

This document contains information that is specific to this product. See the following documents for other relevant information:

Table 1-2: Arm publications

Document name	Document ID	Licensee only
Arm® Server Base System Architecture 7.0	DEN-0029F	No

Document name	Document ID	Licensee only
Arm® Architecture Reference Manual ARMv8, for Armv8-A architecture profile	DDI 0487G.b (ID072021)	No
Arm® Generic Interrupt Controller Architecture Specification for GIC architecture version 3.0 and version 4.0	IHI 0069C (ID070116)	No
GICv3 and GICv4 Software Overview	DAI 0492	No


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1.3 Other information

See the Arm® website for other relevant information.

- Arm® Developer.
- Arm® Documentation.
- Technical Support.
- Arm® Glossary.

Contents

2. Introduction

This chapter provides an overview of the SBSA tests and the test IDs.

2.1 Abbreviations

This section lists the abbreviations used in this document.

Table 2-1: Abbreviations and expansions

Abbreviation	Expansion
ACPI	Advanced Configuration and Power Interface
DT	Device Tree
GIC	Generic Interrupt Controller
IOMMU	Input-Output Memory Management Unit
PAL	Platform Abstraction Layer
PCIe	Peripheral Component Interconnect express
PE	Processing Element
RCiEP	Root Complex integrated End Point
SATA	Serial Advanced Technology Attachment
SBSA	Server Base System Architecture
SMC	Secure Monitor Call
SMMU	System Memory Management Unit
UEFI	Unified Extensible Firmware Interface

2.2 Overview of tests

The following table describes the general divisions of Server Base System Architecture (SBSA) tests between Unified Extensible Firmware Interface (UEFI) shell application, Linux application, and Bare-metal.

Table 2-2: Test environment and modules

Test environment	Modules
UEFI Shell	PE, GIC, Timers, Watchdog, Wakeup, PCIe, NIST, Peripherals, SMMU
Linux command line	PCIe, SMMU, Exerciser
Bare-metal	Exerciser

2.3 Test IDs

Each test ID is generated as an addition of module ID and unit test ID. For a given module, unit test ID begins from 1.

The following table lists the module names and their IDs.

Table 2-3: Module names and module IDs

Module name	Module ID
PE	0
GIC	100
Timer	200
Watchdog	300
PCIe	400
Power and Wakeup	500
Peripheral	600
SMMU	700
Exerciser	800
NIST	1000

3. UEFI shell application

This chapter provides information on executing tests from the UEFI Shell application and its PAL API implementation.

3.1 UEFI application arguments

Run the UEFI Shell application with the following set of arguments:

```
uefi shell> sbsa.efi [-v <n>] [-l <n>] [-skip <x,y,z>] [-f <file name>] [-s] [-p
 <n>] [-nist] [-mmio] [-p2p] [-cache]
```

The following table provides descriptions to the arguments.

Table 3-1: Descriptions of UEFI application arguments

Argument	Description
-v	Print level **1** INFO and above. **2** DEBUG and above. **3** TEST and above. **4** WARN and ERROR. **5** ERROR. **Note:** For print level 1, mmio read, write, and prints can be enabled for a specefic module by using module id. For example, -v11 enables for GIC module, and -v10 enables for PE module.
-l	Level of compliance to be tested for (0-6). The default value is 4.
-skip	Overrides the suite to skip the execution of a particular test. It allows a maximum of three values (comma-separated). For example, 300 skips test case with ID = 300. 500 skips all tests in module with ID = 500. For details on module IDs, see 2.3 Test IDs on page 9.
-f	File name to which the output log is written.
-s	Runs Secure tests before executing Non-secure tests. It requires Secure firmware code from SBSA ACS to be ported to EL3 FW. If this option is not provided, only Non-secure tests are run.
-p	Enables or disables the execution of SBSA v6.0 PCIe compliance tests (RCiEP rules). Allowed values for `<n>` are 0 and 1, where 1 enables the PCIe tests and 0 disables it. **Note:** • If this option is not provided, SBSA v6.0 PCIe (RCiEP rules) tests are not run. • If `-l` has a value of 4 and above, these tests are always run.

Argument	Description
-nist	Runs the SBSA ACS with NIST STS.
-mmio	Enables all the mmio read/write prints.
-p2p	Enables p2p feature support.
-cache	Enables cache support.


Note

- The UEFI session becomes unusable after the SBSA tests are run and the test results are printed on the UEFI console.
- The UEFI Shell application is enhanced to accept an additional argument `[-p <n>]` for PCIe. This is to enable optionally running SBSA v6.0 PCIe tests even when the other tests run at older levels. For example, you can optionally run SBSA v6.0 PCIe tests even when running other SBSA tests at level 3.

