Accelerating massively parallel .NET code using FPGAs with Hastlayer

GPU Day, 20.06.2022

Zoltán Lehóczky @ Lombiq

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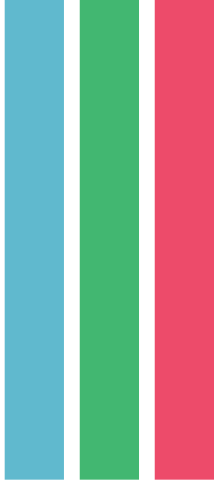
be the hardware



Let’s talk about you!

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You’re a researcher doing some number crunching.

Number crunching like in…

- Artificial intelligence, machine learning
- Image and video processing, computer vision
- Fast Fourier transform
- Monte Carlo simulation
- Data compression

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To make faster you can…

- Profile and optimize it
- Parallelize it
- Use faster and/or more hardware

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To make faster you can…

- Profile and optimize it
- Parallelize it
- Use faster and/or more hardware
- Use heterogeneous computing: GPUs, FPGAs…

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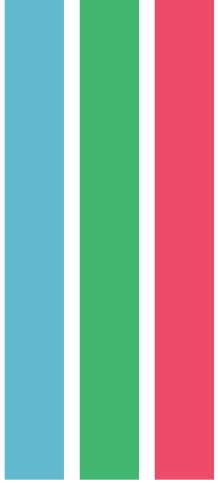

Let’s explore the last part a bit.

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FPGAs?

- Field-Programmable Gate Array
- Can behave like any other chip (with limitations)
- Can dynamically be „re-wired”

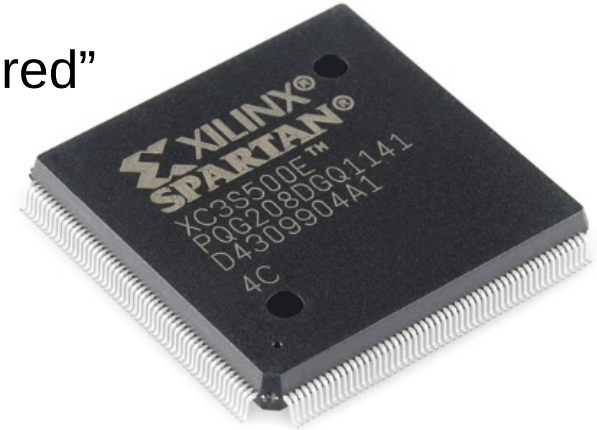

Image by SparkFun Electronics, Boulder, USA

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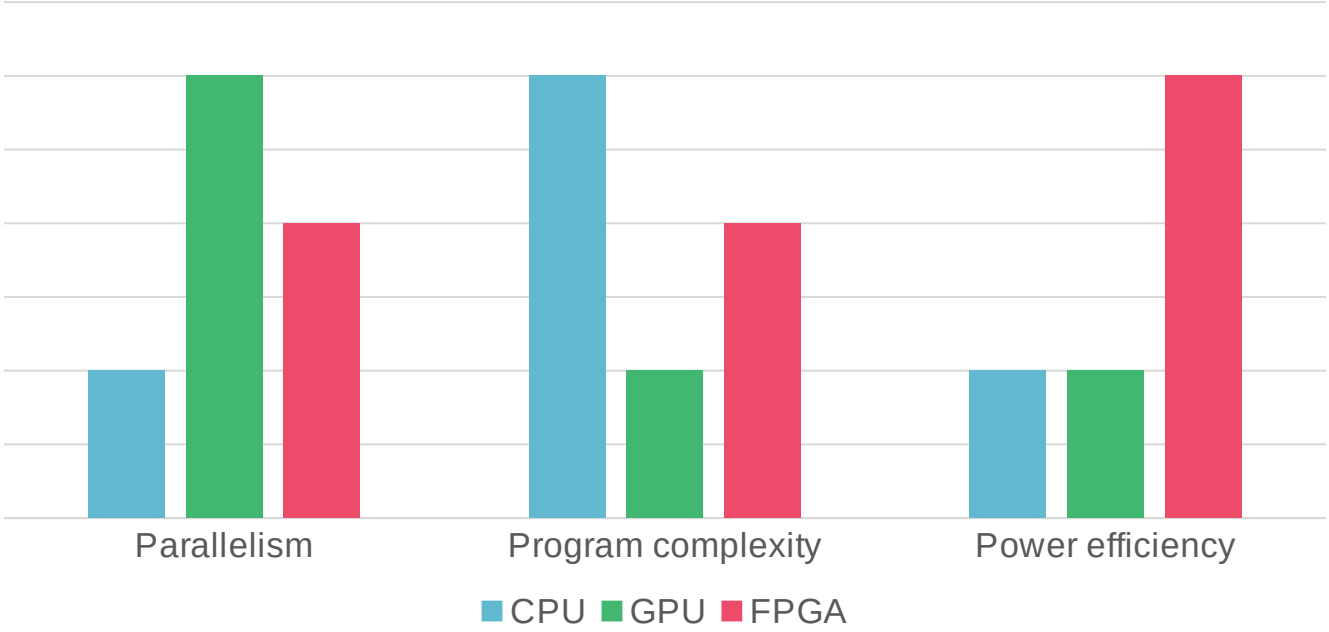
CPU vs GPU vs FPGA



