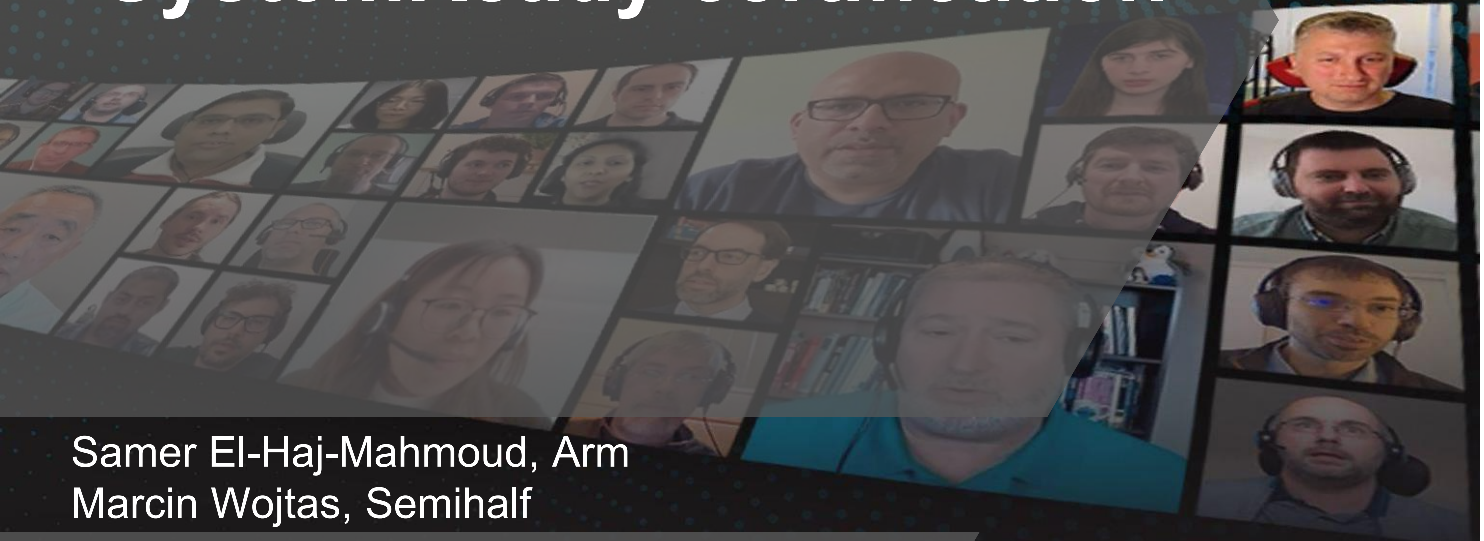
LVC21F-313
A firmware journey through standards to Arm SystemReady certification



Samer El-Haj-Mahmoud, Arm
Marcin Wojtas, Semihalf

Linaro Connect
VIRTUAL • FALL 2021

The beginnings - Arm ServerReady?

Marvell MACCHIATOBin - Rev 1.3
By SolidRun ltd. (www.solid-run.com)
CP1 SRD1
CP1 SRD3
CP0 SRD5
CP1 SRD0
CP1 SRD4
CP0 SRD4
CP1 SRD5

http://macchiatobin.net/product/macchiatobin-double-shot/

- Marvell Armada7k8k and SolidRun MacchiatoBin
- One of the first public arm64 UEFI ports in Linaro OpenPlatformPkg

The beginnings - Arm ServerReady?

Marvell MACCHIATOBin - Rev 1.3
By SolidRun ltd. (www.solid-run.com)

http://macchiatobin.net/product/macchiatobin-double-shot/

- SBSA/SBBR evaluation in 2018/2019
  - SBSA level 1
  - UEFI 2.x
  - ACPI 6.0
  - SMBIOS 3.2
  - Minor remaining issues in SBBR tests
- Why it failed to get certified as Arm ServerReady?

The beginnings - Arm ServerReady?

Marvell MACCHIATOBin - Rev 1.3
By SolidRun ltd. (www.solid-run.com)
CP1 SRD1
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CP0 SRD5
CP1 SRD0
CP1 SRD4
CP0 SRD4
CP1 SRD5

http://macchiatobin.net/product/macchiatobin-double-shot/

- It’s not a server!
- Ecosystem was not ready.
- HW limitations
  - Non-standard PCIe require quirks
  - Several non-discoverable controllers/platform devices, lacking ACPI support
  - FW cannot work around some of the SBSA compliance issues

Solution? SystemReady ES!

- SystemReady ES is perfect match for the Marvell SoCs
- Previous FW work paid off
- Already 3 systems certified!
  - Marvell OCTEON TX2 CN9130 Dev Board
  - SolidRun Macchiatobin Double Shot
  - SolidRun CN9132 CEx7 Eval Board

arm SystemReady ES

MacchiatoBin Double Shot

SolidRun CN9132 CEx7 Eval Board

MARVELL

Marvell® OCTEON TX2™ CN913X

SystemReady Vision

arm SystemReady

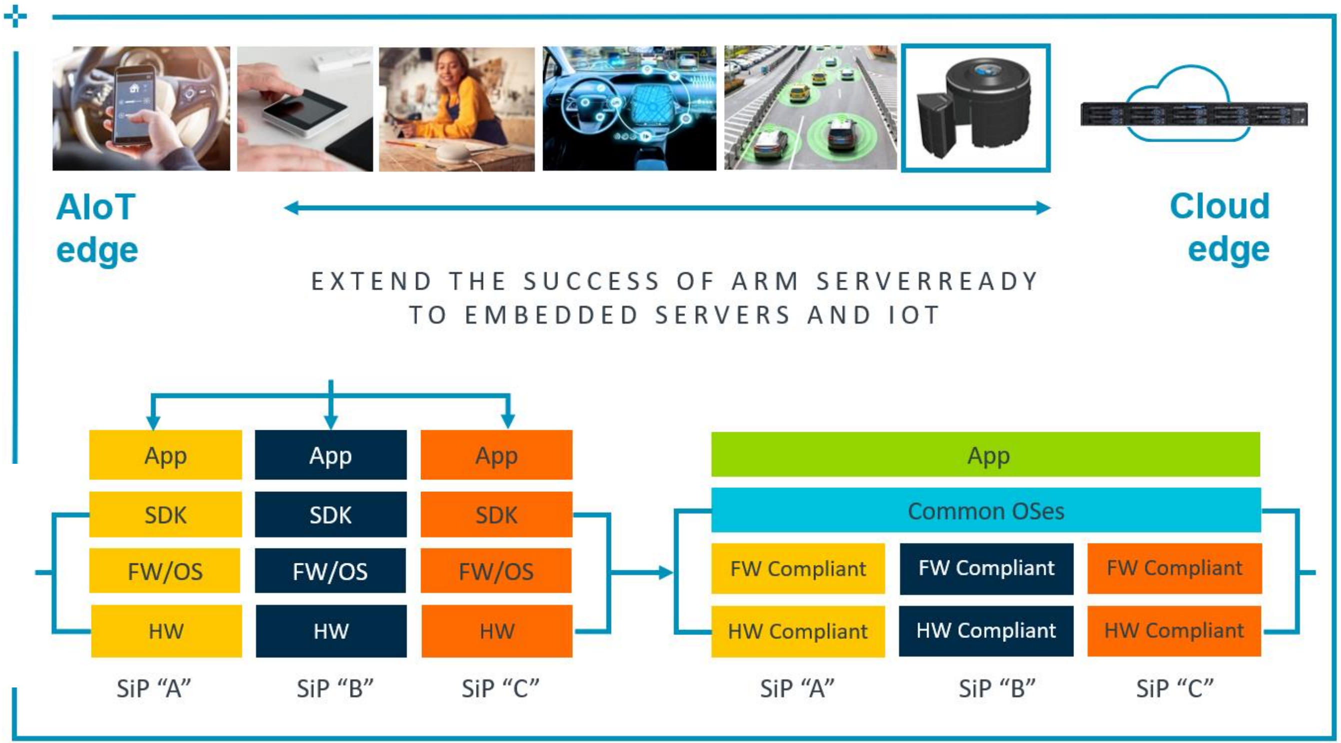
Software Can Just Work on Arm-based Devices

