MuCCRA-3: A Low Power Dynamically Reconfigurable Processor Array

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MuCCRA-3 Overview

- Dynamically Reconfigurable Processor Array (DRPA)
- Flexible offloading engine in various SoCs
  - streaming applications
- Multi-Context style
  - Datapath changing clock by clock
- Instruction-Level Parallelism
- Data-Level Parallelism

High flexibility & High performance

- MuCCRA-3
  - Third prototype chip
- Optimized for low power consumption

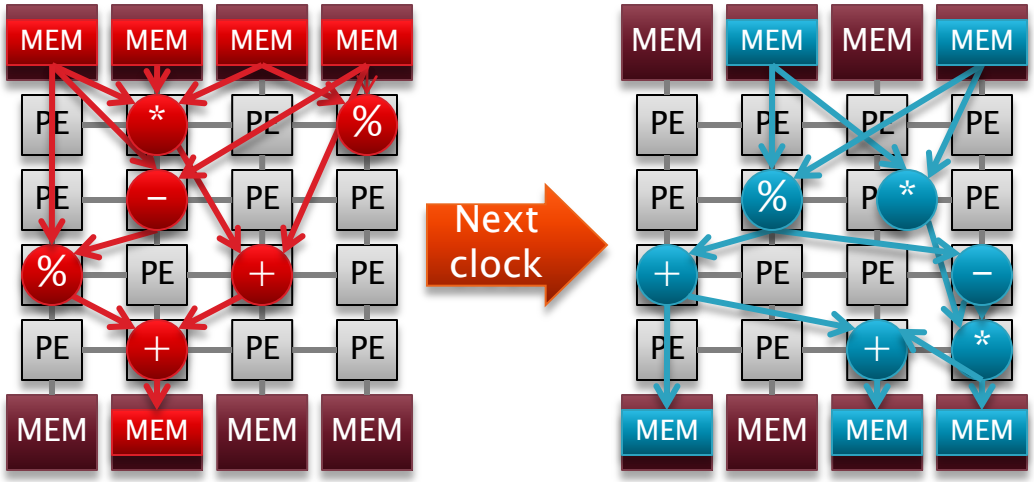

Fig. 1: Datapath changing on DRPA

Structure of MuCCRA-3

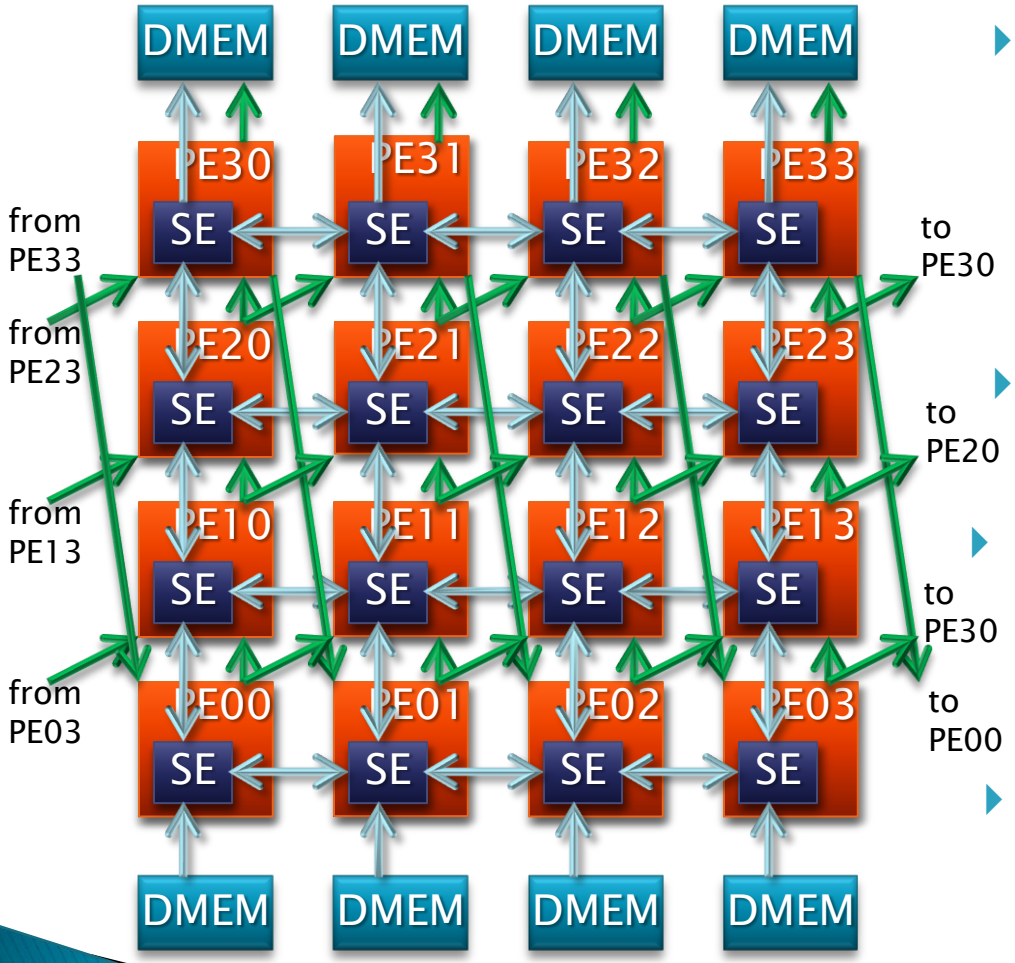

Fig. 2: PE Array of MuCCRA-3