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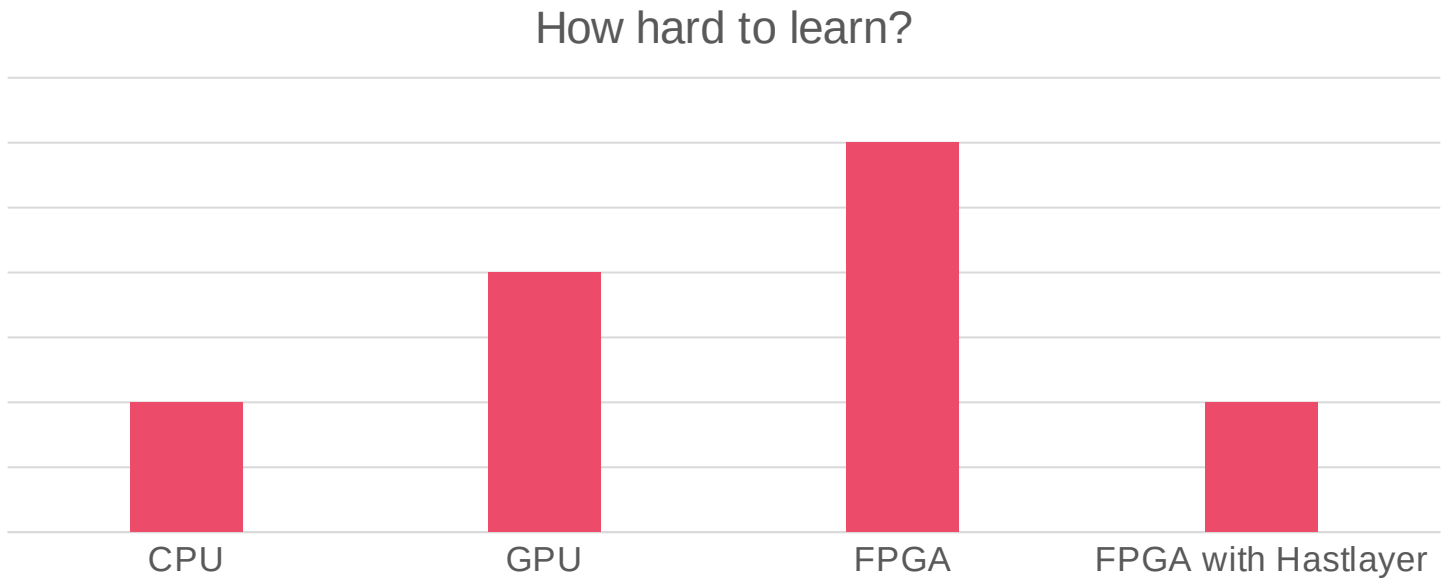

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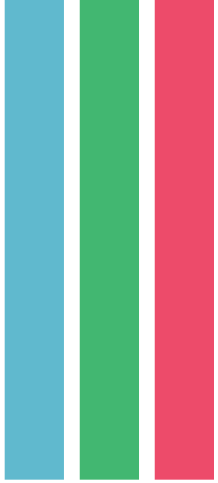

What’s Hastlayer?

computer program → FPGA logic

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.NET (C#, VB, C++, F#, Python, PHP, JavaScript…) → FPGA logic

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But why .NET?

