At the Very Edge

Enabling AI

Presented by:

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AI IS MOVING TO THE EDGE

From the cloud

To the edge of IoT

WHY?

- CLOUD CONGESTION
- PRIVACY
- DECISION LATENCY
- POWER
But what happens WHEN You GET TO THE VERY EDGE?

<table>
<thead>
<tr>
<th>Wide range of compute STATES</th>
<th>Wide range of compute TASKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Scale consumption to workload</td>
<td>• Acquisition, pre-processing, inference, (communication)</td>
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<tr>
<td>• Absolute consumption in state</td>
<td>• Rapidly changing algorithms</td>
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<tr>
<td>• Speed of transitions between states</td>
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GAP8 enables **AI** at the very Edge

A highly integrated MCU combining a 8 core parallel compute cluster and a single core controller

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**01**

**High compute at ultra-low-power**

~20x better power efficiency than the state-of-the-art on content understanding applications at < 100mW

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**02**

**Agile**

Ultra-fast dynamic, power state transitions
Wake up in 0.5ms
1uA standby current

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**03**

**Flexible**

Fully programmable
Wide range of accelerated algorithms
An example of GAP8’s Energy Efficiency

<table>
<thead>
<tr>
<th>TARGET</th>
<th>CLOCK</th>
<th>TIME</th>
<th>CYCLES</th>
<th>ACTIVE POWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>STM32 F7</td>
<td>216Mhz</td>
<td>99.1ms</td>
<td>21,400,000</td>
<td>60mW</td>
</tr>
<tr>
<td>GAP8 *</td>
<td>15.4Mhz</td>
<td>99.1ms</td>
<td>1,500,000</td>
<td>3.7mW</td>
</tr>
<tr>
<td>GAP8 *</td>
<td>175Mhz</td>
<td>8.7ms</td>
<td>1,500,000</td>
<td>70mW</td>
</tr>
<tr>
<td>GAP8 **</td>
<td>4.7Mhz</td>
<td>99.1ms</td>
<td>460,000</td>
<td>0.8mW</td>
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Comparison of Latest optimized ARM CMSIS-NN library versus GAP8 implementation of identical CNN graph trained on CIFAR-10 images.

Source*: ARM processors blog

Running on GAP8 cluster.

* No Hardware Convolution Engine
** With Hardware Convolution Engine

STM 32 H7 216Mhz 40nm

16 x reduction

11 x

75 x

16 x reduction
How does GAP8 achieve Energy Efficiency?

01 Uniform Extended Instruction Set (ISA)
   - DSP Extensions
   - SIMD instructions
   - Bit manipulation

02 Efficient parallelization
   - Hardware thread dispatch and synchronization integrated with automatic clock gating

03 Shared instruction cache
   - Reducing power overhead of instruction fetch

04 HW Convolution Engine
   - Single cycle 5 x 5 16 bit fixed point convolution

05 Ultra fast HW state changes
   - All power management on SoC

Programmable in C/C++
GCC based toolchain
Visual IDE based on Platform IO
Code generation tool (AutoTiler) smooths parallel code generation
Pre-built generators for a wide range of algorithms
A wide range of use cases are enabled by GAP8
Open source origins

Best in class Instruction Set Architecture (ISA) UC Berkeley originated

Open Source Computing Platform created by ETHZ and UniBo

Engineered as Ultra-low power IoT Application Processor

GreenWaves staff are on the RISC-V technical and marketing committees

GreenWaves is a key contributor to PULP

LEVERAGING COMMUNITIES UNIQUE CAPITAL EFFICIENCY
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<th>GAP8 is Available Now</th>
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<td>GAPuino GAP8 - buy on the websites:</td>
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<td><img src="https://greenwaves-technologies.com/store/" alt="GAPuino logo" /></td>
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<th>04</th>
<th>GAP8 production qualified - Q2 2019</th>
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Thank you!

Questions?