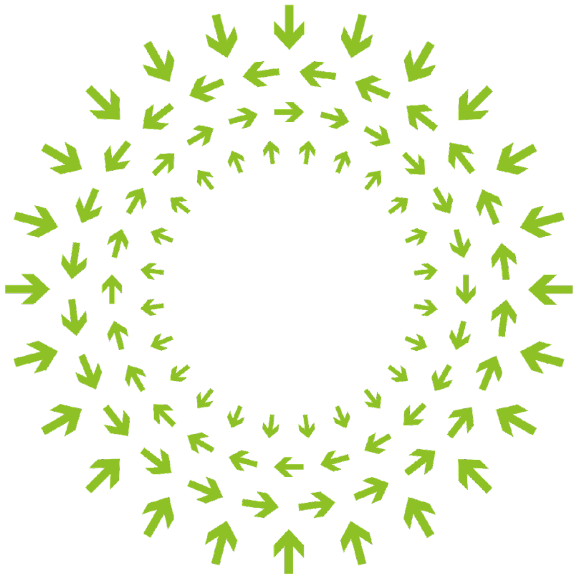

OPEN

Compute Project

<Title>

<Revision>

<Version>

Base Specification Template

Effective XXXX, 2023

Author: <Primary>
Author: <Secondary. Delete if unnecessary>

Table of Contents

1. License

PLEASE PICK EITHER THE OCP CLA OPTION OR THE OWF OPTION. ONLY ONE CAN BE USED. DELETE THE ONE NOT USED.

☐ OPTION A: OCP CLA
☐ OPTION B: Open Web Foundation (OWF) CLA

1.1. OPTION A: OCP CLA

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Notes:

1) The above license does not apply to the Appendix or Appendices. The information in the Appendix or Appendices is for reference only and non-normative in nature.

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1.1. OPTION B: Open Web Foundation (OWF) CLA

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Notes:

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1.2 Acknowledgements

The Contributors of this Specification would like to acknowledge the following companies for their feedback:

List all companies or individuals who may have assisted you with the specification by providing feedback and suggestions but did not provide any IP.

2. Compliance with OCP Tenets

Please describe how this Specification complies to the following OCP tenets. Compliance is required for at least four of the five tenets (Sustainability is a required tenet). The ideals behind open sourcing stipulate that everyone benefits when we share and work together. Any open source project is designed to promote sharing of design elements with peers and to help them understand and adopt those contributions. There is no purpose in sharing if all parties aren't aligned with that philosophy. The OCP Incubation Committee will look beyond the contribution for evidence that the contributor is aligned with this philosophy. The contributor actions, past and present, are evidence of alignment and conviction to all the tenets.

A full explanation of the OCP core tenets can be seen here.

2.1. Openness

The measure of openness is the ability of a third party to build, modify, or personalize the device or platform from the contribution. OCP strives to achieve completely open platforms, inclusive of all programmable devices, firmware, software, and all mechanical and electrical design elements, including ancillary, external components or tools such as software utilities necessary to modify or use design contributions. Barriers to achieving this goal should be constantly addressed and actions taken to remove anything that prevents an open platform. Openness can also be demonstrated through collaboration and willingness to share, seek feedback, and accept changes to design and specification contributions under consideration. Ensure this contribution can be extended and enhanced by others.

2.2. Efficiency

Continuous improvement has been a fundamental value of the industry. New contributions (and updates to existing contributions) shall be more efficient than existing or prior generation contributions. Efficiency can be measured in many ways - OpEx and CapEx reduction, performance, modularity, capacity, power or water consumption, raw materials, utilization, size or floorspace are some examples. The goal is to express efficiency with clear metrics, valued by end-users, when the contribution is proposed.

2.3. Impact

OCP contributions should have a transformative impact on the industry. This impact can come from introducing new technology, time-to-market advantage of technology, and/or enabling technology through supply chains that deliver to many customers in many regions of the world. New technologies are impactful when such technology is enabled through a global supply

channel. One example is the NIC 3.0 specification which achieved global impact by having over 12 companies author, adopt, and supply products that conformed to the specification. Another example is emerging and open security features that establish and verify trust of a product

2.4. Scale

OCP contributions should be designed such that end products may be easily implemented and/or deployed, irrespective of quantity, with minimal intervention. Ensure all necessary tools, such as supporting documentation, etc., are included in the final contribution.