- Modern development tools
- Huge community
- Open-source

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The benefits of FPGAs for us all

- Performance increase for parallel compute-bound algorithms
- Higher power efficiency
- Still only software development

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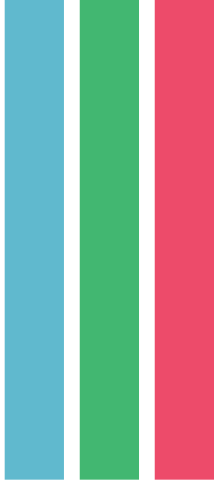

Demo: Hands-on Hastlayer

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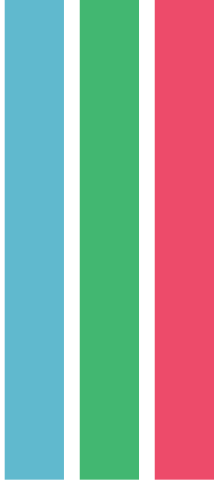

What’s under the hood?

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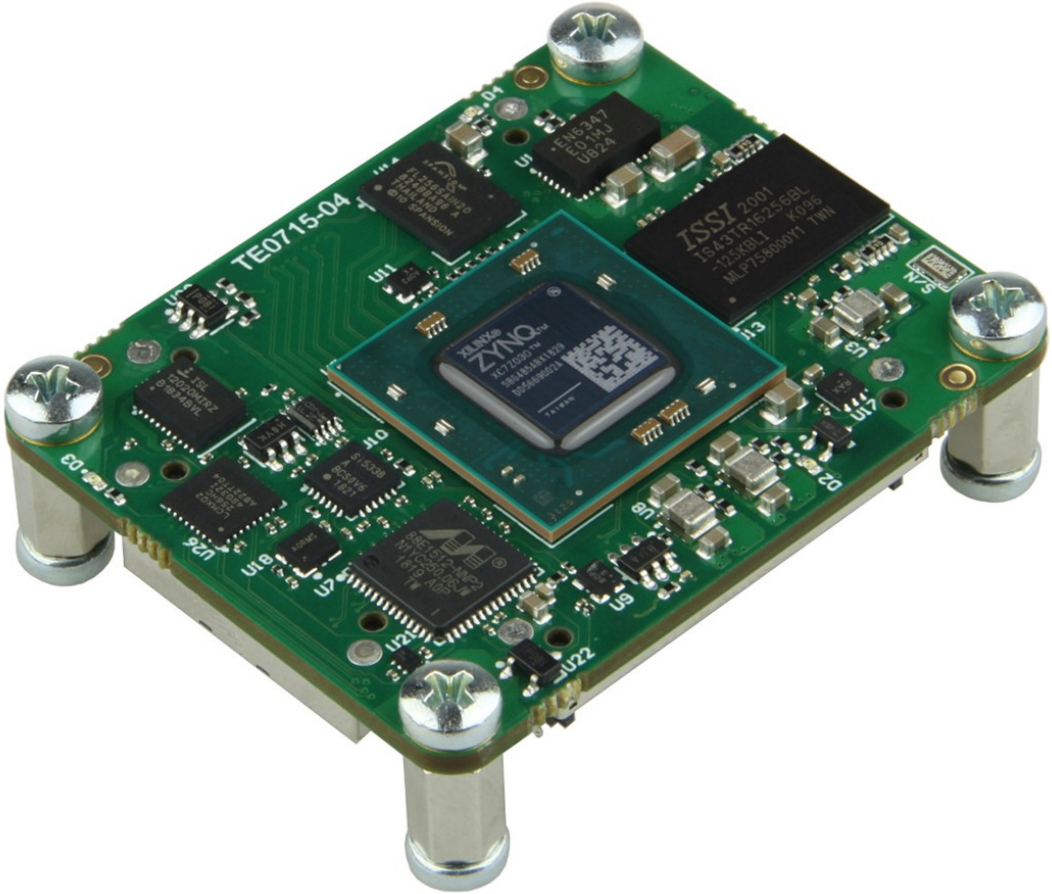
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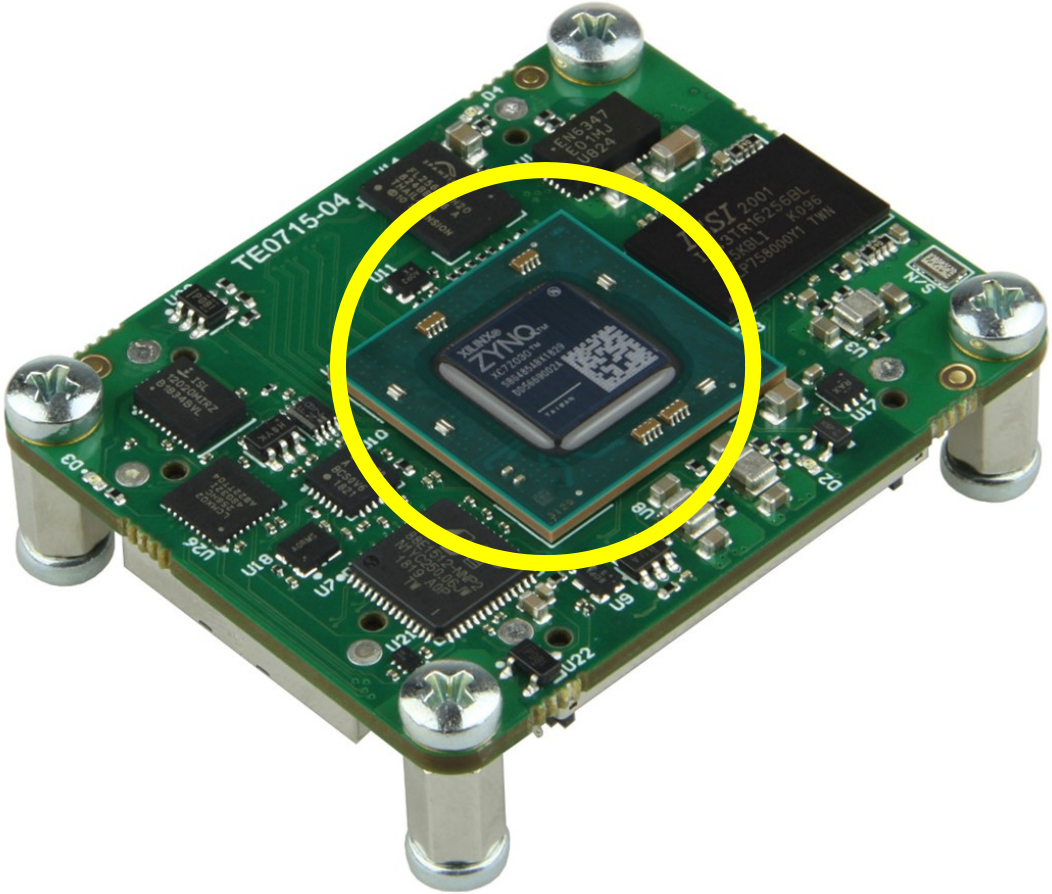

