Reliability-Configurable Mixed-Grained Reconfigurable Array Compatible with High-Level Synthesis

Masanori Hashimoto[1]*, Dawood Alnajjar[1]*, Hiroaki Konoura[1]*,
Yukio Mitsuyama[2]*, Hajime Shimada[3]*, Kazutoshi Kobayashi[4]*,
Hiroyuki Kanbara[5]*, Hiroyuki Ochi[6]*, Takashi Imagawa[7]*,
Kazutoshi Wakabayashi[8]*, Takao Onoye[1]*, Hidetoshi Onodera[7]*

[1]Osaka Univ., [2]Kochi Univ. of Tech., [3]NAIST, [4]Kyoto Institute of Tech.,
[5]ASTEM, [6]Ritsumeikan Univ., [7]Kyoto Univ., [8]NEC Corp., *JST CREST

hasimoto@ist.osaka-u.ac.jp

Background

- ➢ NRE cost is elevating as VLSI technology advances.
  - Reconfigurable VLSIs are widely used to save cost.
- ➢ Guaranteeing reliability of information systems becomes a societal requirement.
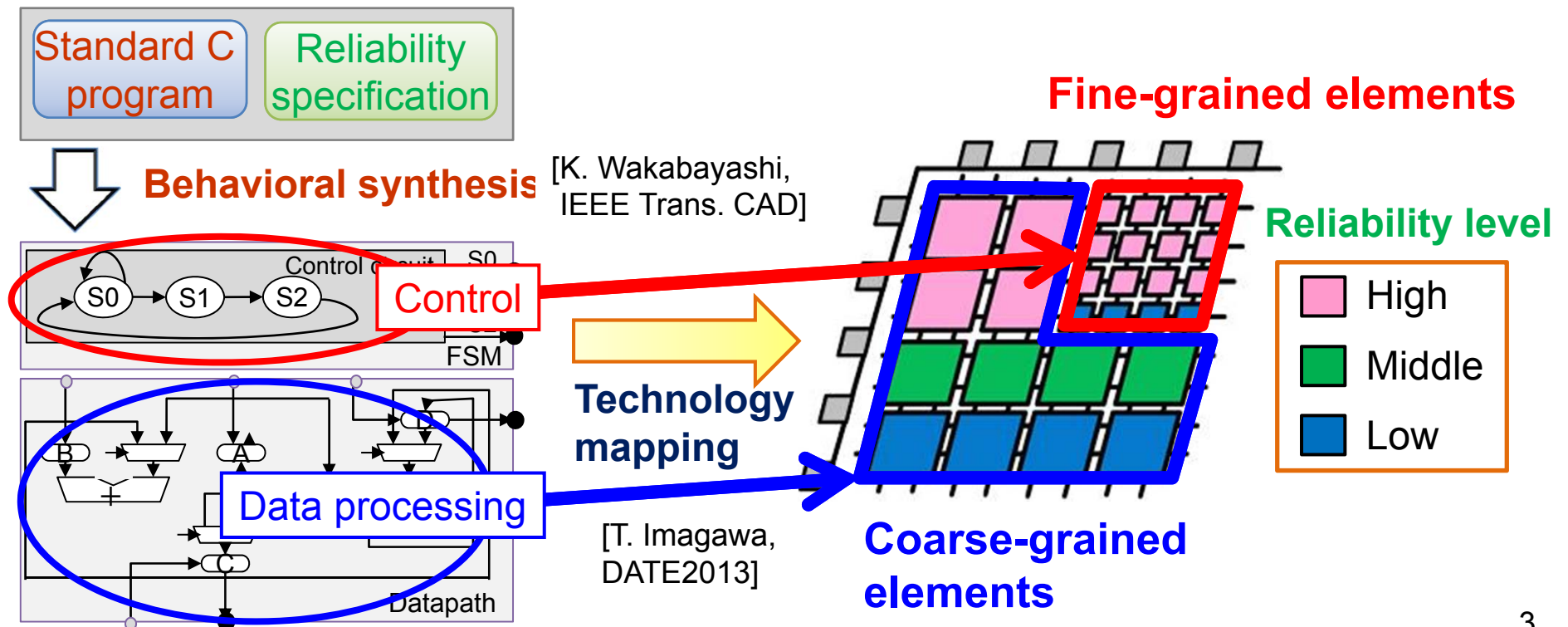
- ➢ Reliability of reconfigurable VLSIs is drawing much attention
 - especially from mission critical applications such as space and medical ones.