arm SystemReady SR

arm SystemReady ES

arm SystemReady IR

arm SystemReady LS

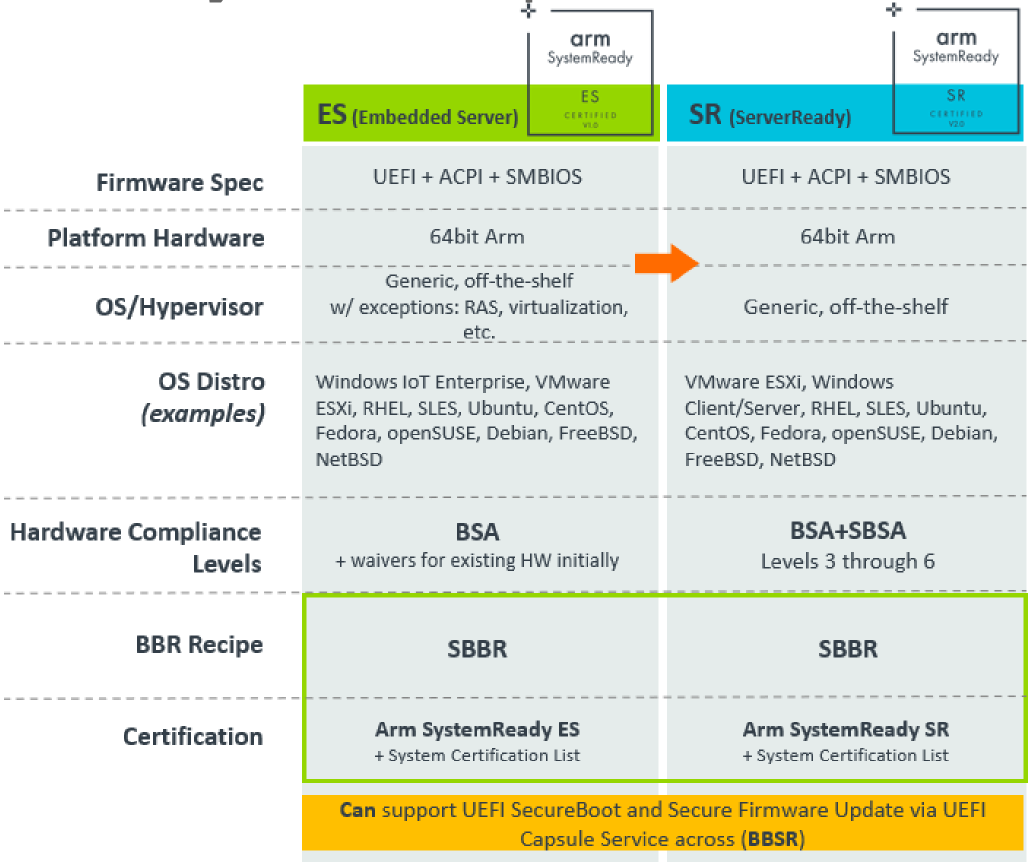


EXTEND THE SUCCESS OF ARM SERVERREADY TO EMBEDDED SERVERS AND IOT

SiP "A"	SiP "B"	SiP "C"
App	App	App
SDK	SDK	SDK
FW/OS	FW/OS	FW/OS
HW	HW	HW

SiP "A"	SiP "B"	SiP "C"
App		
Common OSes		
FW Compliant	FW Compliant	FW Compliant
HW Compliant	HW Compliant	HW Compliant

SystemReady ES - requirements



	ES (Embedded Server)	**SR** (ServerReady)
Firmware Spec	UEFI + ACPI + SMBIOS	UEFI + ACPI + SMBIOS
Platform Hardware	64bit Arm	64bit Arm
OS/Hypervisor	Generic, off-the-shelf w/ exceptions: RAS, virtualization, etc.	Generic, off-the-shelf
OS Distro *(examples)*	Windows IoT Enterprise, VMware ESXi, RHEL, SLES, Ubuntu, CentOS, Fedora, openSUSE, Debian, FreeBSD, NetBSD	VMware ESXi, Windows Client/Server, RHEL, SLES, Ubuntu, CentOS, Fedora, openSUSE, Debian, FreeBSD, NetBSD
Hardware Compliance Levels	**BSA** + waivers for existing HW initially	**BSA+SBSA** Levels 3 through 6
BBR Recipe	**SBBR**	**SBBR**
Certification	**Arm SystemReady ES** + System Certification List	**Arm SystemReady SR** + System Certification List

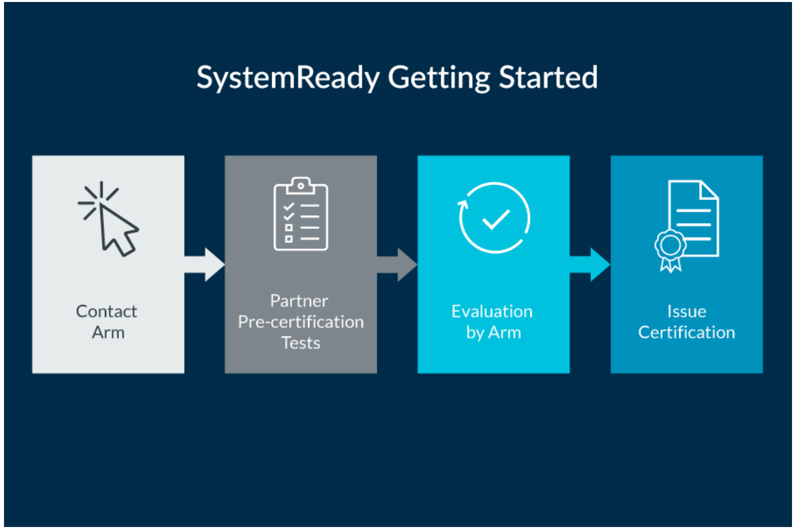
Can support UEFI SecureBoot and Secure Firmware Update via UEFI Capsule Service across (**BBSR**)

SystemReady ES – why is it needed?