Example

```
shell> sbsa.efi -v 2 -l 3 -skip 20,36 -f acs.txt -p 1
```

The set of parameters shown in the code block:

- Prints messages with verbosity of 2 and above.
- Tests for compliance against SBSA level 3 for other tests and runs SBSA v6.0 PCIe (RCiEP rules) tests.
- Skips execution of all tests belonging to GIC module and test number 36.
- Stores the log messages to the file `acs.txt`.

3.2 UEFI implementation of PAL APIs

This section provides information on infrastructure APIs and module-specific APIs.

Infrastructure APIs

The following table describes the Platform Abstraction Layer (PAL) APIs and UEFI interfaces.

Table 3-2: PAL APIs and UEFI interfaces

PAL API	UEFI interfaces
pal_print	AsciiPrint
mem_alloc	gBS->AllocatePool
mem_free	gBS->FreePool
mem_alloc_shared	gBS->AllocatePool
mem_free_shared	gBS->FreePool
mem_get_shared_addr	None
mmio_read	None
mmio_write	None

Module-specific APIs

The following table represents the mapping of PAL API to Advanced Configuration and Power Interface (ACPI), if the system firmware presents platform configuration through ACPI tables.

Table 3-3: PAL APIs, UEFI interfaces, and ACPI tables consumed

PAL API	UEFI interfaces consumed	ACPI table consumed
pe_create_info_table	• gST->ConfigurationTable • CompareGuid • IndustryStandard/Acpi61.h	MADT Table
call_smc	-	-
pe_execute_payload	-	-
pe_install_esr	• gEfiCpuArchProtocolGuid • Cpu->RegisterInterruptHandler	-
gic_create_info_table	• gST->ConfigurationTable • CompareGuid • IndustryStandard/Acpi61.h	MADT table
gic_install_isr	• gHardwareInterruptProtocolGuid • RegisterInterruptSource • EnableInterruptSource	-
timer_create_info_table	• gST->ConfigurationTable • CompareGuid • IndustryStandard/Acpi61.h	GTDT table
wd_create_info_table	• gST->ConfigurationTable • CompareGuid • IndustryStandard/Acpi61.h	GTDT table
pcie_create_info_table	• gST->ConfigurationTable • CompareGuid • IndustryStandard/Acpi61.h	MCFG table
pcie_get_mcfg_ecam	• gST->ConfigurationTable • CompareGuid, IndustryStandard/Acpi61.h • IndustryStandard/ MemoryMappedConfigurationSpaceAccessTable.h	MCFG table
iovirt_create_info_table	• gST->ConfigurationTable • CompareGuid • IndustryStandard/Acpi61.h	IORT table
peripheral_create_info_table	• gEfiPciIoProtocolGuid • Pci->GetLocation • Pci->Pci.Read	-
memory_create_info_table	gBS->GetMemoryMap	-

4. Linux application

This chapter provides information on executing tests from the Linux application.

4.1 Linux application arguments

Run the Linux application with the following set of arguments:

```
shell> sbsa [--v <n>] [--l <n>] [--skip <x,y,z>]
```

Table 4-1: Description of Linux application arguments

Argument	Description
v	Print level **1** INFO and above **2** DEBUG and above **3** TEST and above **4** WARN and ERROR **5** ERROR
l	Level of compliance to be tested for. (0 to 6)
skip	Overrides the suite to skip the execution of a particular test. For example, 53 skips test case with ID 53.

Example

```
shell> sbsa --v 3 --l 3 --skip 57
```

This set of parameters tests for compliance against SBSA level 3 with print verbosity set to 3, and skips test number 57.

Loading the kernel module

Before the SBSA ACS Linux application is run, load the SBSA ACS kernel module using the insmod command.

```
shell> insmod sbsa_acs.ko
```

4.2 Build steps and environment setup

This section lists the porting and build steps for the kernel module.

The patch for the kernel tree and the Linux PAL are hosted separately on linux-acs.

Building the kernel module

Prerequisites

- Linux kernel source version 4.18.

```
git clone --branch v4.18 git@github.com:torvalds/linux.git
```

- Linaro GCC tool chain 7.5 or above.

```
export CROSS_COMPILE=<local_dir>/gcc-linaro-5.3-2016.02/bin/aarch64-linux-gnu-
```

- Build environment for AArch64 Linux kernel.

Porting steps for Linux kernel

1.
```
git clone https://git.gitlab.arm.com/linux-arm/linux-acs <local_dir/linux-acs>
```

2.
```
git clone https://github.com/ARM-software/sbsa-acs.git <local_dir/sbsa-acs>
```

3. Apply the <local_dir/linux-acs>/kernel/src/0001-Enterprise-acs-linux-v4.18.patch to your kernel source tree.
4. Build the kernel.