2.5. Sustainability

OCP contributions must be sustainable. Submissions should maximize transparency of environmental impacts of the contribution, with the aspiration of improvement over time. Other focuses:

- Responsible use of our natural resources (land, air, power, water and materials)
- Positively impact society
- Reduced Costs (Energy, Water, materials)

Practically this can be realized in a base specification as high level design requirements, or architectural decisions, for example, that reflect this intent.

3. Change Log

Date	Version #	Author	Description

4. Scope

This document defines a Hardware Base Specification.

The Base Specification is an architectural framework for coarse alignment— a requirements description for flexible hardware and software modules to interoperate. Market requirements drive Base Specifications. Without defining details of a specific design, the Base Specification may be light on IP content. This structure enables and simplifies the process for multiple parties (including potential competitors) to engage in this phase.

Please see the presentation and recording on the Modular Contribution Process from the OCP Global Summit 2022 for more information.

This document defines the technical details for one of the following types of specifications:

- base specification for a de-facto standard (new standard with no hardware product)
- base specification for an intended physical <hardware product type>
- modification of an existing specification (state which existing spec is being modified)
    - either a complete revision update or
    - a minor version update

Note: Any supplier seeking OCP recognition for a hardware product must be 100% compliant with these Base requirements and subsequent design and product specifications as described.

Examples are provided for reference only and can be found in the OCP Contribution Portal:
De-facto Standard -
Cooling Environments: Immersion Fluid Specification *
Server - DC-MHS Modular Specifications *
Network - DS1000 Ethernet Access Switch Hardware Specification
Rack - ORV3 Base Specification*
Storage -
Cards - Open Accelerator Infrastructure (OAI) - Universal Baseboard (UBB) Specification
Revision Update -
Version Update -

* Note: Few Base Specifications were submitted prior to the final approved template.

5. Overview

Describe your contribution or product. Include the problems it addresses. Explain its utility within the Open Compute Project ecosystem.

INSTRUCTIONS FOR ALL FOLLOWING SECTIONS:

1. *Sections 6 – 17 are required to document features and functions of the Hardware system, platform or card. If a section is not applicable to your contribution, you may skip the section and leave it blank.*
2. *Where possible, please use the OCP Terminology Guidelines for Inclusion and Openness.*
3. *No NDA (Non-disclosure Agreement) or confidential material should be included in the document or charts. This will be an OPEN document.*

6. Environmental Regulatory Compliance and Requirements

Please describe any environmental regulations or requirements for any platform boards and full system, if applicable..

Note to author of this specification: This section can include the following but is not limited to the below items:

- *UL/CE/NRTL/FCC/IEC/EN/etc Requirements*
- *RoHS/WEE directives, REACH regulations*
- *NEBS compliance requirements*
- *Operating temperature range*
- *Storage temperature range*
- *Transportation temperature range*
- *Shock and Vibration requirements*
- *Operating Altitude*