- Arm ServerReady had great success in achieving its goals (standardizing Arm servers, hyperscale/datacentre segments)
- Arm SystemReady was launched @ Arm DevSummit Oct 2020 to continue & expand on the success of ServerReady
    - SystemReady SR for servers
    - SystemReady ES for IoT/edge segments (non-server HW)
- SystemReady ES Provides a path for certification
    - ES makes certification more achievable on non-server HW
    - ES requires SBBR+BSA, SR requires SBBR+ BSA+SBSA
    - ES certification waivers Levels 0 – 2 allowed
    - FW workarounds to hide PCIe ECAM and other BSA issues (may be possible on non-servers with limited PCIe topology)

SystemReady ES - how it’s done?

- Partners contact Arm SystemReady Certification Program
- Partners then prepare pre-certification tests to evaluate the platform (HW and FW) readiness for certification
- Once ready, partners submit the platform HW and test results to be evaluated by Arm
- After evaluation, and addressing any FW issues, Arm issues Certification, along with any necessary Waivers, and publishes to Arm SystemReady ES Certification List
- Details of the process and criteria are in the Arm SystemReady Requirements Specification



SystemReady Getting Started

SystemReady ES - FW/HW evaluation

- SystemReady ES certification is based on standards specifications:
  - BSA – Base System Architecture
  - BBR – Base Boot Architecture (SBBR Recipe)
- Initial evaluation include:
  - Completing a “Firmware Readiness Checklist”
  - Initial run of the test suites and installation of unmodified OS distros
  - Making HW and FW available to Arm
  - Arm performs a gap-analysis to determine compliance issues that need to be addressed in the FW

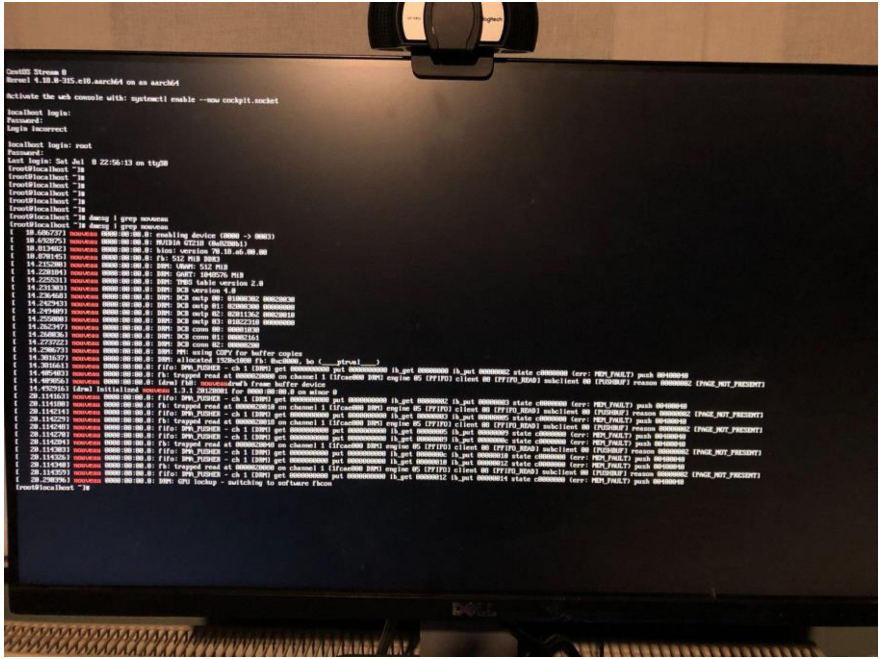
SystemReady ES - Testing

- Architecture Compliance Suite (ACS)
- Arm Enterprise ACS
- Includes open-source components:
  - UEFI Self Certification Test (SCT)
  - Firmware Test Suite (FWTS)
  - sbsa-acs (UEFI and Linux)
  - LUVOS
- Latest release: Enterprise ACS 3.0
- Currently still being used for SystemReady ES certification

- SystemReady ES ACS
- Using re-structured ACS tailored for different SystemReady bands
  - bbr-acs(SCT and FWTS)
  - bsa-acs (UEFI and Linux)
  - Linux busybox
- Beta 0.9 release available

