

Scalar Crypto Standardization Status Summary

Status at a glance:

- **Current** [Definition-of-Done](#) Status: **Ratified**
 - We finished **public review** on Oct 17'th, 2021
 - See [here](#) for a summary of public review feedback.
 - Scalar Crypto Standardization have been **Ratified**
- ~~Next~~ ~~Definition of Done Status: Ratification~~
- Definition of Done [Status Top Sheet](#)

Scalar Crypto Specification:

- [Latest Draft Scalar Crypto Specification](#) (v1.0.0)
 - Contains feedback from public review.

Lightweight instruction set extensions for RV32 and RV64 HARTs. Proposed extensions:

- Extensions fully defined in the Scalar Crypto Specification: Zk, Zkn, Zks, Zkr, Zkne, Zknd, Zknh, Zksed, Zksh, Zkt
- Shared with the Bit-Manipulation Specification: Zbkx, Zbkz, Zbkbc
- [Instruction Group Names Diagram](#) (click thumbnail for full-size image)



Pub

Architecture & Opcode consistency review

- The results of the review can be seen here. [Scalar Crypto Arch Review Results.pdf](#)
- After discussion within the task group, the following changes will be made to the spec, with the changes expected to land in 0.9.4 before the end of August.
 - Stop overlapping the aes32 and aes64 opcodes. See [riscv/riscv-ops#77](#)
 - Clarify the effect of misa.k
 - Some updates to the entropy source and zkt detailed [here](#).
 - Miscellaneous editorial issues.
- Some downstream tasks for our group development partners now we are in public review.

Who	What	Status	Task
PLCT	GCC	Not started	Update extension names: Zkb Zbkb etc.
PLCT	GCC	Not started	Update aes32/64* encodings if applicable.
PLCT	LLVM	Done	Update extension names: Zkb Zbkb etc.
PLCT	LLVM	Done	Update aes32/64* encodings if applicable.
IIT	riscv-config	Not started	Update extension names: Zkb Zbkb etc.
IIT	riscv-config	Not started	Update instruction inclusion in different extensions
IIT	riscv-arch-tests	Not started	Break up K suite into Zk* extensions
IIT	riscv-arch-tests	Not started	Update instruction inclusion in different extensions

Architecture Tests

- Test plan for the scalar-crypto specific instructions is [available](#).
- Imperas have a complete set of tests, written to the existing test plan, for the scalar crypto instructions and the bitmanip instructions we borrow.
 - These have been merged into the main test suite as of [PR#177](#), with many thanks to Imperas for the contribution.
 - Spike, OVPSim and Sail all agree on the test signatures.
 - They form a base we can use to develop prototype implementations / Spike / SAIL / QEMU very easily and quickly.
- Upstream Spike support for enabling it to work with the K test suite is being added in [PR#687](#).
- IIT Madras are also looking at writing the scalar crypto tests for integration into the official architectural tests repo as well.
 - [Agreed SoW](#) for IITM
 - They are re-implementing the tests as part of the blessed coverage and test generation tooling.

- Making good progress with the simple test patterns for scalar-crypto specific instructions A/O April 7'th '21
 - We then switch over to using the IIT tests when they are finished, since they will be easier to maintain/extend going forward than the Imperas tests.
 - YAML config changes for K have been merged in. See [here](#).
 - Update from IIT Madras as on 25-Oct
 - Sample cgf file for Kspec ver 1.0.0-rc4 is in <https://github.com/anku-anand/riscv-ctg/tree/kspec-rc4>
 - Status from IIT Madras as on 17-Jun:
 - All test cases and coverage reports has been generated and presented.
 - If there are any changes in future on these that is required in future, IIT Madras will enhance the scripts as per requirements.
 - Status from IIT Madras as on 20-May:
 - Real world test cases as per the test plan has been generated.
 - Currently waiting for the fixed toolchain with K extension from PLCT to test the generated test cases. All the test cases are working fine when we run against the patched toolchain
 - A PR has been raised with a pull request for this suite to be reviewed and merged in the riscv-arch tests github repo.
 - Status from IIT Madras as on 12-May:
 - Coverage report for all developed cases in CTG/ISAC has been generated and it is reported as 100%
 - Currently real world test cases are being developed as per test plan and will be completed and send for review by beginning of next week
 - Status from IIT Madras as on 05-May:
 - Resolved issues in running the rv64ik toolchain after interacting with PLCT and compile the relevant tests generated from CTG and run them on spike
 - Currently resolving issues in the running the rv64ibk toolchain. Once this is done, will generate the coverage report of the test cases built till now and share with team.
 - Status from IIT Madras as on 26-Apr:
 - Completed the coverage points specification for all 32-bit and 64-bit instructions
 - Generated test cases from the coverage points
 - Currently working on trying to install the scalar crypto enabled toolchain.