Operating temperature	-40 ° to +55 °C	The RRH and mounting hardware shall fulfil its defined performance at ambient temperatures that range from -40°C...+55°C. The higher temperature range considers a solar radiation of 1120 W/m2".
Temperature changes	The RRH shall fulfil its defined performance after being exposed to the following test based on the norm DIN IEC 68-2-14 Nb: 1. Temperature range -40°C...+55°C 2. Time T1 = 3h (low...high, high...low temperature range) 3. Number of cycles 5	
Lighting protection	The RRH equipment shall fulfil lightning protection requirements from IEC 62305-1...4 and 61643-11 for SPD (Surge Protection device)	
Wind Speed Specification	150 km/h operation and 200 km/h survival	
Acoustic Noise	RRH shall be silent in operation; i.e. convection cooled. No fans. Acoustic noise emission must fulfil the standard: ETS 300 743 &ISO 7779	
Icing	Neither the RRH nor the mounting hardware should get damaged from 30mm of ice covering	
Salt	The RRH and mounting hardware shall fulfil its defined performance after being subjected to the following tests, based on the norm DIN IEC 68-2-52 Kb, severity class 2: 1. Test cyclic 2. Salt spray @ 1 cycle 2...3 hours 3. Dwell time @ 1 cycle 20...22 hours 4. Number of cycles 6 Based on the norm DIN IEC 68-2-11 Ka with salt solution spraying duration of 96 hours.	
Vibrations	The RRH shall fulfil its defined performance after being subjected to the following test. The following specifications sinusoidal vibration, apply (operating) based on the norm IEC 68-2-6, test Fc.: 1. Start frequencies 5 Hz 2. Stop frequency 200 Hz 3. Displacement 1,2 mm 4. Acceleration 4 m/s² 5. Duration 5 cycles per axis (3 axis tests)	
shocks	The RRH shall fulfil its defined performance after being subjected to the following test. The following specifications apply (non-operating) based on the norm DIN IEC 60068-2-27 Ea, Class 1 1. Acceleration 5G 2. Duration 11msec 3. Number of shocks 100 at minimum for each axis	
Operating altitude	Unit must meet all performance requirements up to 4000m above MSL. Derate maximum operating temperature by 1°C for every 300 m above MSL.	
Environment (water & dust)	Outdoor IP65	according to CEI/EN60529, for mounting in outdoor environments. (This is VDF RRH common requirement).
Safety	The RRH has to fulfil the following safety requirements: IEC 62305-4 class II and VDE 0855-300:2008-08	
ISO Certification	For RRH, ISO 9001 certification is required, and ISO 14001	

Example Outdoor Equipment Environmental Requirements

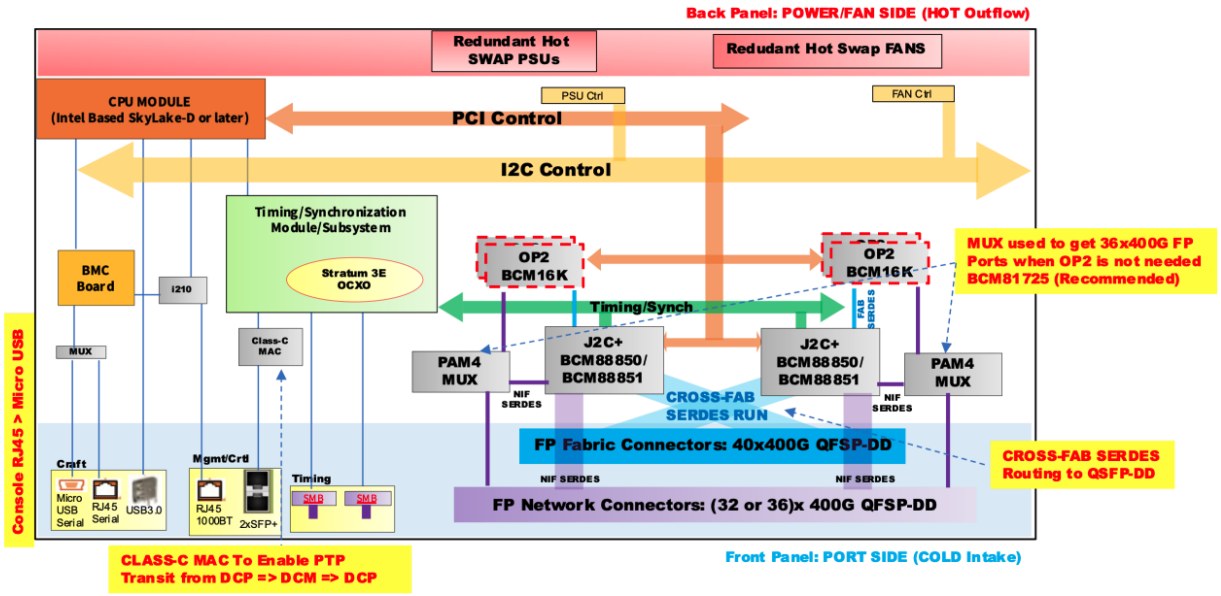
7. Physical Specifications

Please describe the physical requirements for your contribution. This may be the limitations of the physical envelope.

If this specification defines a chassis type system, be sure to include the description of the chassis and associated modules, midplane, backplanes etc….

