THE VARIABLE EXTENDED PRECISION PROCESSOR (VXP)

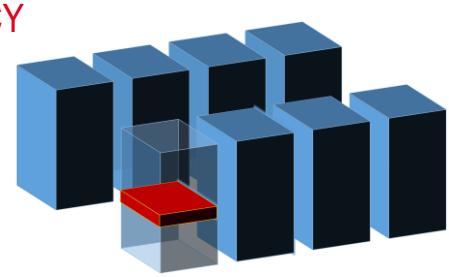
A Computing Accelerator Designed for High Precision Computation (up to 512 bit mantissa)

OVERVIEW

The variable extended precision processor (VXP) is a dedicated hardware/software **accelerator suitable for the resolution of large ill-conditioned systems of equations.** Its **tunable, dynamic precision speeds up convergence** and **improves memory usage** and **computational efficiency.**

BENEFIT : HIGHER PRECISION FOR IMPROVED EFFICIENCY

Increased precision greatly reduces rounding errors, and improves the computing efficiency of algebraic computations at the compute node level. Certain problems do not even converge with standard double precision.
The VXP accelerator supports **arithmetic operations in hardware with up to 512 bits of mantissa.** Its **dynamic precision** is **fine grain tunable** for **optimal use of near processor memory.**

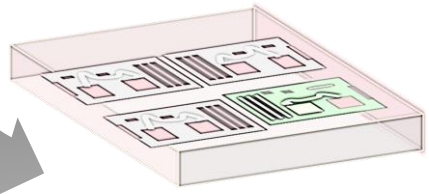


Computing Infrastructure (Supernodes)

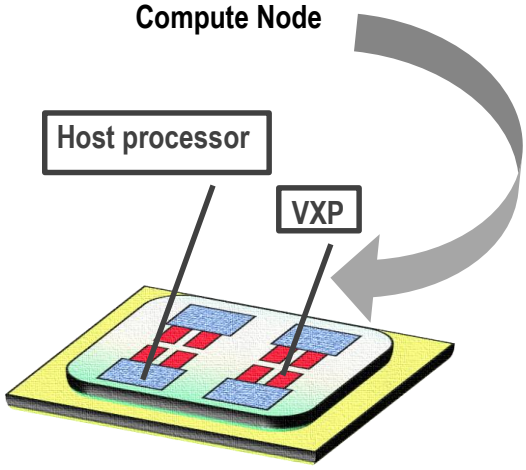
KEY FEATURES

The VXP is a complete **hardware** and **software** solution with:

- Dedicated hardware :
  - ✓ Silicon proven in GF 22nm FDX and new design in TSMC 7nm (**E**uropean **P**rocessor **I**nitiative)
  - ✓ FPGA board for early access
- Software stack :
  - ✓ C-like programming environment (compiler and assembler)
  - ✓ Library for mathematic and low-level algebraic subroutines
  - ✓ Runtime environment



Compute Node



Processor + Accelerator(s)

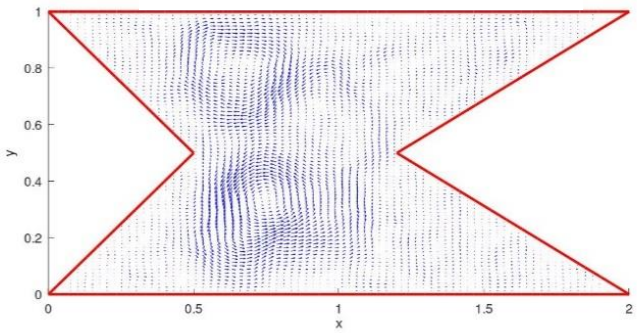
APPLICATIONS

Improve the efficiency of computing for algebraic solvers and eigensolvers :

- Scientific computing : computational physics and chemistry, electronic simulation, structural computation, climate models, weather prediction, fluid dynamics.
- Model order reduction : learning for AI, large dynamic systems.