SystemReady ES - OS installations

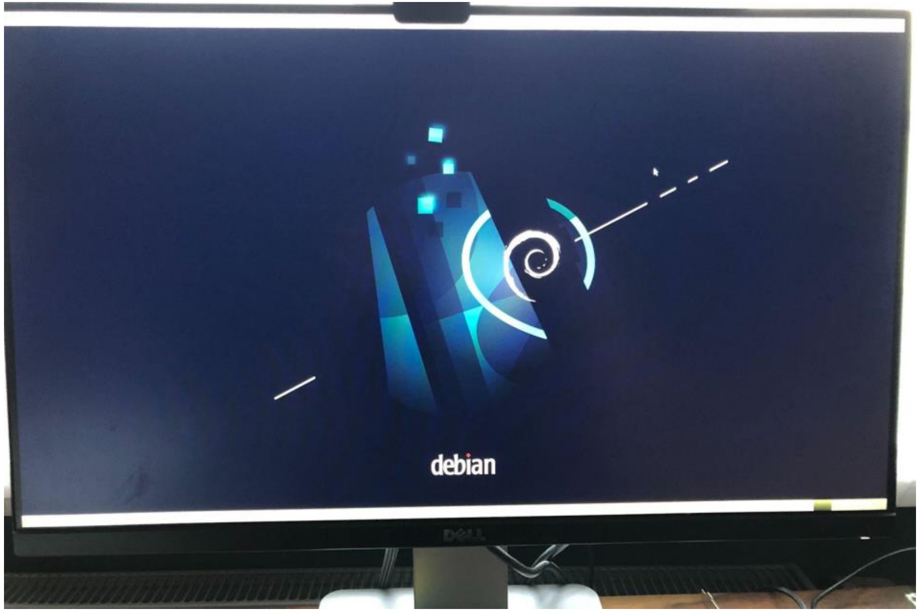
- Installation from ISO **just works**!
- Examples:
    - Centos 8 Stream



```
CentOS Stream 8
Kernel 4.18.0-315.el8.aarch64 on an aarch64

Activate the web console with: systemctl enable --now cockpit.socket

localhost login:
Password:
Login incorrect

localhost login: root
Password:
Last login: Sat Jul  8 22:56:13 on ttyS0
[root@localhost ~]#
[root@localhost ~]#
[root@localhost ~]#
[root@localhost ~]#
[root@localhost ~]#
[root@localhost ~]#
[root@localhost ~]# dmesg | grep nouveau
[root@localhost ~]# dmesg | grep nouveau
[   10.686737] nouveau 0000:00:00.0: enabling device (0000 -> 0003)
[   10.692875] nouveau 0000:00:00.0: NVIDIA GT218 (0a8280b1)
[   10.813482] nouveau 0000:00:00.0: bios: version 70.18.a6.00.00
[   10.870145] nouveau 0000:00:00.0: fb: 512 MiB DDR3
[   14.215200] nouveau 0000:00:00.0: DRM: VRAM: 512 MiB
[   14.220184] nouveau 0000:00:00.0: DRM: GART: 1048576 MiB
[   14.225531] nouveau 0000:00:00.0: DRM: TMDS table version 2.0
[   14.231303] nouveau 0000:00:00.0: DRM: DCB version 4.0
[   14.236468] nouveau 0000:00:00.0: DRM: DCB outp 00: 01000302 00020030
[   14.242943] nouveau 0000:00:00.0: DRM: DCB outp 01: 02000300 00000000
[   14.249489] nouveau 0000:00:00.0: DRM: DCB outp 02: 02011362 00020010
[   14.255800] nouveau 0000:00:00.0: DRM: DCB outp 03: 01022310 00000000
[   14.262347] nouveau 0000:00:00.0: DRM: DCB conn 00: 00001030
[   14.268036] nouveau 0000:00:00.0: DRM: DCB conn 01: 00002161
[   14.273722] nouveau 0000:00:00.0: DRM: DCB conn 02: 00000200
[   14.290673] nouveau 0000:00:00.0: DRM: MM: using COPY for buffer copies
[   14.301637] nouveau 0000:00:00.0: DRM: allocated 1920x1080 fb: 0xc0000, bo (____ptrval____)
[   14.301661] nouveau 0000:00:00.0: fifo: DMA_PUSHER - ch 1 [DRM] get 0000000000 put 0000000000 ib_get 00000000 ib_put 00000002 state c0000000 (err: MEM_FAULT) push 00400040
[   14.405403] nouveau 0000:00:00.0: fb: trapped read at 0000020000 on channel 1 [1fcae000 DRM] engine 05 [PFIFO] client 08 [PFIFO_READ] subclient 00 [PUSHBUF] reason 00000002 [PAGE_NOT_PRESENT]
[   14.409856] nouveau 0000:00:00.0: [drm] fb0: nouveaudrmfb frame buffer device
[   14.492916] [drm] Initialized nouveau 1.3.1 20120801 for 0000:00:00.0 on minor 0
[   20.114163] nouveau 0000:00:00.0: fifo: DMA_PUSHER - ch 1 [DRM] get 0000000000 put 0000000000 ib_get 00000002 ib_put 00000003 state c0000000 (err: MEM_FAULT) push 00400040
[   20.114180] nouveau 0000:00:00.0: fb: trapped read at 0000020010 on channel 1 [1fcae000 DRM] engine 05 [PFIFO] client 08 [PFIFO_READ] subclient 00 [PUSHBUF] reason 00000002 [PAGE_NOT_PRESENT]
[   20.114214] nouveau 0000:00:00.0: fifo: DMA_PUSHER - ch 1 [DRM] get 0000000000 put 0000000000 ib_get 00000003 ib_put 00000005 state c0000000 (err: MEM_FAULT) push 00400040
[   20.114229] nouveau 0000:00:00.0: fb: trapped read at 0000020010 on channel 1 [1fcae000 DRM] engine 05 [PFIFO] client 08 [PFIFO_READ] subclient 00 [PUSHBUF] reason 00000002 [PAGE_NOT_PRESENT]
[   20.114240] nouveau 0000:00:00.0: fifo: DMA_PUSHER - ch 1 [DRM] get 0000000000 put 0000000000 ib_get 00000005 ib_put 00000009 state c0000000 (err: MEM_FAULT) push 00400040
[   20.114270] nouveau 0000:00:00.0: fifo: DMA_PUSHER - ch 1 [DRM] get 0000000000 put 0000000000 ib_get 00000009 ib_put 0000000c state c0000000 (err: MEM_FAULT) push 00400040
[   20.114284] nouveau 0000:00:00.0: fb: trapped read at 0000020040 on channel 1 [1fcae000 DRM] engine 05 [PFIFO] client 08 [PFIFO_READ] subclient 00 [PUSHBUF] reason 00000002 [PAGE_NOT_PRESENT]
[   20.114303] nouveau 0000:00:00.0: fifo: DMA_PUSHER - ch 1 [DRM] get 0000000000 put 0000000000 ib_get 0000000c ib_put 00000010 state c0000000 (err: MEM_FAULT) push 00400040
[   20.114326] nouveau 0000:00:00.0: fifo: DMA_PUSHER - ch 1 [DRM] get 0000000000 put 0000000000 ib_get 00000010 ib_put 00000012 state c0000000 (err: MEM_FAULT) push 00400040
[   20.114340] nouveau 0000:00:00.0: fb: trapped read at 0000020000 on channel 1 [1fcae000 DRM] engine 05 [PFIFO] client 08 [PFIFO_READ] subclient 00 [PUSHBUF] reason 00000002 [PAGE_NOT_PRESENT]
[   20.114359] nouveau 0000:00:00.0: fifo: DMA_PUSHER - ch 1 [DRM] get 0000000000 put 0000000000 ib_get 00000012 ib_put 00000014 state c0000000 (err: MEM_FAULT) push 00400040
[   20.290396] nouveau 0000:00:00.0: DRM: GPU lockup - switching to software fbcon
[root@localhost ~]#
```

SystemReady ES - OS installations

- Installation from ISO **just works**!
- Examples:
  - Centos 8 Stream
  - Debian 11



SystemReady ES - OS installations

- Installation from ISO **just works**!
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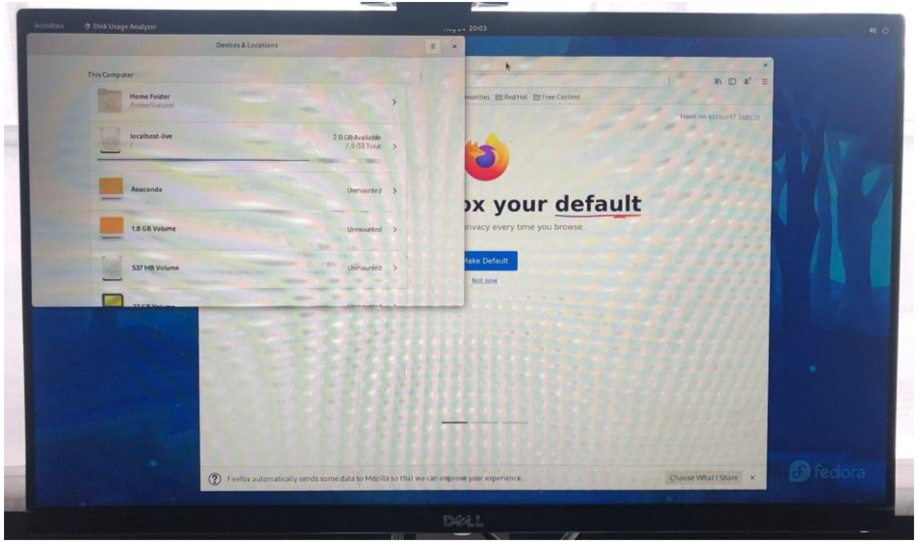
  - Fedora 34



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SystemReady ES - OS installations