Build steps for SBSA kernel module

1.
```
cd <local_dir/linux-acs>/sbsa-acs-drv/files
```

2.
```
export KERNEL_SRC=<linux kernel path>
```

3.
```
./setup.sh <local_dir/sbsa-acs>
```

4.
```
./linux_sbsa_acs.sh
```

`sbsa_acs.ko` file is generated.

SBSA Linux application build

1.
```
cd <sbsa-acs path>/linux_app/sbsa-acs-app
```

2.
```
make
```

The executable file `sbsa` is generated.

4.2.1 Target environment setup

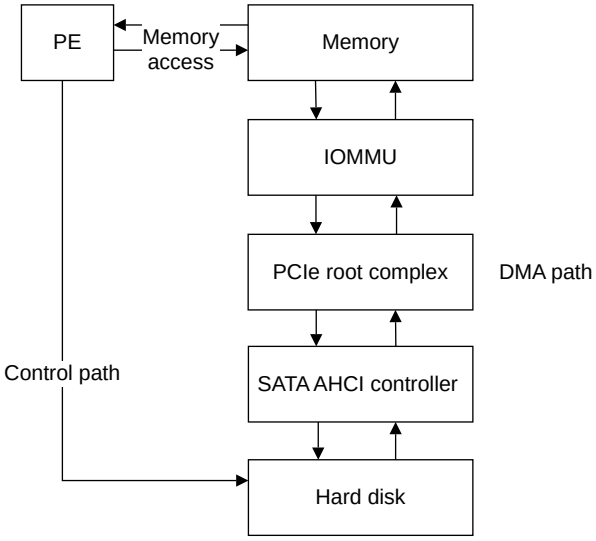
The set of tests assumes that at least one Serial Advanced Technology Attachment (SATA) controller is behind a PCIe root complex. The SATA controller may or may not be behind an Input-Output Memory Management Unit (IOMMU).

Before running these tests, at least one SATA hard disk must be connected to the SATA controller. The test performs read and write operations to the SATA hard disk. Therefore, the data on the HDD is overwritten. The SATA drive must not be the boot device for the OS.

4.2.2 Runtime environment

The following figure describes the hardware functional blocks.

Figure 4-1: Hardware functional blocks



The PCIe-DMA tests initiate data transfers from a DMA requester. By default, the test searches for a SATA controller which is part of the PCIe subsystem.

1. The test programs the known data from the PE to main memory.
2. The test programs the DMA requester to transfer this known data to its end-point device.
3. The test programs the DMA requester to transfer the data back to a different location in the main memory.
4. The test compares the data at both the locations.

If the SATA controller is not placed before an IOMMU, then during this data transfer, the address that is used by the SATA controller is retrieved and compared with the DMA address that is seen by the PE.

If the DMA requester is placed before an IOMMU, then the address that is used by the SATA AHCI controller is compared with the address that is seen by the IOMMU. Both these addresses must match.

To enable the export of the addresses that are seen by the SATA AHCI controller and IOMMU, the kernel drivers for these two modules must be patched.

Appendix A Revisions

This appendix describes the technical changes between released issues of this book.

A.1 Revisions

The following tables describe the changes between different issues of this document.

Table A-1: Issue 0200-01

Change	Location
Information about exerciser is added.	See 2.3 Test IDs on page 9.
A new parameter [--e] is added to Linux application arguments.	See 4.1 Linux application arguments on page 14.

Table A-2: Differences between Issue 0200-01 and Issue 0200-02

Change	Location
Bare-metal test environment is added to the table.	See 2.2 Overview of tests on page 9.
A note about additional porting for the exerciser is added.	See 4.1 Linux application arguments on page 14.

Table A-3: Differences between Issue 0200-02 and Issue 0200-03

Change	Location
No technical changes.	-

Table A-4: Differences between Issue 0200-03 and Issue 0200-04

Change	Location
• Arguments for NIST and PCIe tests are added. • A note about UEFI session is added.	See 3.1 UEFI application arguments on page 11.
NIST module ID is updated.	See 2.3 Test IDs on page 9.
Linux application arguments are updated.	See 4.1 Linux application arguments on page 14.

Table A-5: Differences between Issue 0200-04 and Issue 0300-01

Change	Location
Additional level of compliance to be tested is added.	See table in 3.1 UEFI application arguments on page 11 and 4.1 Linux application arguments on page 14.

Table A-6: Differences between Issue 0300-01 and Issue 0301-01

Change	Location
Removed Secure module.	See 2.3 Test IDs on page 9.
Updated the link to linux-acs.	See 4.2 Build steps and environment setup on page 14.
Updated the build steps and environment setup.	See 4.2 Build steps and environment setup on page 14.

Table A-7: Differences between Issue 0301-01 and Issue 0302-01

Change	Location
Arguments for p2p and cache are added.	See 3.1 UEFI application arguments on page 11.