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NANOxCOMP

Synthesis and Performance Optimization of a Switching Nano-Crossbar Computer

DATE 16

14-18 March 2016
Dresden
Germany

General Overview

- 1963, 1965: CMOS and Moore's Law
- 2005: Gordon Moore himself claimed that the validity of Moore's Law will be lost.
- February 2016: Mitchell Waldrop stated:

"Next month, the worldwide semiconductor industry will formally acknowledge … Moore's law … is nearing its end."

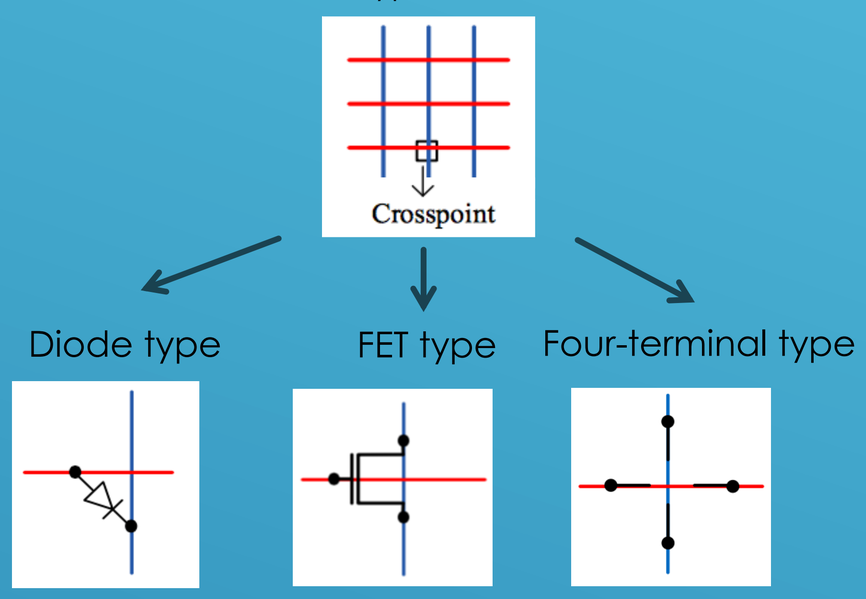
- Novel fabrication methods like self-assembly
- Regular shaped Crossbar structures

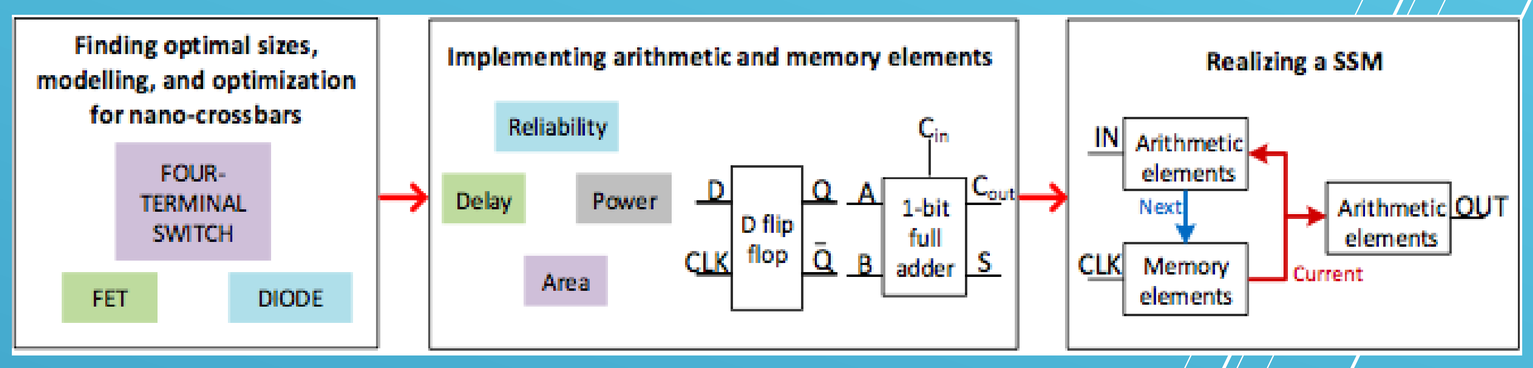
Project Goal

- Synthesis and optimization methodology for switching nano-crossbar arrays: diode, FET, and four-terminal switch based
- Performance parameters such as area, delay, power dissipation, and reliability.
- New computing models arithmetic and memory elements,
- Realization of a synchronous state machine (SSM) with combination of arithmetic and memory elements