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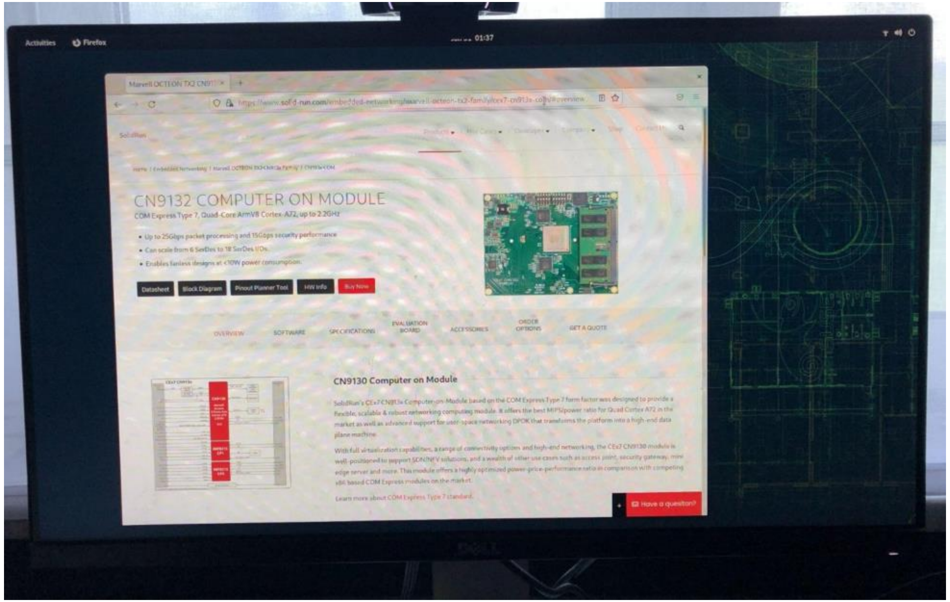
  - OpenSUSE Tumbleweed



CN9132 COMPUTER ON MODULE

COM Express Type 7, Quad-Core ArmV8 Cortex-A72, up to 2.2GHz

- Up to 25Gbps packet processing and 15Gbps security performance
- Can scale from 6 SerDes to 18 SerDes I/Os.
- Enables fanless designs at <10W power consumption.

CN9130 Computer on Module

SolidRun's CEx7 CN913x Computer-on-Module based on the COM Express Type 7 form factor was designed to provide a flexible, scalable & robust networking computing module. It offers the best MIPS/power ratio for Quad Cortex A72 in the market as well as advanced support for user-space networking DPDK that transforms the platform into a high-end data plane machine.

With full virtualization capabilities, a range of connectivity options and high-end networking, the CEx7 CN9130 module is well-positioned to support SDN/NFV solutions, and a wealth of other use cases such as access point, security gateway, mini edge server and more. This module offers a highly optimized power-price-performance ratio in comparison with competing x86 based COM Express modules on the market.

Learn more about COM Express Type 7 standard.

SystemReady ES - OS installations

- Installation from ISO **just works**!
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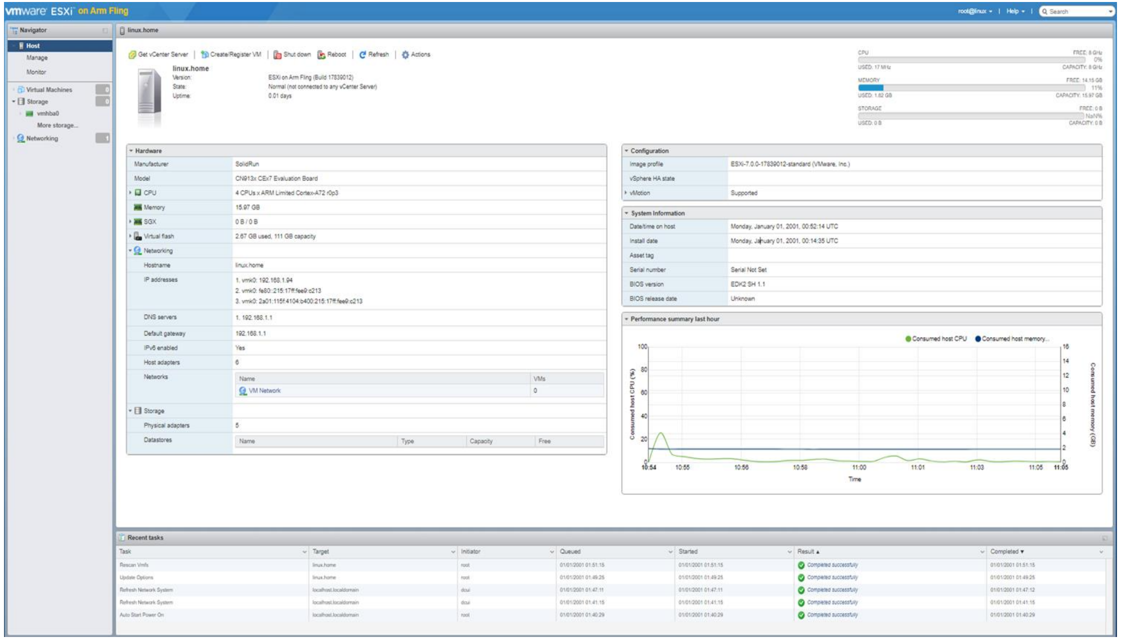
  - Debian 11
  - Fedora 34
  - Ubuntu 21.10
  - OpenSUSE Tumbleweed
  - VMware ESXI-Arm v1.5



linux.home

Version: ESXi on Arm Fling (Build 17839012)

State: Normal (not connected to any vCenter Server)

Uptime: 0.01 days

CPU FREE: 8 GHz 0% USED: 17 MHz CAPACITY: 8 GHz

MEMORY FREE: 14.15 GB 11% USED: 1.82 GB CAPACITY: 15.97 GB

STORAGE FREE: 0 B NaN% USED: 0 B CAPACITY: 0 B

Hardware

Manufacturer	SolidRun
Model	CN913x CEx7 Evaluation Board
CPU	4 CPUs x ARM Limited Cortex-A72 r0p3
Memory	15.97 GB
SGX	0 B / 0 B
Virtual flash	2.67 GB used, 111 GB capacity
Networking	
Hostname	linux.home
IP addresses	1. vmk0: 192.168.1.94 2. vmk0: fe80::215:17ff:fee9:c213 3. vmk0: 2a01:115f:4104:b400:215:17ff:fee9:c213
DNS servers	1. 192.168.1.1
Default gateway	192.168.1.1
IPv6 enabled	Yes
Host adapters	6
Networks	Name: VM Network, VMs: 0
Storage	
Physical adapters	5
Datastores	Name / Type / Capacity / Free

Configuration

Image profile	ESXi-7.0.0-17839012-standard (VMware, Inc.)
vSphere HA state	
vMotion	Supported

System Information

Date/time on host	Monday, January 01, 2001, 00:52:14 UTC
Install date	Monday, January 01, 2001, 00:14:35 UTC
Asset tag	
Serial number	Serial Not Set
BIOS version	EDK2 SH 1.1
BIOS release date	Unknown

