# 7 MOPS/lemon-battery image processing demonstration with an ultra-low power reconfigurable accelerator CMA-SOTB-2

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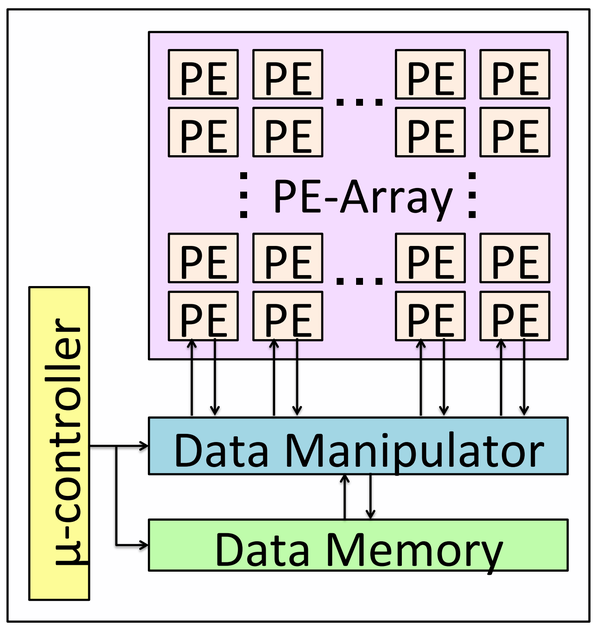
## *Introduction*

To realize low power and high performance processing in battery driven devices, Cool Mega Array (CMA)-SOTB-2, a coarse grained reconfigurable accelerator, was implemented by using Silicon on Thin BOX (SOTB). SOTB is a new process technology developed by the Low-power Electronics Association & Project (LEAP). In a real chip evaluation, it achieved 743 MOPS/mW (297 MOPS/0.4 mW) with a power supply of 0.5 V.

## *CMA-SOTB-2*

### *Cool mega array (CMA)-Architecture*

- A coarse grained reconfigurable accelerator
  - A large PE array consisting of combinational circuits.
  - A simple programmable µ-controller which manages the data transfer between PE array and Data Memory.
  - A Data Manipulator which controls the data from Data Memory to each PEs flexibly.




Block diagram of the CMA-SOTB-2

**3 features of PE array**

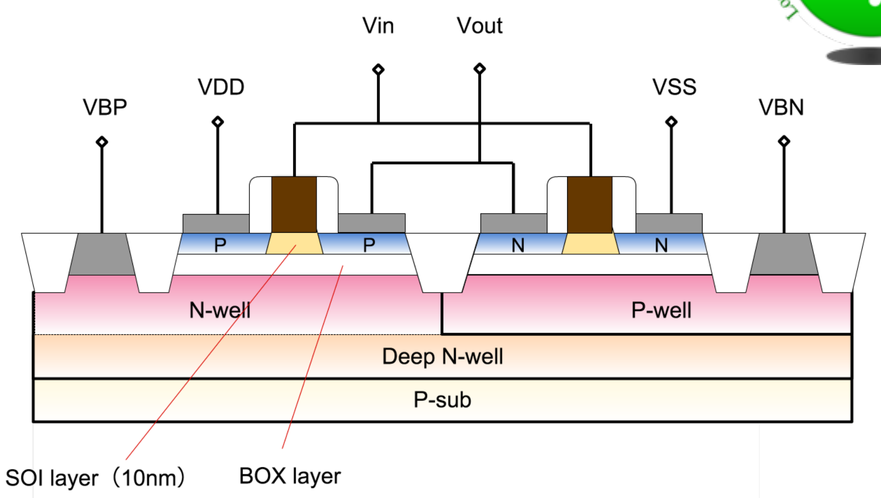
1) Clock is NOT distributed.
2) Intermediate results are NOT stored.
3) Configuration data is NOT dynamically reconfigured.

PE array's supply voltage can be scaled independently of the data memory and µ-controller.

### *SOTB technology*

- What is silicon on thin BOX (SOTB) ?
  - Transistors are formed on thin berried oxide.
  - A type of silicon on insulator (SOI) developed by Japanese national project LEAP.

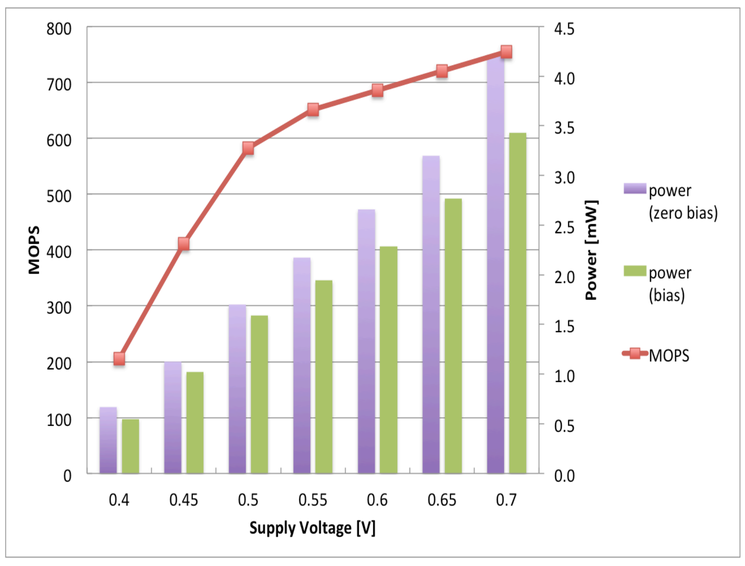
1) Leakage power and delay can be widely controlled by body bias voltage（The performance balance can be controlled）.
2) High speed with low supply voltage.
3) Transistor characteristics variability is small.