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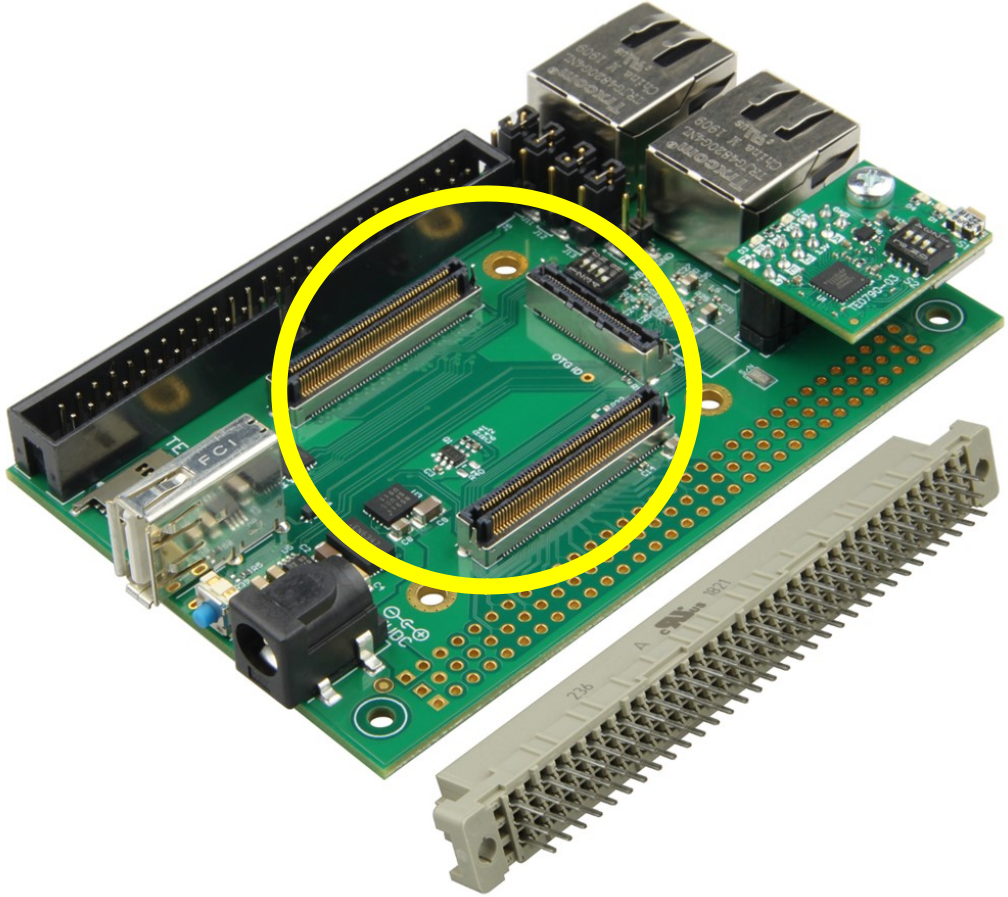