- PE Array
  - 4x4 PEs
  - Data bit width: 16bit
  - No. of instruction: 14
- Data Memory (DMEM)
  - 16bits × 128words × 8RAMs
- Inter PE Network
  - Island-style Links
  - Direct Links
- Multi-Context style
  - 1clock context switching
  - 32 hardware contexts

PE Structure and Context Switching

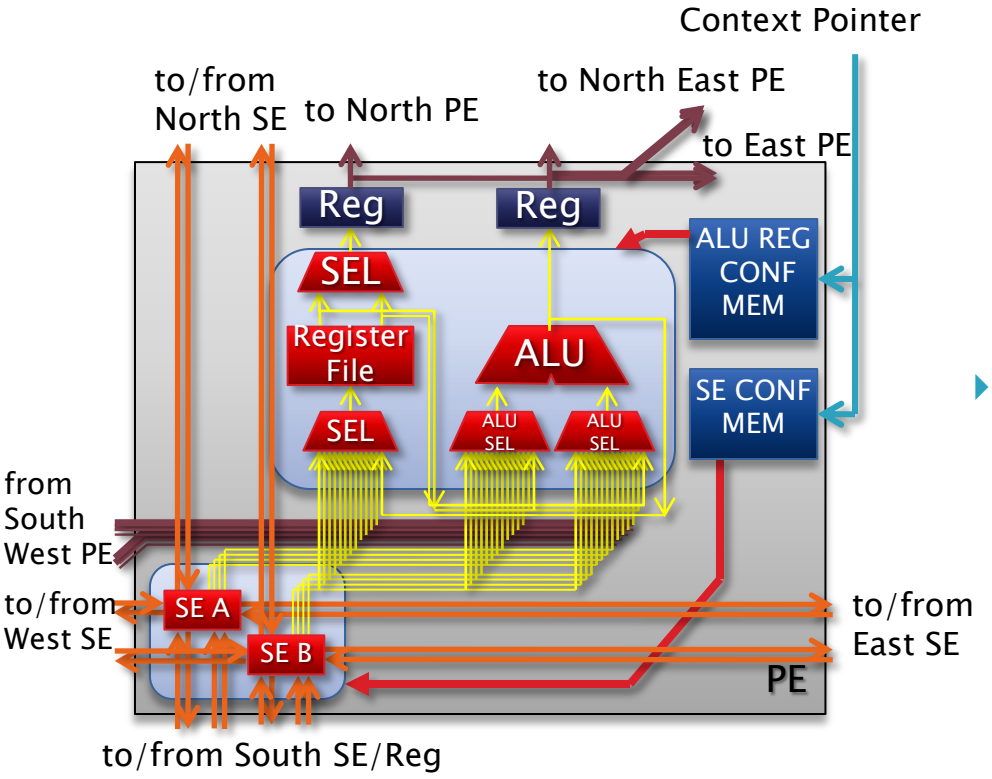

Fig. 3: Structure of PE

- Dynamically Reconfigurable Modules
  - ALU, Register file, ALU Input SELs, SEs
  - Changes function of each module clock by clock
- Context Memory
  - Storing Configuration Data
  - Give Conf. Data to each module
    - by Context Pointer from Context Switch Controller (CSC)
  - No. of Entries: 32

