HULK-V: a Heterogeneous Ultra-low-power Linux capable RISC-V SoC

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Low-power devices:
- Hundreds kB of SRAM
- Bare-metal runtime
- Energy efficient accelerators

Single Board Computers:
- Powerful (CortexA53 like Linux-capable) CPU
- High perf & power DDR memories
- Watts of power consumption

HULK-V (22nmFDSOI):
- Linux-capable (CPU and enough mem)
- Energy efficient accelerator
- 250mW power envelope

How?
1) Leverage heterogeneity

• Combine different kinds of processors

Host core
- Decide: modulate flow of instructions
- Linux support

Accelerator cores:
- Compute: modulate flow of data
- Energy efficient
- DSP and ML extension
2) Choose the right memory

- **High performance and power**
- **Expensive**

- **Capacity** to boot Linux
- **Throughput** for IoT

- Deeply embedded IoT

| CAPACITY (MB) | THROUGHPUT (MBPS) |
|--------------|-------------------|
| 10.00        | 50.00             |
| 100.00       | 500.00            |
| 1000.00      | 5000.00           |
| 10000.00     |                   |

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HW-SW infrastructure: HULK-V

User-Space Software

Kernel-Space Software

HETEROGENEOUS APPLICATION

ACCELERATED KERNEL

HOST DOMAIN

L2 SPM

Mem

AXI interconnect

LLC

Mem ctrl

HyperRAMs

L1 SPM

Mem

Mem

Mem

Mem

Interconnect

DMA

RV 32

RV 32

I$

Programmable MultiCore Accelerator

LINUX KERNEL

PMCA DRIVER

PMCA RUNTIME

HW ABSTRACTION LIBRARY

User-Space Software

Kernel-Space Software

Hardware
## Comparison with SoA

|                  | OS       | CPU mem.          | Technology | CPU               | Accelerator        | Peak power |
|------------------|----------|-------------------|------------|-------------------|--------------------|------------|
| GAP10 (Greenwaves) | RTOS     | 512kB SRAM        | ASIC       | RI5CY 200MHz      | 8-core cluster     | 100mW      |
| Sapphire         | RTOS     | 4MB-3GB HYPER/DDR | FPGA       | VEX RISC 400MHz   | -                  | Few W      |
| i.MX RT (NXP)    | RTOS     | 1.5MB SRAM        | ASIC       | CORTEXM7 1GHz     | MIPI               | 100mW      |
| Raspberry Pi0    | Linux    | 512MB LPDDR2      | ASIC       | 4-Core CortexA53 1GHz | -              | 3W         |
| SiFive Unmatched | Linux    | 16GB DDR4         | ASIC       | U74 1GHz          | -                  | 3W         |
| **HULK-V**       | Linux    | 512MB HYPER       | ASIC       | CVA6 900MHz       | 8-core cluster     | 250mW      |
Question? Poster session!