Performance summary last hour

Recent tasks

Task	Target	Initiator	Queued	Started	Result ▲	Completed ▼
Rescan Vmfs	linux.home	root	01/01/2001 01:51:15	01/01/2001 01:51:15	✓ Completed successfully	01/01/2001 01:51:15
Update Options	linux.home	root	01/01/2001 01:49:25	01/01/2001 01:49:25	✓ Completed successfully	01/01/2001 01:49:25
Refresh Network System	localhost.localdomain	dcui	01/01/2001 01:47:11	01/01/2001 01:47:11	✓ Completed successfully	01/01/2001 01:47:12
Refresh Network System	localhost.localdomain	dcui	01/01/2001 01:41:15	01/01/2001 01:41:15	✓ Completed successfully	01/01/2001 01:41:15
Auto Start Power On	localhost.localdomain	root	01/01/2001 01:40:29	01/01/2001 01:40:29	✓ Completed successfully	01/01/2001 01:40:29

SystemReady ES - OS installations

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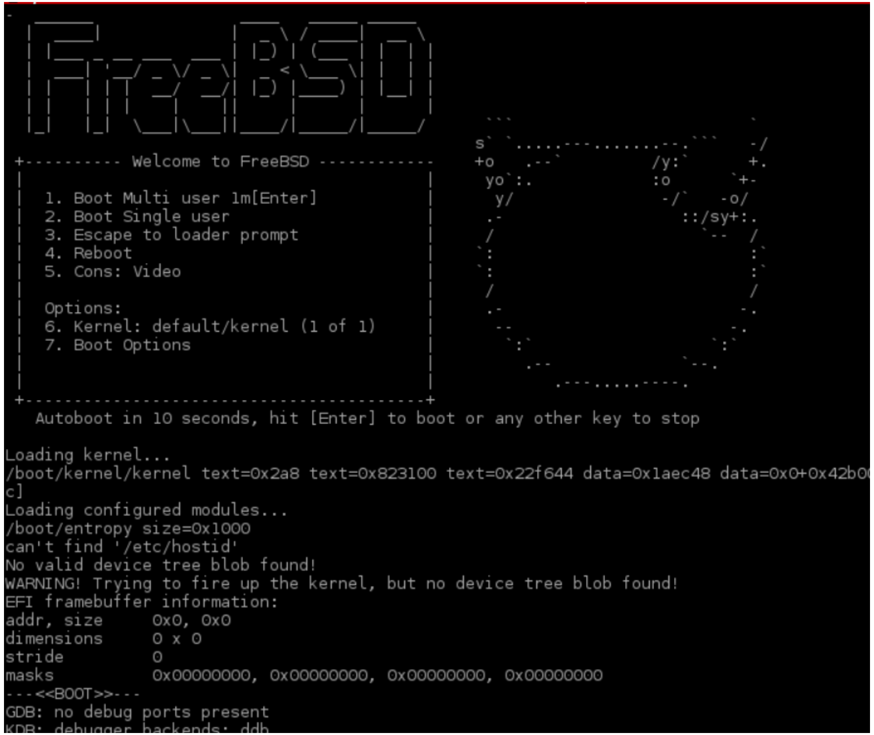
- Examples:
  - Centos 8 Stream
  - Debian 11
  - Fedora 34
  - Ubuntu 21.10
  - OpenSUSE Tumbleweed
  - VMware ESXI-Arm v1.5
  - FreeBSD & OpenBSD

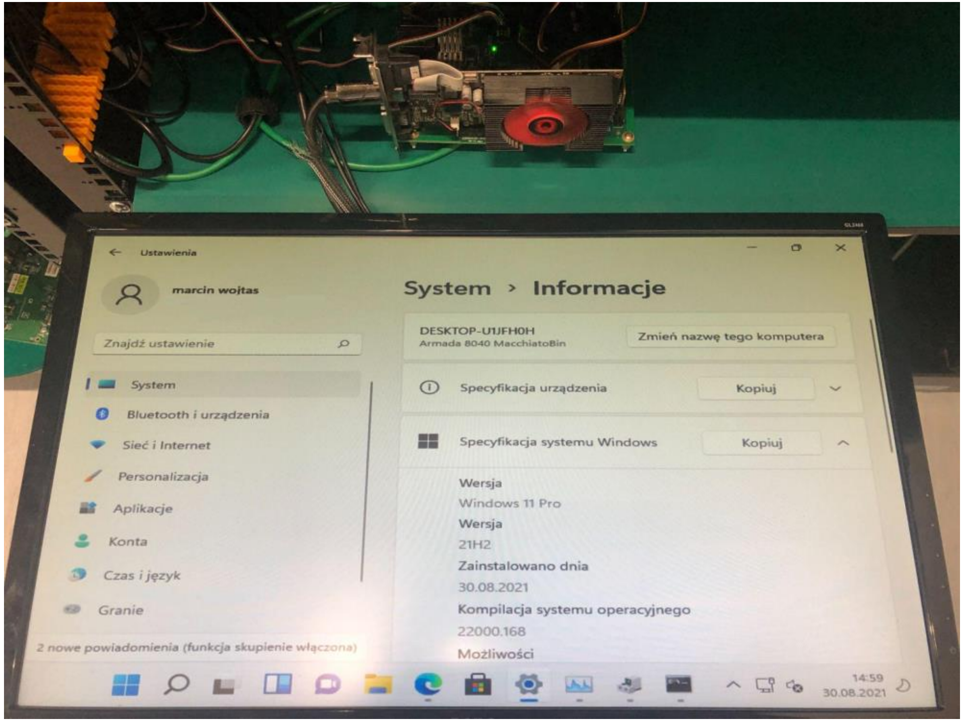


```
+---------- Welcome to FreeBSD -----------
|
|  1. Boot Multi user 1m[Enter]
|  2. Boot Single user
|  3. Escape to loader prompt
|  4. Reboot
|  5. Cons: Video
|
|  Options:
|  6. Kernel: default/kernel (1 of 1)
|  7. Boot Options
|
|
+---------------------------------------+
   Autoboot in 10 seconds, hit [Enter] to boot or any other key to stop

Loading kernel...
/boot/kernel/kernel text=0x2a8 text=0x823100 text=0x22f644 data=0x1aec48 data=0x0+0x42b0
c]
Loading configured modules...
/boot/entropy size=0x1000
can't find '/etc/hostid'
No valid device tree blob found!
WARNING! Trying to fire up the kernel, but no device tree blob found!
EFI framebuffer information:
addr, size      0x0, 0x0
dimensions      0 x 0
stride          0
masks           0x00000000, 0x00000000, 0x00000000, 0x00000000
---<<BOOT>>---
GDB: no debug ports present
KDB: debugger backends: ddb
```

SystemReady ES - OS installations

- Installation from ISO **just works**!
- Examples:
  - Centos 8 Stream
  - Debian 11
  - Fedora 34
  - Ubuntu 21.10
  - OpenSUSE Tumbleweed
  - VMware ESXI-Arm v1.5
  - FreeBSD & OpenBSD
  - Windows 11 in a VM and natively (!)