Note to author of this specification: This section can include the following but is not limited to the below items:

- *Block Diagrams*
- *Form Factor Requirements*
- *Figures & Illustrations*



Sample Block Diagram

7.1 Mechanical

Please describe any key mechanical requirements of your contribution.

Note to author of this specification: This section can include the following but is not limited to the below items:

- *Chassis*
- *Single sled/double sled*

Physical FH interface	4x 25GHz SFP28	or 1x QSFP
Local Maintenance Port (LMP)	Supported	LMP is included for laboratory/factory use. LMP includes RS232 serial port, 100baseT Ethernet, JTAG, frame sync, 10 MHz, 1PPS. Requires external interface board.
Power supply	-48 VDC 3 wires	
Antenna connector	4.3-10	PIM performance = OK for 40 W.
External antenna line device	DIN-8 RET, AISG 2.0	AISG 2.0 will be supported. Support for TMAs etc. via external Smart biasT. No AISG OOK modem in RRU.
External alarms	4-pin DIN connector	2 alarm wire pairs, open/short: open >10 kOhms, short < 10 Ohms
Mounting	Rail, wall and pole	
Volume target	< 24 liters	
Weight target	< 25 kg die cast	

Dual-Band RRU Mechanical Requirements

8. Electrical Requirements

Please describe general electrical power requirements. Example: Power Input envelope +48VDC, 110VAC, peak/average power, etc…

Air interface	1. LTE, LTE-A 2. NB-IoT (modes- In-band NB-IoT, Guard-band NB-IoT) , NB-IoT boost factor <= 9 dB 3. 5G NR : BW up to 100 MHz	Stand-Alone NB-IoT not supported. To meet band-C requirements in future, IBW of 100MHz need to be supported
Operating mode	FDD	
Single or multi-Band	Multi-band	More than one band. Most likely 2, but depending on bands, there can be more than 2 bands
Number of bands	2	depending on the bands, there can be more than two bands supported. There are two preferred band arrangement mentioned: 1- Band 3 + Band 1 2- Band 28 (28B) + 20 + 8
Frequency Band #1	1	
Frequency Band #1 Tx Power	40W	Minimum 40W for mid and high bands. For low band it can be as high as 80W
Frequency Band #1 MIMO order	4T4R	
Frequency Band #2	3	
Frequency Band #2 Tx Power	40W	Minimum 40W for mid and high bands. For low band it can be as high as 80W
Frequency Band #2 MIMO order	4T4R	
Antenna Ports	4	
Antenna Configuration	4T4R	
Beam Forming	No	
Instantaneous BW (IBW)	Full band	60MHz for Band 1 and 75MHz for Band 3
Occupied BW (OBW)	Full Band	
Carrier capacity	6 per band	At least 2 LTE and 2 5G NR carriers
Carrier bandwidth	LTE: 5, 10, 15, 20 NR: 5, 10, 15, 20, 25, 30	
Sub-Carrier Spacing	LTE: 15kHz NR: 15KHz, 30KHz, 60KHz	
Physical FH interface	4x 25GHz SFP28	or 1x QSFP
Local Maintenance Port (LMP)	Supported	LMP is included for laboratory/factory use. LMP includes RS232 serial port, 100baseT Ethernet, JTAG, frame sync, 10 MHz, 1PPS. Requires external interface board.
Power supply	-48 VDC 3 wires	

Dual-Band RRU Electrical Requirements

9. Thermal Design Requirements

Please describe the thermal design requirements for your contribution and any CFD and/or thermal models etc...

Note to author of this specification: Examples include:

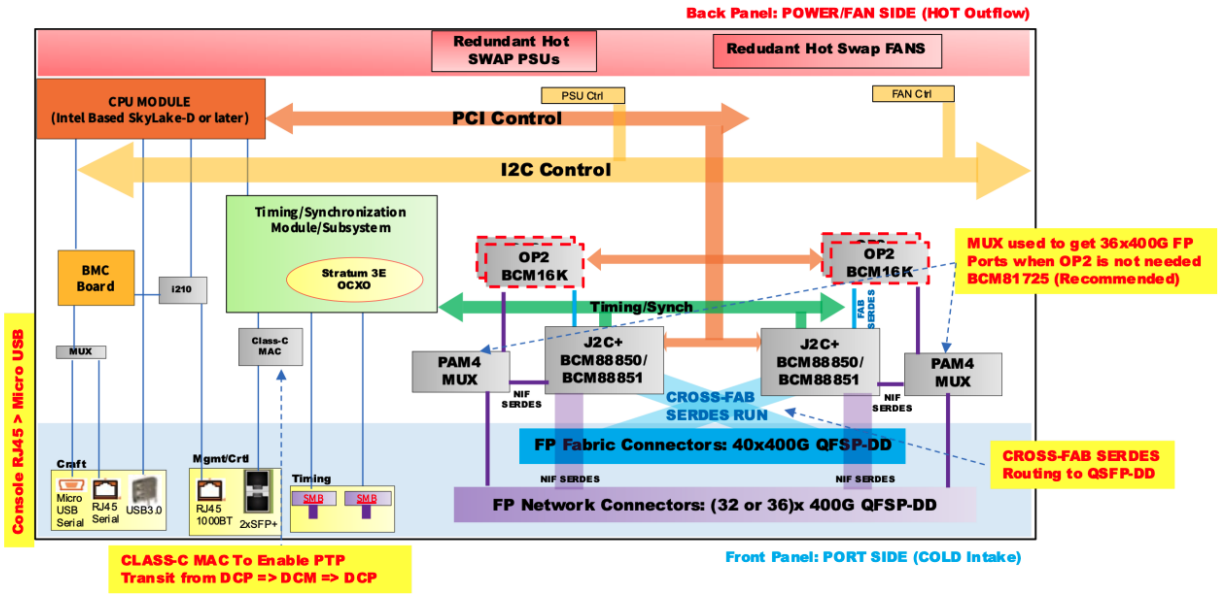
- *Cooling Media*
- *Flow Management*
- *Fan Controls*

Operating temperature	-40 ° to +55 °C	The RRH and mounting hardware shall fulfil its defined performance at ambient temperatures that range from -40°C...+55°C. The higher temperature range considers a solar radiation of 1120 W/m2".
Temperature changes	The RRH shall fulfil its defined performance after being exposed to the following test based on the norm DIN IEC 68-2-14 Nb: 1. Temperature range -40°C...+55°C 2. Time T1 = 3h (low...high, high...low temperature range) 3. Number of cycles 5	
Wind Speed Specification	150 km/h operation and 200 km/h survival	
Acoustic Noise	RRH shall be silent in operation; i.e. convection cooled. No fans. Acoustic noise emission must fulfil the standard: ETS 300 743 &ISO 7779	
Icing	Neither the RRH nor the mounting hardware should get damaged from 30mm of ice covering	

Dual-Band RRU Thermal Requirements

10. Interfaces

Please describe the I/O System of the contribution, be sure to delineate the control and data planes. Block diagrams here.



10.1 Signal List

Note to author of this specification: Examples only

- *Power and Ground*
- *Synchronization/Clocks*
- *PCIe*
- *i2C/i3C*
- *GPIO*
- *USB 3.0*

10.2 Rear Side Power, I/O, Expansion Board and Midplane Subsystems

Please describe any modular design implementation requirements of the contribution.

Note to author of this specification: This section can include the following but is not limited to the below items:

- *Overview of Footprint and Population Options*
- *Rear Side Connectivity*
- *Midplane*
- *Expansion*
- *Fixed, redundant, modular, pluggable, adapter?*
- *Power, Grounding etc…*