Chip Implementation

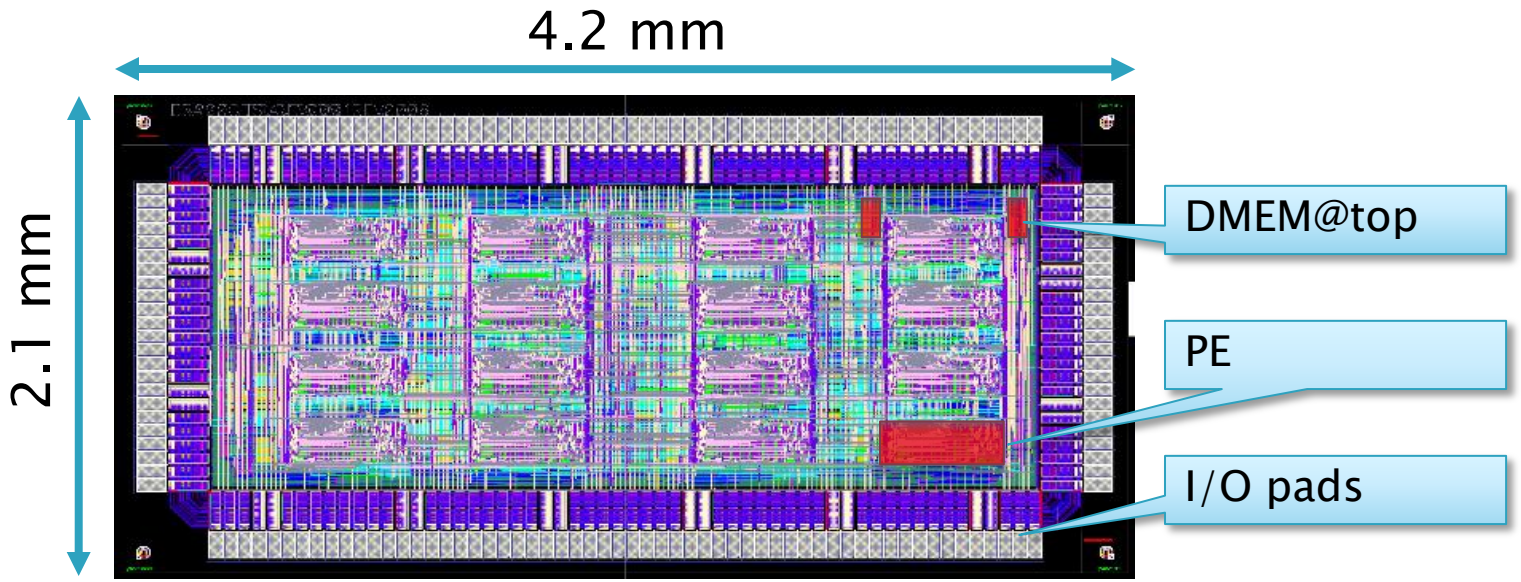

Fig. 4: MuCCRA-3 Floorplan

- Fujitsu e-shuttle 65nm CMOS Process
- Synthesize: Synopsys Design Compiler 2007.12-SP3
- Layout: Cadence's SoC Encounter 7.1
- Target clock frequency: 41.4 MHz

Evaluation Results

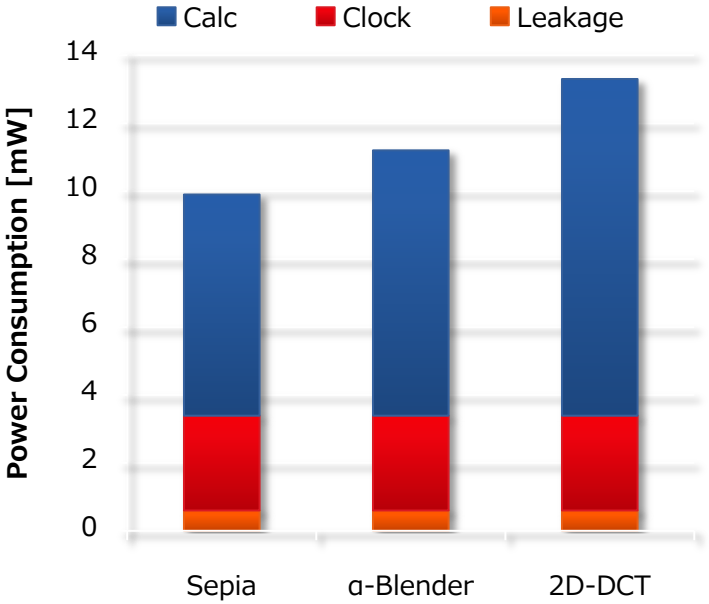

Table 1: Comparing Power Consumption

Device Name (Process Scale [nm])	Clock Freq. [MHz]	Core Supply Voltage [V]	Ave. Power [mW] Energy [nJ]
TI TMS32C6201 (130nm)	167	1.26	684 (310.2) 8412.2 (3815.1)
MuCCRA-1 (ROHM 180nm)	25	1.8	85.1 (13.66) 663.8 (106.54)
MuCCRA-3 (Fujitsu 65nm)	41.4	1.2	11.0 (11.0) 41.8 (41.8)

Fig.5 Power for Executing Applications

- Power for Applications
  - Power consumption of clock tree: 30% of entire power (Sepia)
  - 10-13mW power consumption for each application
- Energy consumption
  - Approximately 90 times better than DSP(TI TMS32C6201)

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