System › Informacje

DESKTOP-U1JFH0H
Armada 8040 MacchiatoBin

Specyfikacja urządzenia

Specyfikacja systemu Windows

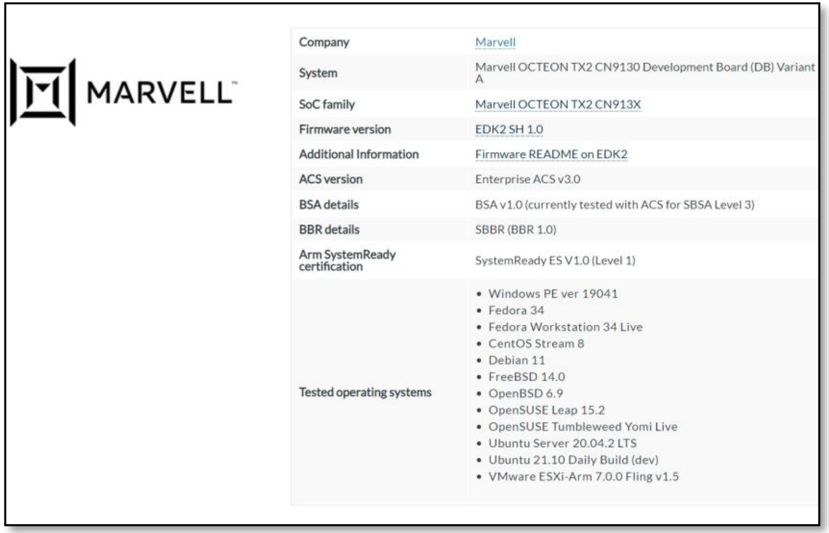
Wersja
Windows 11 Pro
Wersja
21H2
Zainstalowano dnia
30.08.2021
Kompilacja systemu operacyjnego
22000.168
Możliwości

2 nowe powiadomienia (funkcja skupienie włączona)

14:59
30.08.2021

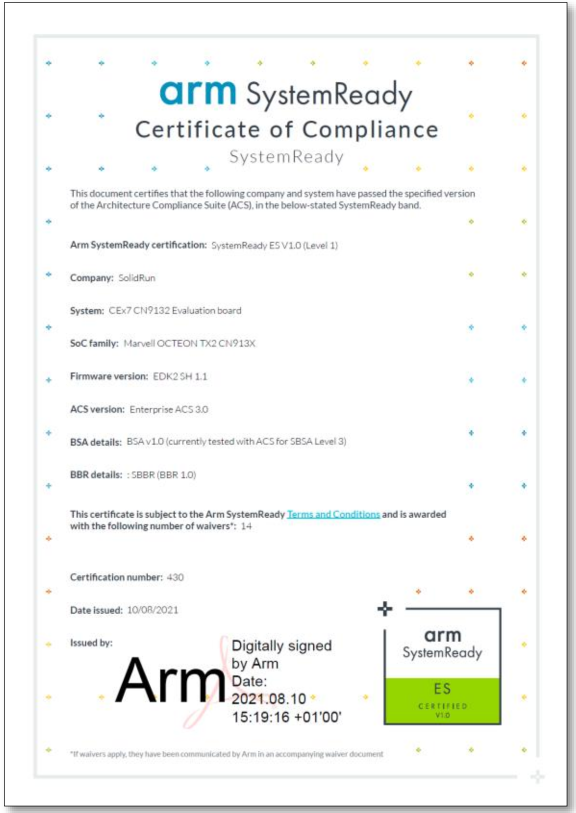
SystemReady ES - final steps

- Results reviewed and evaluated by Arm
- Waivers approved by Arm
- Certification issued by Arm



MARVELL™

Company	Marvell
System	Marvell OCTEON TX2 CN9130 Development Board (DB) Variant A
SoC family	Marvell OCTEON TX2 CN913X
Firmware version	EDK2 SH 1.0
Additional Information	Firmware README on EDK2
ACS version	Enterprise ACS v3.0
BSA details	BSA v1.0 (currently tested with ACS for SBSA Level 3)
BBR details	SBBR (BBR 1.0)
Arm SystemReady certification	SystemReady ES V1.0 (Level 1)
Tested operating systems	• Windows PE ver 19041 • Fedora 34 • Fedora Workstation 34 Live • CentOS Stream 8 • Debian 11 • FreeBSD 14.0 • OpenBSD 6.9 • OpenSUSE Leap 15.2 • OpenSUSE Tumbleweed Yomi Live • Ubuntu Server 20.04.2 LTS • Ubuntu 21.10 Daily Build (dev) • VMware ESXi-Arm 7.0.0 Fling v1.5



arm SystemReady

Certificate of Compliance

SystemReady

This document certifies that the following company and system have passed the specified version of the Architecture Compliance Suite (ACS), in the below-stated SystemReady band.

Arm SystemReady certification: SystemReady ES V1.0 (Level 1)

Company: SolidRun

System: CEx7 CN9132 Evaluation board

SoC family: Marvell OCTEON TX2 CN913X

Firmware version: EDK2 SH 1.1

ACS version: Enterprise ACS 3.0

BSA details: BSA v1.0 (currently tested with ACS for SBSA Level 3)

BBR details: : SBBR (BBR 1.0)

This certificate is subject to the Arm SystemReady Terms and Conditions and is awarded with the following number of waivers*: 14

Certification number: 430

Date issued: 10/08/2021

Issued by:

Arm Digitally signed by Arm Date: 2021.08.10 15:19:16 +01'00'

arm SystemReady ES CERTIFIED V1.0

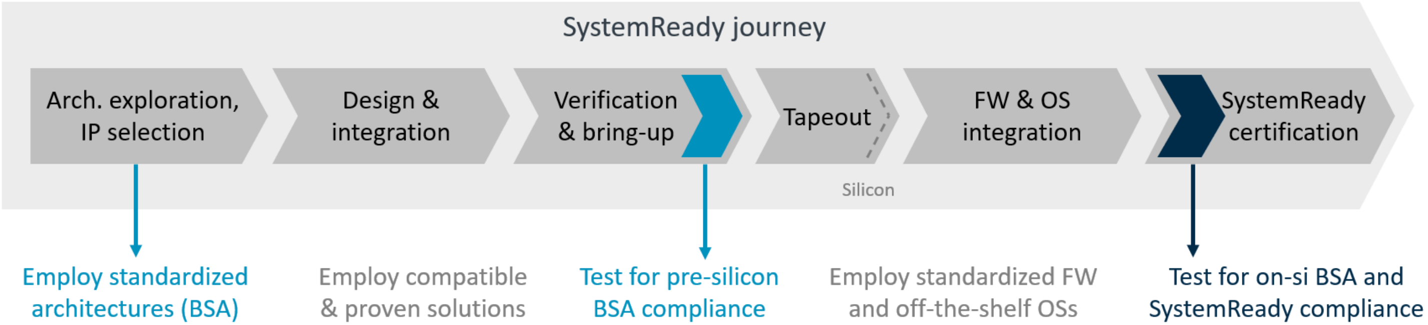
*If waivers apply, they have been communicated by Arm in an accompanying waiver document

