Recent Achievements of the Open-Source CVA6 Core

Sébastien Jacq, Jean-Roch Coulon, Kevin Eyssartier, Jérôme Quévremont

**CORE-V CVA6:**
- Open-source RISC-V application core.
- Two flavors: CV32A6 (32-bit) and CV64A6 (64-bit).
- Written in SystemVerilog.
- Highly Configurable: optional features and extensions, customizable L1 cache.

**Major Thales recent contributions to CVA6:**
1. Add the CV-X-IF coprocessor interface to extend the supported instruction set.
2. Optimize CV32A6 (performance, resources) for FPGA targets in a technology-agnostic fashion.
3. Add Yocto Linux support.

**Domain-Specific Acceleration**

**Challenge:** Extend CVA6 with coprocessors to accelerate applications
- CV-X-IF coprocessor interface specified by the OpenHW Group to promote the interoperability of CPU cores and coprocessors.
- Domain-specification acceleration with custom extensions.
- Support of RISC-V extensions not featured by the core (e.g. SIMD).
- No change to the RTL source code of the RISC-V core.

**How it works:**
- When the core decodes an instruction that it cannot execute, the instruction is offloaded to the coprocessor.
- Compressed instructions are supported.
- The coprocessor can also submit memory requests.

**Results:**
- CV-X-IF available in CVA6.
- Already demonstrated with several coprocessors.
- CV-X-IF implementation can handle speculative execution.

**Optimizations for FPGA targets**

**Challenge:** Optimize CV32A6 for FPGA targets to offer a competitive and technology-agnostic soft core for FPGA.
- Alternative to FPGA proprietary soft processor cores (Microblaze, Nios-II...).
- Same core, same source code for FPGA and ASIC developments.
- Boosting multi-sourcing and the reuse of HW/SW architectures, with reduced risks, costs and delays.

**How it works:**
- Better mapping to FPGA resources.
- Making features optional.
- Selecting relevant parameters for FPGA typical use cases.
- Optimizing the microarchitecture.

**Results:**
- CV-X-IF available in CVA6.
- Already demonstrated with several coprocessors.
- CV-X-IF implementation can handle speculative execution.

**Embedded Linux Support**

**Challenge:** Extend the SW ecosystem with Yocto support
- Popular generator of Linux distributions for embedded systems.
- Access to a wide catalog of applications and frameworks.
- Handles the whole embedded complexity with a packaged SDK and easy deployment.

**How it works:**
- Meta-cva6-yocto contains recipe modifications of:
  - U-Boot with SDCard and TFTP support.
  - OpenSBI.
  - Busybox.
  - Linux 5.10.7 kernel.

**Results:**
- Recently released Yocto support allows contributors and users to quickly run a Linux distribution on CV32A6 and CV64A6.
- Eclipse IDE-based Linux and bare metal debug also available.

**Perspectives**

These CVA6 results will be further expanded in upcoming projects:
- More performance optimizations of the core
- More acceleration with new CV-X-IF coprocessors
- Richer and improved documentation
- Industrial-grade verification
- Safe & secure features
- Software ecosystem

**Acknowledgements**

The authors acknowledge the European projects which support CVA6, the OpenHW staff and the OpenHW members who are contributing to CVA6: hypervisor mode, high performance cache interface, vector processor interface, bit-manipulation (Zb) extension, verification...

---

**https://github.com/openhwgroup/cva6/**
**https://github.com/openhwgroup/meta-cva6-yocto**
**jerome.quevremont@thalesgroup.com**