Compilers / Toolchains

Imperas maintain pre-built toolchains for various in-progress RISC-V extensions [here](#). See the "rvk-*" branches for scalar crypto.

GCC and Binutils

- Experimental / development toolchain available in the riscv-crypto [repository](#).
 - This cannot be up-streamed, but can be used for development work for now.
- [Intrinsics proposal from Markku](#)
- PLCT lab have developed complete Binutils and GCC patches.
 - The pull requests into the main RISC-V repos can be found here:
 - Binutils pull request: <https://github.com/riscv/riscv-binutils-gdb/pull/254>
 - GCC pull request: <https://github.com/riscv/riscv-gcc/pull/250> (merged)
 - The PLCT lab continuous integration server can be found here:
 - <https://ci.rvperf.org/view/Krypto-Scalar/>
 - This is a good place to start for re-producing the PLCT builds of GCC/Binutils
 - Some small changes will be needed as we move to v1.0 of scalar crypto around encodings.

LLVM

- Work will be done by PLCT lab under the group contributor model.
 - [Github repository](#)
 - [Continuous integration status](#)
- [Slides from PLCT Update](#) Weds 10'th Feb
- As of 21'st April '21, LLVM work is mostly complete, waiting on PLCT lab for an update about merging things upstream.
 - Some small changes will be needed as we move to v1.0 of scalar crypto around encodings.
- As of 24'st Jan '22, LLVM upstream is able to compile the assembly code of [Zk*](#) and [Zbk*](#)

Simulators

Though all listed under "simulators", these are actually a collection of formal model / virtual machine / architectural simulators / DV simulators etc.

SAIL

- Currently working on getting support merged in upstream in [PR#99](#)
 - Support for all scalar-crypto dedicated instructions and the entropy source is present.
 - No support for Bitmanip yet.

Spike

- Upstream support has been merged in.
- Instructions are up to date with v1.0.0

riscvOVPSimPlus

- Imperas Commercial Simulator

- [Freeware version](#)
- Supports:
 - Crypto-scalar v0.7.2, v0.8.1, 0.9.0, 0.9.2, 1.0.0-rc1, + Bitmanip subsets
 - Bitmanip 0.90, 0.91, 0.92, 0.93-draft, 0.93, 0.94, 1.0.0
 - Functional coverage collection.

QEMU

- Work will be done by PLCT lab under the group contributor model.
 - [Github repository](#)
 - [Continuous integration status](#)
 - Waiting to hear back from PLCT on status.

Proof-of-Concept implementations

Hardware

Project Name	Base Architecture	Level of implementation	Notes
Stand-alone functional units	RV32/64	Yosys Synthesis	Stand-alone functional-unit style implementations of the dedicated scalar crypto instructions. Free to use as "drop-ins" for prototyping.
scarv-cpu	RV32	Behavioural RTL simulation / Yosys Synthesis / FPGA	Completely Public/Open Source. Useful as a public baseline. Commercial implementations should aim to be better than this!
PQShield security core	RV32	(assumed) Behavioural RTL simulation. Running on FPGA.	Closed / commercial source - PQShield.
Minidice TRNG	N/A	FPGA Implementation	Closed / commercial source - PQShield. Complete implementation of the RISC-V entropy source.
Romain Dolbeau / VexRISC-V	RV32	Running on FPGA.	Uses VexRiscv core as a base. Completely independent implementation from scratch, outside the Crypto TG.
IQonIC Works RV32IC_P5	RV32	In development	"implemented Zkn (...), along with selectable Zb* and Zkb. We also have an optional custom extension that does AES block encrypt/decrypt, and a bus-based AES/cipher-mode accelerator. Work in progress benchmarking them on FPGA to compare relative performance in accelerating crypto library functions."
croyde-riscv	RV64	Behavioural RTL simulation / Yosys Synthesis / FPGA	3-stage RV64 micro-controller. rv64imck. Free/Open source. Something commercial implementations should better. Implements everything <i>except</i> ZKR.

- ⚠️ We still need RV64 implementations. ⚠️
- Barry Spinney has offered to do advanced node synthesis runs for open source implementations.
 - I (Ben) intend to take him up on this when I get time. No idea when that will be.

Software

Project/Maintainer	Description
Romain Dolbeau	Independent implementations of various important ciphers + modes of operation.
rvkrypto-fips / Markku	"FIPS 140-3 and higher-level algorithm Tests for RISC-V Crypto Extension"
riscv-crypto benchmarks	Initial benchmarks used to develop the scalar crypto extension.

ABI Extensions

- None required