Objective

Develop a **mixed-grained** reliability-variable reconfigurable array enabling C-based design

- **Fine-grained** elements for state machine
- **Coarse-grained** elements for data processing
- **Element-wise configuration to cover various apps.**

Standard C program | Reliability specification

Behavioral synthesis [K. Wakabayashi, IEEE Trans. CAD]

Control circuit S0

S0 → S1 → S2

FSM

Control

Fine-grained elements

Technology mapping

Data processing

B | A

C

Datapath

[T. Imagawa, DATE2013]

Reliability level

High
Middle
Low

Coarse-grained elements

3

Implementation

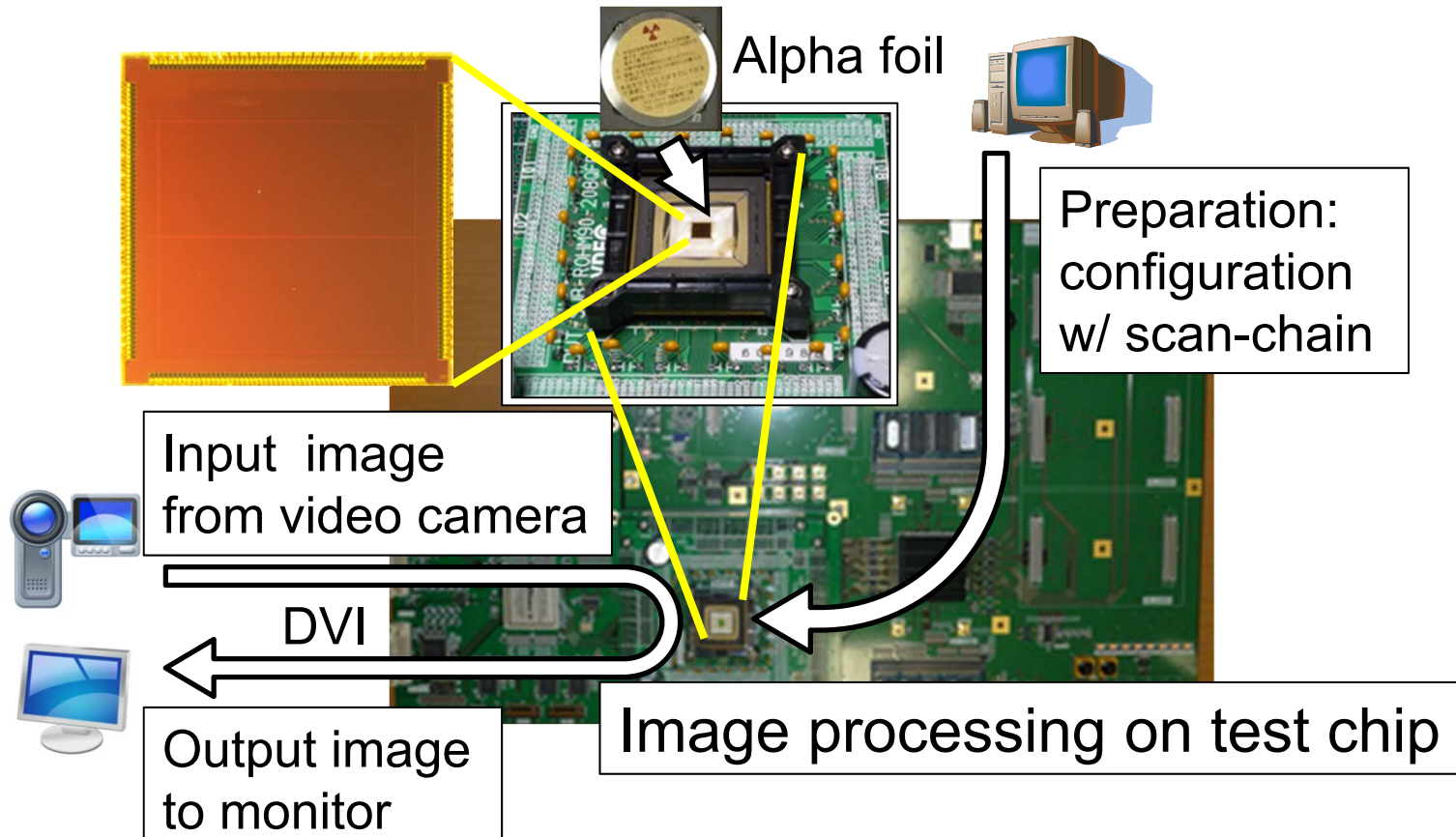| Process	65nm 12ML CMOS
Die size	4.2 x 4.2 mm^2
Config. bits	165,312
#gates	ALU: 120k, LUT: 4k, MEM: 99k
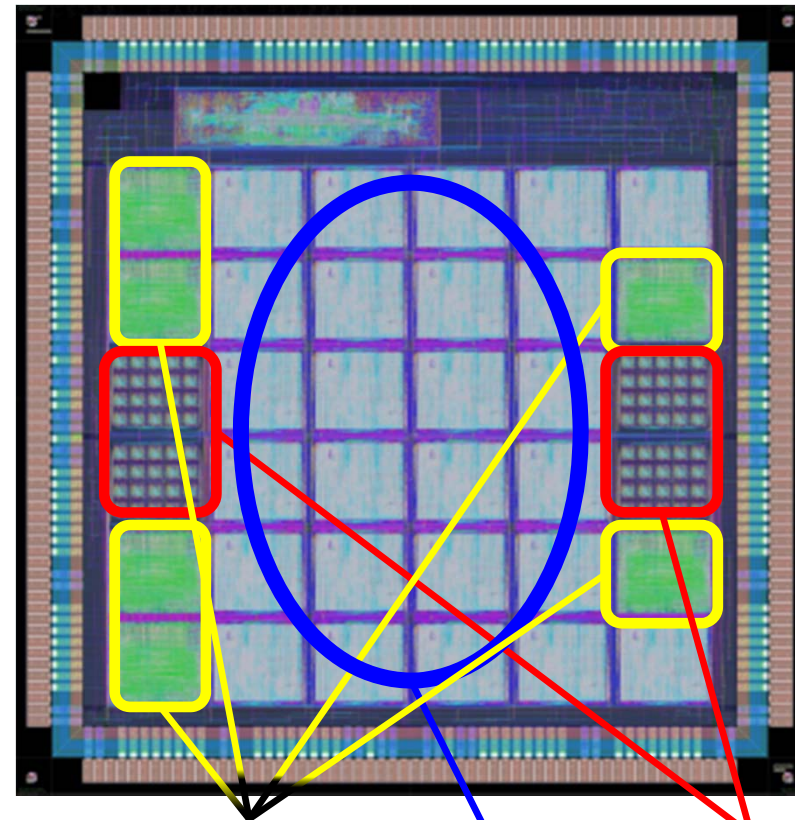
MEM clusters
Memory

ALU clusters
Coarse-grained

LUT blocks
Fine-grained

Demonstration setup

➢ To validate the functionality and reliability, a demonstration using two mappings with different reliability levels was performed.
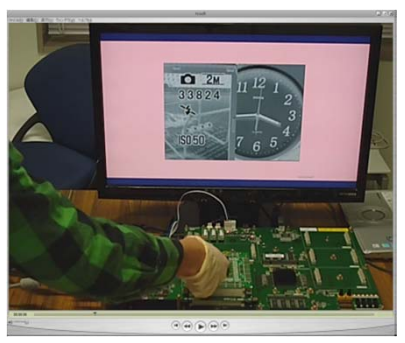

Alpha foil

Preparation: configuration w/ scan-chain

Input image from video camera

DVI

Output image to monitor

Image processing on test chip

Demo: Alpha irradiation test

Start irradiation   After 10 secs.

Trial #1	Trial #2
Trial #3	Trial #4

Normal mapping

- config. mem. singular
- datapaths singular

4 trials

**Corrupted
or
stopped**

High reliability mapping

- config. mem. triplicated
- datapaths singular

All working

**Single chip can cover wide reliability
specifications with different mappings.**