Cross sectional view of the SOTB Device

## *Evaluation & Demonstration*

### *Performance*




Performance and power vs. supply voltage (α-blender)

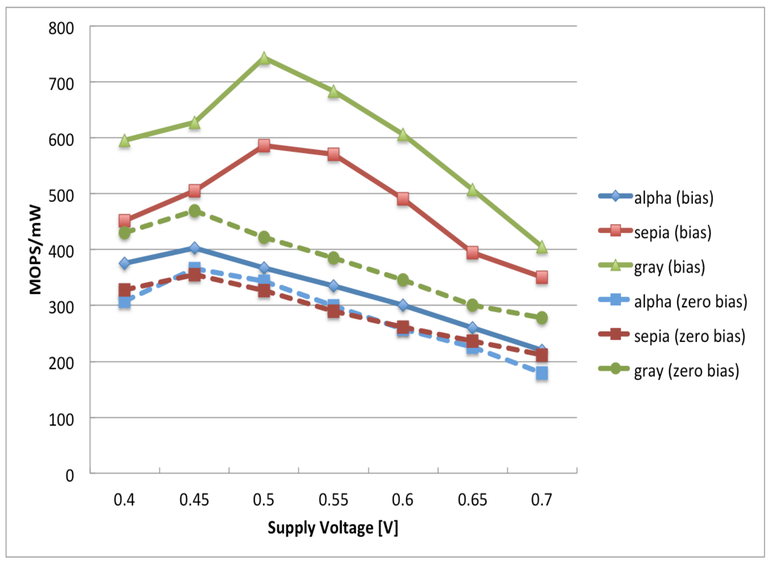
- 200-750 MOPS achieved
- Power budget optimized by body biasing
  - Reduced 13% on average

* (zero bias)
  Without body biasing

* (bias)
  Optimized power by body biasing

* Operations for a simple image filter were evaluated. (MOPS)

### *Energy efficiency*



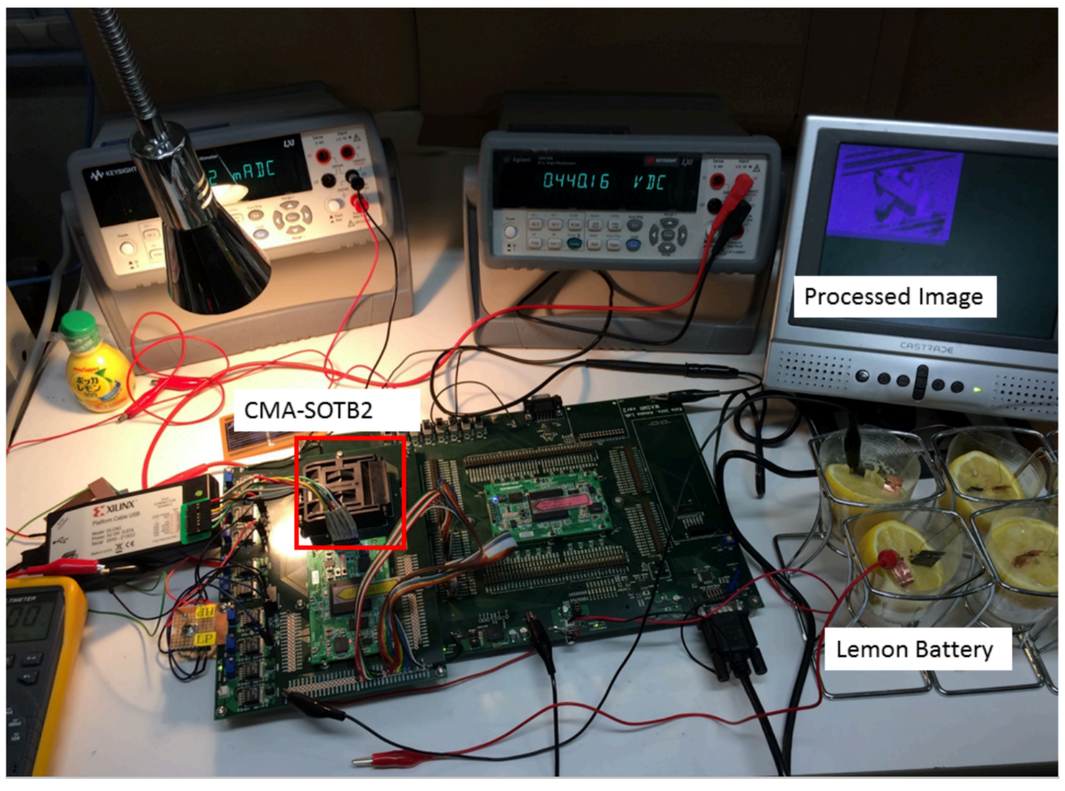

Energy efficiency vs. supply voltage by application programs

**<Zero bias>**
470 MOPS/mW
(297 MOPS/0.71 mW)
was achieved at 0.45 V

**<Body biasing>**
743 MOPS/mW
(297 MOPS/0.40 mW)
was achieved at 0.5 V.

### *Demonstration*

- A simple image processing application (8bit α-blender) is executed on CMA-SOTB-2 by using lemon battery at only 0.7- 0.8 V.
  - 7 MOPS performance is sustained.
  - Only 0.3 mW power budget is needed.
- Also it works with solar battery at 0.4- 0.5 V.




Demonstration of CMA-SOTB-2 using lemon battery