Physical FH interface	4x 25GHz SFP28	or 1x QSFP
Local Maintenance Port (LMP)	Supported	LMP is included for laboratory/factory use. LMP includes RS232 serial port, 100baseT Ethernet, JTAG, frame sync, 10 MHz, 1PPS. Requires external interface board.
Logical fronthaul interface	OAM: NetConf/YANG (O-RAN) Fronthaul: O-RAN split 7-2x, RRU type A	All the OAM aspects including software upgrades, configuration, KPIs, alarms etc. for RRU would be managed from BBU/DU via M-plane O-RAN interface as specified in O-RAN specifications.
O-RAN RRU Type	RRU Type A	O-RAN - RRU Type A, 7.2x implies following PHY functions on RRU: * DL Direction- IFFT and CP addition * UL Direction - FFT, CP removal and PRACH filtering/handling Note - RRU type B is not supported. It is NOT upgradeable to RRU Type B.
Power supply	-48 VDC 3 wires	
Antenna connector	4.3-10	PIM performance = OK for 40 W.
External antenna line device	DIN-8 RET , AISG 2.0	AISG 2.0 will be supported. Support for TMAs etc. via external Smart biasT. No AISG OOK modem in RRU.
External alarms	4-pin DIN connector	2 alarm wire pairs, open/short: open >10 kOhms, short < 10 Ohms

Dual-Band RRU External Interface Requirements

11. Onboard Power System

Please describe the architecture of the power systems and requirements in your contribution.

Note to author of this specification: This section can include the following but is not limited to the below items:

- *Voltage Regulation*
- *Power Management*
- *Input voltages*
- *Hot swap controller circuit*
- *Hard drive power*
- *Power Tree*
- *Power Policy*
- *Power Budget*
- *Platform Budget*
- *Capacitive Load*

Power supply	-48 VDC nominal. -57V < Vin < -40.5V 3 wires

Dual-Band RRU Power Supply Requirements

12. Prescribed Materials

Please list any prescribed materials in your contribution. Specific components that are being referenced but not contributed.

Note to author of this specification: This section can include the following but is not limited to the below items:

- *Disallowed components*
  Any specifically required components with no substitution (Ex: IC Intel JHL8540 or greater for Thunderbolt 4 compliance)

13. System Firmware

Please document firmware function, and necessary features, licensing and distribution rights, explanation of ownership rights, system build utilities, test regime explanations, standards compliance, options for changing firmware configurations, and how firmware upgrades can be accomplished.

Note to author of this specification: This section can include the following but is not limited to the below items:

- *BIOS Chip*
- *BIOS Feature Requirements*

14. Hardware Management

Please document the hardware management implementation of your contribution. Include Firmware (BIOS) optional Board Management Controller (BMC), Data Center Secure Control Modules (DC-SCM), etc.

*Note to author of this specification: This section **should** include the following below items:*

- *Statement on whether the contribution supports out-of-band manageability.*
- *Statement on the modularity of the manageability architecture. (i.e. is an OCP management module used?)*

*Note to author of this specification: This section **can** include the following but is not limited to the below items:*

- *Architecture of out-of-band management*
    - *Dedicated or shared NIC*
    - *In which power state is the OOB management enabled*
- *A list of on-platform manageability interfaces:*
    - *Connections: I2C/I3C, SMBus, RMII,*
    - *Transport Protocol: MCTP, IPMI (KCS, BT, etc)*
    - *Commands constructs: PLDM …, IPMI, SPDM, CPER*
- *A list of components whose firmware which can updated programmatically*
    - *Which support failover/rollback mechanisms*
- *A list of diagnostic or management LEDs supported*
- *A list of minimum telemetry/sensors*
- *A list of minimum controls*
- *Whether conformance to OCP Profiles has been tested*
- *For Arm-based Servers, whether conformance to Arm Server Base Manageability Requirements Specification has been followed. If so, please also indicate the conformance level (e.g., M2)*

14.1. Compliance

All Products seeking OCP Accepted™ Product Recognition shall have source code and binary blobs submitted for BMC, if applicable.

The BMC management source code shall be uploaded at:
https://github.com/opencomputeproject/Hardware-Management/[vendor_name]/[product_name]

15. Security

*Please briefly describe security functionality that **your specification requires and recommends***. Include a "required by" date on recommendations. Omit what doesn't apply and add whatever is missing. Remember, the greater the detail in this specification, the less flexibility is allowed during design and product specification.*

- *For cryptography, key derivation, key agreement, and hashing, identify*
    - *o Required algorithms, modes, strengths, and usage*
    - *o Required compliance with national or international standards*
    - *o Acceptable sources of entropy*
    - *o Acceptable certifications of algorithm implementations*
    - *o Recommended certifications of cryptographic modules*
    - *o Recommended safeguards against cryptanalysis by quantum computers*