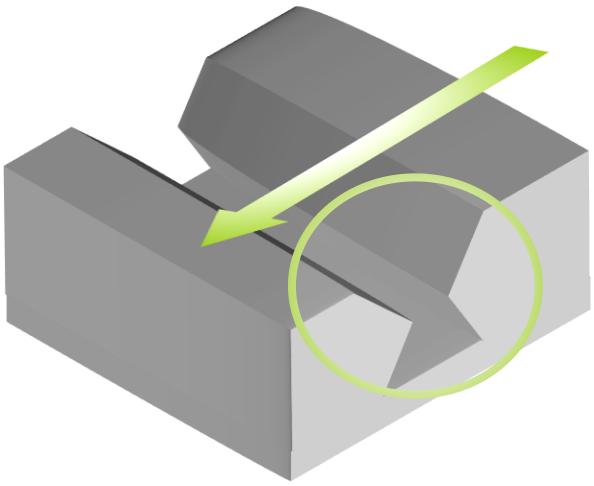
FIRST RESULTS ON AN ILLUSTRATIVE EXAMPLE

Modern linear algebra kernels (solvers, eigensolvers…) are highly sensitive to numerical pitfalls (cancellation, absorption...) which are a source of computational instability. This may alter or even occult some physical phenomena, whereas augmenting precision restores the numerical consistency of the model.
By modelling a classical laminar flow problem over a cavity with **192 bits** of mantissa**, turbulence details appear** whereas they are lost in the noise with double precision (53 bits of mantissa).

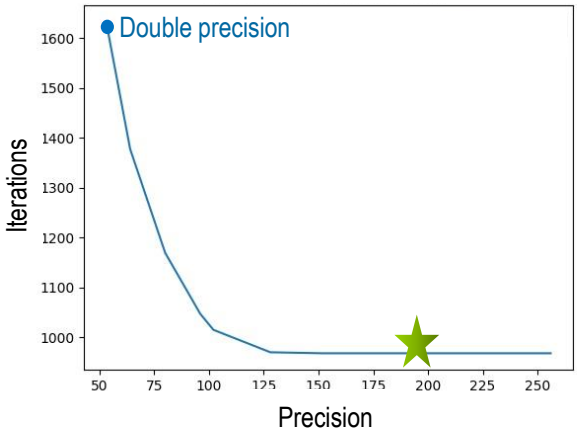


Difference in Laminar Flow between Solutions with 53- and 192-bit Precision.

In this application, the variable extended precision processor (VXP) allows us to :
- model non-observable variations in standard precision.
- reduce the number of iterations until convergence by 40%



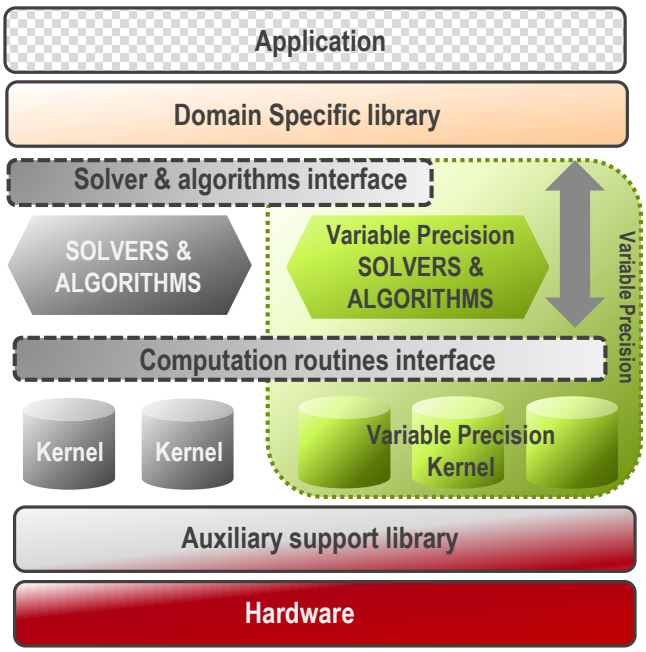
Laminar Flow over a Cavity



Number of Required Iterations versus Numeric Precision (bits of mantissa)

HOW DOES IT WORK ?

A conventional scientific application can smoothly be integrated with the VXP unit, just as a plug-in for scientific software applications. Whenever the compute node host cannot achieve the expected accuracy with standard precision, the VXP takes over and continues with extended precision until the error tolerance constraint is met.
In the current version, the VXP is embedded as a functional unit in a 64-bit RISC-V processor pipeline. The VXP extends the standard RISC-V instruction set with basic arithmetic operations and specific instructions in variable precision.
The VXP relies on the RTEMS software for communication with the host and global synchronization.



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