https://developer.arm.com/architectures/system-architectures/arm-systemready/es

Lessons learned & best practices

✓ Check BSA spec pre-silicon

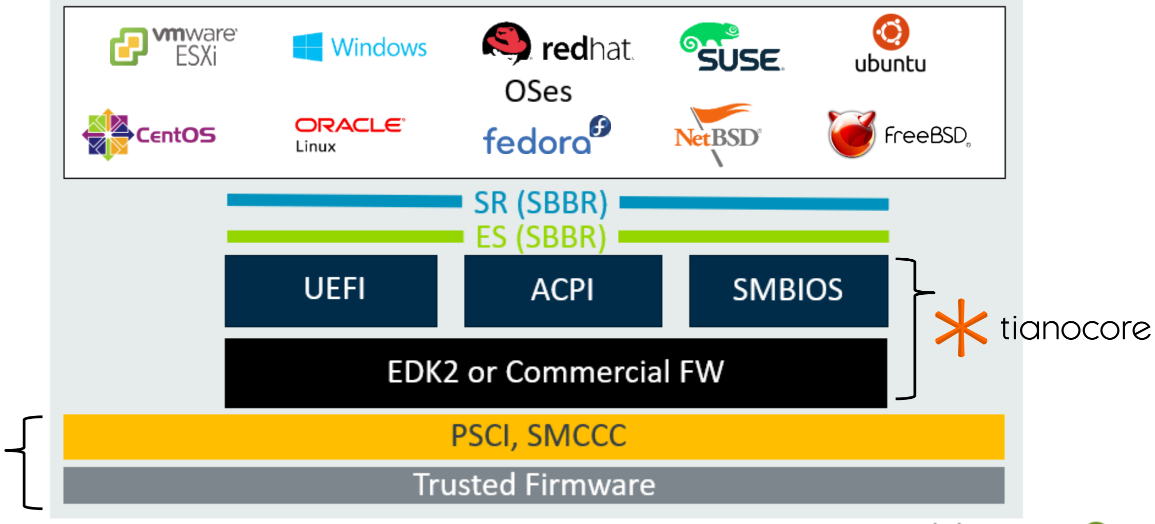
- Pre-silicon validation testing helps reduce most costly / problematic silicon compliance issues
- Validation include running Arm ACS test suites and EDA partners (S)BSA verification solutions


SystemReady journey
Arch. exploration, IP selection
Design & integration
Verification & bring-up
Tapeout
FW & OS integration
SystemReady certification
Silicon
Employ standardized architectures (BSA)
Employ compatible & proven solutions
Test for pre-silicon BSA compliance
Employ standardized FW and off-the-shelf OSs
Test for on-si BSA and SystemReady compliance

Lessons learned & best practices

- ✓ Check BSA spec pre-silicon
- ✓ SBBR leverage open source and commonalities

- Open source FW is not required for Arm SystemReady certification
- But having open source platforms helps in building the ecosystem
- Leverage open source components and common silicon / platform code, whenever possible
- Common firmware projects: tianocore.org and trustedfirmware.org



TrustedFirmware .org

Lessons learned & best practices

- ✓ Check BSA spec pre-silicon
- ✓ SBBR leverage open source and commonalities
- ✓ Common problematic areas:
  - ✓ PCIe ECAM

- Lack of **standard PCIe ECAM** is the most common BSA compliance issue
- Pre-silicon validation testing is key in resolving before tape-out.
- Firmware workarounds (to fake ECAM, or make it “look OK” to the OS) are possible, but costly and have side effects
- OS platform specific quirks not desired: Existing OS distros will not “just work”
- Arm standard: PCI Configuration Space Access SMC Interface as a possible alternative

Lessons learned & best practices

- ✓ Check BSA spec pre-silicon
- ✓ SBBR leverage open source and commonalities
- ✓ Common problematic areas:
  - ✓ PCIe ECAM
  - ✓ UART

- BSA requires either Arm Generic UART (such as PL011) or 16550 fully compliant UART for OS console and debug
- PL011 / Arm Generic UART is the safest choice
- 16550 IP in SoCs vary widely, and mostly not fully compliant to the standard: Assume OS specific drivers/quirks (e.g. many "DW8250" variations Linux drivers)
- Critical for embedded systems to provide main/only OS console (especially if there is no video console or PCIe slot to add a graphics card)

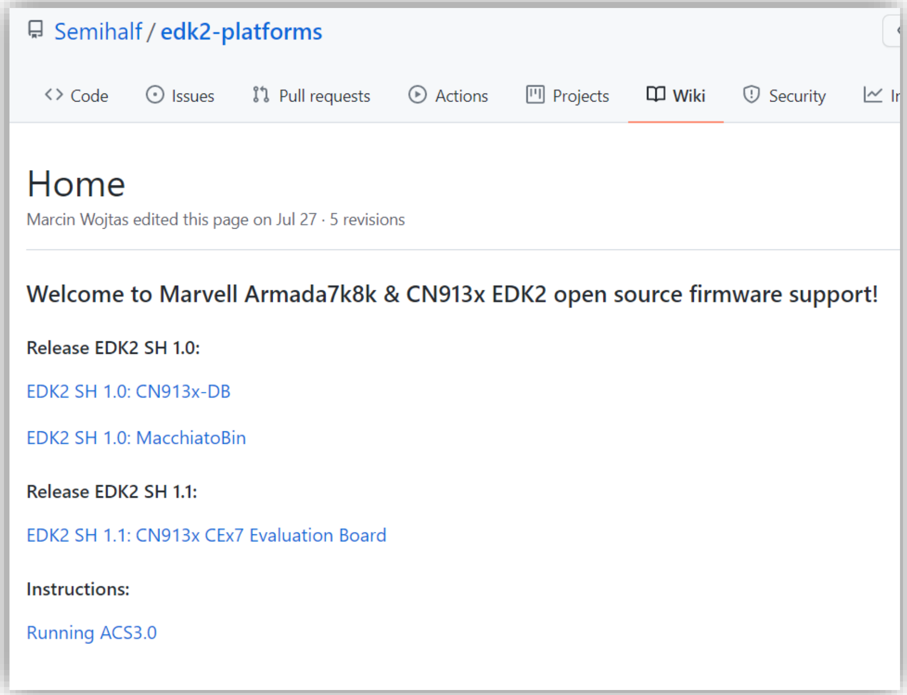
Lessons learned & best practices

- ✓ Check BSA spec pre-silicon
- ✓ SBBR leverage open source and commonalities
- ✓ Common problematic areas:
  - ✓ PCIe ECAM
  - ✓ UART
- ✓ Enable networking!

- Some OS/Hypervisor install require NIC card (e.g. ESXi-Arm)
- NICs on embedded systems are usually not supported in ACPI world (at least initially)
- For SystemReady ES certification, use PCIe or USB NIC common adapters with UEFI & OS support

Where is the firmware?

- Public binaries available on Semihalf GitHub wiki page
- What about the FW sources?
- Marvell CN913x/Armada7k8k - all code already in upstream!
- Fast path for next certifications



Home

Marcin Wojtas edited this page on Jul 27 · 5 revisions

Welcome to Marvell Armada7k8k & CN913x EDK2 open source firmware support!

Release EDK2 SH 1.0:

EDK2 SH 1.0: CN913x-DB

EDK2 SH 1.0: MacchiatoBin

Release EDK2 SH 1.1:

EDK2 SH 1.1: CN913x CEx7 Evaluation Board

Instructions:

Running ACS3.0

Thank you

Accelerating deployment in the Arm Ecosystem

LVC21F-313
A firmware journey through standards to Arm SystemReady certification

Contact us at: **systemReady@arm.com**

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