- *Required flow of Secure Boot starting from hardware root(s) of trust*
- *Required measurements from hardware reset through firmware*
- *Required attestation protocols*

- *Acceptable environments and processes for provisioning keys and device secrets*
- *Acceptable processes for identifying CVEs and distributing field updates to address them*
- *Acceptable Secure Boot and Attestation key lifecycle management (from generation through*
- *revocation)*

- *Recommended standards for software bills of materials*
- *Recommended firmware recovery mechanisms*

**Required = Required now*
Acceptable = Required now and chosen from a list of acceptable alternatives
Recommended = Recommended now, but required by a specified future date

Please find guidance and examples in the OCP Security Project documents on Secure Boot, Attestation of System Components, Common Security Threats, and the CSIS document on Secure Firmware Development Best Practices.

All products seeking OCP Inspired™ or OCP Accepted™ Product Recognition shall have a completed Security Profile in the 2021 Supplier Requirements Checklist. Whether the answer is a yes or no, the profile must be completed.

16. Software Support (recommended)

Please identify any software and/or tools used to validate the hardware design and include test and validation using virtual simulation, design decisions based upon digital models, or proof of manufacturability via 3-D tools.

17. Arm SystemReady (only for Arm-based Systems)

Please document the full Arm SystemReady certificate information: Company, System, SoC Family, Firmware Version, Date Issued.

For Server Sleds, Open Edge Sleds and Monolithic Servers, the certification of either SystemReady SR or LS certification is required.

For Storage and Networking, the certification of SystemReady SR, LS, ES, or IR is recommended.

For Systems that are SystemReady SR, ES or IR certified, SystemReady Security Interface Extension (SIE) certification is recommended.

More details on Arm SystemReady can be found at https://www.arm.com/architecture/system-architectures/systemready-certification-program.

18. References (recommended)

1. “Title”, publication year, publication journal/conference/standard, volume, pages, link to publication if available

Appendix A - Checklist for IC approval of this Specification (to be completed by contributor(s) of this Spec)

Complete all the checklist items in the table with links to the section where it is described in this spec or an external document .

Item	Status	Link to detailed explanation
Has this contribution been presented to an OCP Project group during a project call or engineering workshop?	Yes or No	If “No”, please state the reason.
Approval by Project Leads	Yes or No	If “No”, please state the reason.
Is this contribution entered into the OCP Contribution Portal?	Yes or No	If “No”, please state the reason.
Was it approved in the OCP Contribution Portal?	Yes or No	If “No”, please state the reason.

Appendix B - Contribution Process FAQs

As a contributor to a hardware specification, here are some questions that often come up.

Q1. What type of specification am I contributing to OCP?

a. **The base specification** for a de-facto standard (ex: interface type)
b. The base specification for a product <product type> (product may be coming but within the next 1-2 years)
c. Modification of an existing <type> specification (state which existing spec is being modified) resulting in a revised specification.
d. **Design specification** (based on an existing base specification) with more refined design details (product coming in 12-15 months)
e. A detailed **Product specification** for a <product type> for a very specific product being available in 3-6 months of approval of this Spec
f. If none of the above, please contact OCP Staff for better direction.

Q2. How do I know if what I am contributing will be accepted by OCP?

a. Before contributing any specifications, please contact either OCP Staff (Rob Coyle, Michael Schill) or the Project Lead for the Project that best represents your contribution. They will guide you as to what's the best form for your contribution. Project List here.

Q3. What is the contribution process for my hardware spec?

a. Follow the flow for your spec type here.

Q4. What if my spec is not developed yet and I want to collaborate with other companies?

a. Please contact either OCP Staff (Rob Coyle or Michael Schill) or the Project Lead for the Project that best represents your contribution. They will help you find other collaborators and help you with the contribution process for a multi-party contribution.

Q5. I have a question about the Contribution License Agreement (CLA).

a. Please contact OCP Staff and we can help you with questions.

Q6. Do I need to have a product in order to make a contribution?

a. Please see Q1. Some types of contributions do not result in a product. Some examples are whitepapers, case studies, OCP Ready Assessment, etc.. Please work with the OCP Staff on the better direction on your specification type.