

GREENWAVES
TECHNOLOGIES



Open-source workshop

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GAP processors applications: battery powered devices

sensors

visible light camera



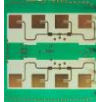
microphone



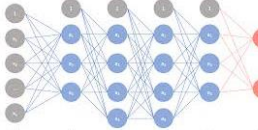
IR light camera



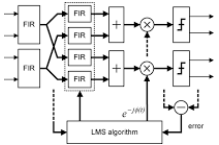
radar



processor



Neural Network Inferencing



Digital Signal Processing

GAP8

- 55LP @ TSMC
- In production since Q4 2019
- One of the very first commercially available RISC-V processor
- Leading energy efficiency in TinyML

GAP9

- 22FDX @ GF
- First samples in house
- Final samples in Sep 2021
- 10x more energy efficient and 10x more powerful than competition in Hearables
- It is really about multi-dimensional computing

battery life



years



weeks



day

GreenWaves and open-source

- We leverage PULP open-source project (ETH-Z & UniBo)
- It is more than RISC-V cores:
respectively 85% and 65% of GAP8 and GAP9 are based on open-source IPs
- License is permissive (SolderPad), but we put back in open-source quite a number of IPs (fixed, modified, improved or new)
- As a small company, we have done some due diligence on our freedom to operate commercially but not under the assumption of a geopolitical war
- All but one of our SW tools are built with open-source projects or are open sourced by us
- We open-source all our application examples
- Vision and voice AI are very much an open-source world, not the rest
- Training data to make AI usable in real life is not in open-source

The value of open-source to GreenWaves

- Fast to market open-source innovation through frictionless collaboration with academic research.
 - The same SoC is a product for us and a research project for our partners.
 - No lengthy licensing discussions
 - As development time is fairly incompressible in SoC design, the fact that the outcome is also available afterward to our competitors doesn't matter, as long as we execute timely 😊
- Proprietary innovation at disruptive capital efficiency
 - In processor design, what makes the difference represents little of the overall effort, especially when factoring in verification.
 - Building it all is just unaffordable to most companies.
 - Alternatively, starting from licensed cores drastically restricts and delay innovation opportunities

RISC-V and open-source

- Deeply embedded RISC-V is a massive trend, as a frictionless commodity
- RISC-V ecosystem strong momentum is making RISC-V open market processors commercially possible: being “not ARM” is not a disqualifier anymore.
- RISC-V open-source cores have dramatically relaunched academic research on processor architecture,
But very few companies seem to have the ambition to exploit the innovation open-source RISC-V cores allows
- After 10 years, the number of open market RISC-V processors is still only a handful (and mostly from China). The large vendors haven't (yet) endorsed it.
Putting aside geopolitics, the trade-off between innovation opportunity and antagonizing ARM is probably challenging.

Closing comments

- Innovation in semiconductor traditionally requires financial investment over long periods of time that only markets with very large perceived potential can justify.
- Open-source drastically changes the game, making innovation accessible to smaller or more speculative markets.
- But most of the semiconductor markets are not innovation driven.
- Open-source arguably removes geopolitical control points ... in design.
- We ought to be careful not to fall into others such as SW tools.

Closing comments

- Open-source is still not well understood by private and public financiers. What are your IPs? Why should we fund something the Chinese or the Americans could benefit from?
- Open-source design doesn't remove the total control on the industry by the 2 US EDA vendors. Open-source EDA doesn't have access to foundries data below 90nm.
- Same problem for open-source analog. EDA vendors forbid open-sourcing the physical views of IPs designed with their tools.
- Leveraging open-source IC design requires some collective learning. All actors need to reinvent themselves at least partially: product companies, research centers, IP vendors, SW tools vendors, EDA vendors, VCs and public financiers

Thank you



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