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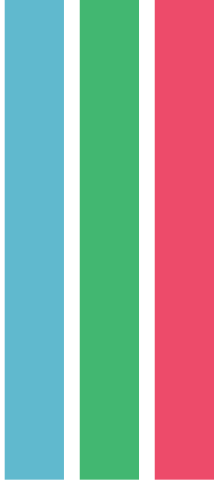
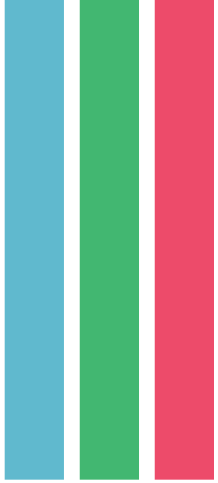


Demo: Peek into the hardware



What else?

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Xilinx Vitis support

- High-performance datacenter accelerator cards
- In all major cloud providers or on-premises
- Aerospace industry, on board of drones and satellites

Xilinx Alveo benchmarks

Algorithm	Speed advantage	Power advantage
ImageContrastModifier	34x	120x
MonteCarloPiEstimator	4x	21x
ParallelAlgorithm	4x	25x

https://github.com/Lombiq/Hastlayer-SDK/blob/dev/Docs/Benchmarks.md

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Xilinx Zynq benchmarks

Algorithm	Speed advantage	Power advantage
ImageContrastModifier	24x	27x
MonteCarloPiEstimator	110x	154x
ParallelAlgorithm	119x	115x

https://github.com/Lombiq/Hastlayer-SDK/blob/dev/Docs/Benchmarks.md

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Posit number format

- https://hastlayer.com/arithmetics
- Better range/accuracy than IEEE float
- We already have a posit „processor”

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And you!

- Thesis work where you write new code
- Optimizing existing scientific code
- Aerospace applications

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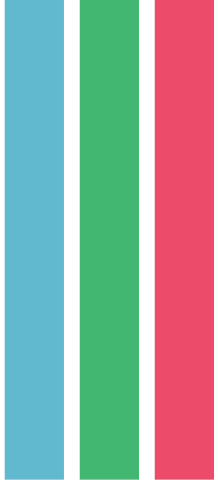

Wrapping up

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I like this, how do I start?

- Check out the SDK: https://github.com/Lombiq/Hastlayer-SDK/
- Be ready for an FPGA-filled future!

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Are you ready to *be* the hardware?

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- https://hastlayer.com
- https://github.com/Lombiq/Hastlayer-SDK/
- https://lombiq.com

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