Huxelerate: Bringing Software Performance Optimization Research into the Market

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GLOBAL ENERGY CONSUMPTION
Doubles every 3 years

GLOBAL ENERGY PRODUCTION
Grows by 2% a year
Huge energy consumption might recall...
COMPUTING EFFICIENCY MUST DOUBLE EVERY 1.1 YEARS

- Computing power 10x each next level of autonomy. L3-L4-L5 autonomy 10s, 100s, 1000s TOPS (tera operations per second)

- By 2050 95% of the global fleet autonomous

Source: MIT "Data Centers on Wheels: Emissions from Computing Onboard Autonomous Vehicles"
The explosion of vehicle electronic components in the last 50 years

A Few Electronic Components
Gradually, Vehicle Manufacturers Added Electrical Systems (I.e. Remote Central Locking), that Made Use Of Ecus

The number of ECUs increases. As a consequence, car weight increases requiring more fuel and running costs. Car price increases
To reduce cost, manufacturers developed tunable (or to be calibrated) ECUs to be developed once and used in different vehicles with similar features

Computer science and algorithm evolve, AI rises
Ecus get more powerful (8bit -> 32 bit),
Off-board computation: from having a network in-vehicle to vehicles that are part of a wider network.

More Than 100 Ecus
5000 Wires/Connectors,
15.000 Signals
More Than 50k Pieces To Fit Together And Maintain

Source: Statista
Explosion of vehicle software complexity

1. **CORRECTLY SIZE** AND OPTIMIZE THE VEHICLE COMPUTING INFRASTRUCTURE

2. **ENABLE SOFTWARE AND RESOURCE USAGE OPTIMIZATION**
HUXELERATE OFFERS A SaaS DEVELOPMENT TOOLBOX TO SUPPORT DEVELOPERS IN OPTIMIZING VEHICLES SOFTWARE AND COMPUTING INFRASTRUCTURE
Huxelerate automates performance estimations and optimization directives virtualizing the entire vehicle

VIRTUALIZED VEHICLE COMPUTING INFRASTRUCTURE

- SINGLE CORE ECU
- MULTI-CORE ECU
- MULTI-ECU

PERFORMANCE ANALYSIS

- Estimate the current and achievable performance of software on different computing hardware
- Correct sizing of vehicles computing infrastructure: select the processors and computing hardware that maximize performance and computing efficiency, given a target cost
- Estimate CO2 Savings

DIRECTIVES FOR OPTIMIZATION

- Software performance and resource optimization: performance estimated and optimization directives to support developers in achieving the highest level of performance and optimizing usage of available resources

1 It may be any kind of vehicle: cars, motorcycles, trucks, tractors
Full integration into standard process and consolidated toolchains

**AVAILABLE DATA TO PERFORM SCENARIO ANALYSIS**

- Design the most efficient architecture at vehicle, domain, and control unit levels (e.g., most efficient processors, communication channels)
- Define the requirements of each software component

**THE SOFTWARE CAN BE OPTIMIZED WHILE DEVELOPING**

- Identify execution time and resources problems immediately
- Obtain and implement optimization directives
- The number of testing on hardware are drastically reduced
Already adopted by car manufactures and Tier 1

- Reduced computing infrastructure costs: Up to 40%
- Reduced optimization time and cost: Up to 60%
- Improved software performance: Up to 50%
WHERE WE STARTED?
Back in 2019-2020: Hugenomic and the focus on genomics research

The Computational Bottlenecks are due to some common limitations

The computational bottlenecks of genomic data analysis are generated by some common limitations:

- **Computational intensive**  
  Sequencing Technologies will require around 2 trillion CPU hours by 2025

- **Massive amount of data**  
  Hundreds of gigabytes of data

- **General purpose architecture are inefficient**  
  The main reason is that they are designed for generic workloads, and they are not optimized for specific scenarios

¹ Source: Decadal Plan Abridged Report
Back in 2019-2020: Hugenomic and the focus on genomics research

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- Computational intensive
- Massive amount of data
- General purpose architecture are inefficient

HUGenomic wants to be a key player in the transition from general purpose architectures to domain specific architectures

On April 23rd Elon Musk, CEO of Tesla, announced that Tesla will no longer use general purpose architectures on its self-driving cars.

Such announcement is one of the first to establish the start in the architecture shift from general purpose architectures to domain specific architectures.

Domain specific architectures (DSA) allow to achieve higher efficiency by tailoring the architecture to characteristics of the domain. This will require that hardware design become much more efficient, and more like modern software design.

1 Source: Decadal Plan Abridged Report
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The Computational Bottlenecks are due to some common limitations

The computational bottleneck

HUGenomic patented methodology to speedup the acceleration of software on FPGA devices

C/C++

Automatic roofline analysis & automatic DSE

HLS

HW Synthesis

Test on FPGA

In order to speedup the process of accelerating algorithms on FPGA, we reshaped the standard design flow and added a preliminary step for quickly converging to optimal FPGA designs without the need to iterate throughout the overall process.

Source: Decadal Plan Abridged Report