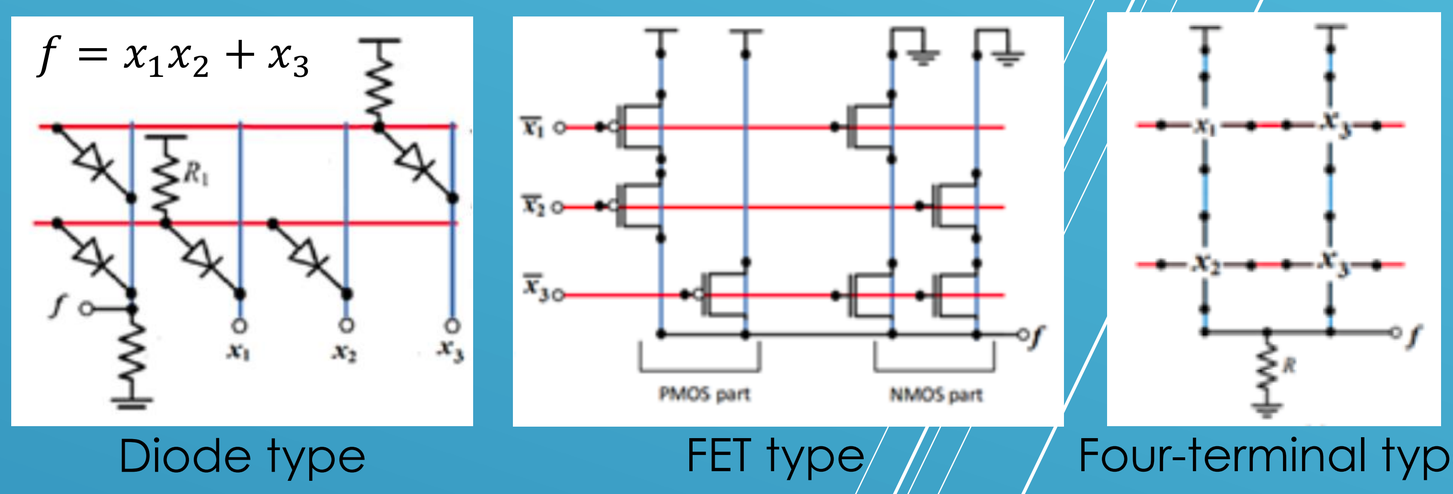
Crossbar-Switch Types

There are three different types of nano crossbar switches



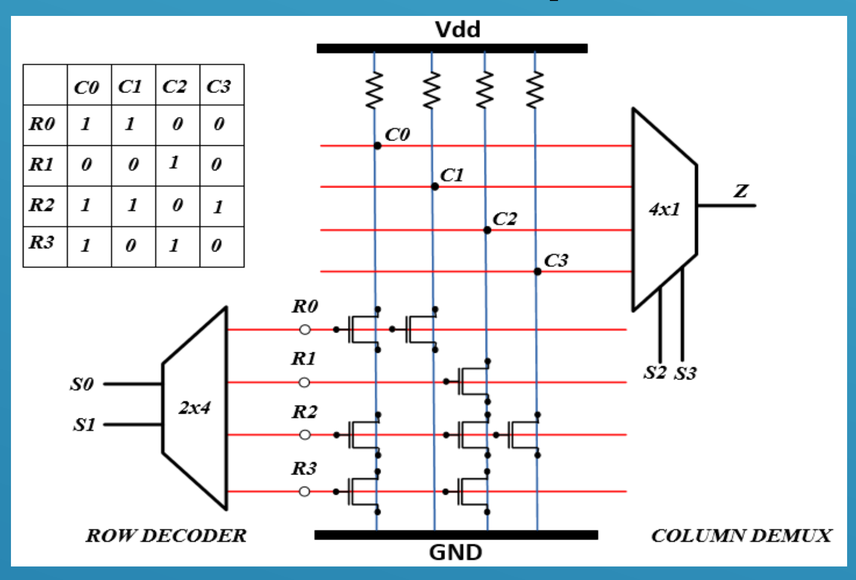


Arithmetic Logic Synthesis Examples



Diode type | FET type | Four-terminal type

4x4 pseudo-nMOS ROM Example



	C0	C1	C2	C3
R0	1	1	0	0
R1	0	0	1	0
R2	1	1	0	1
R3	1	0	1	0

of Switch Optimization Example

For Four-terminal switch type

x_1	$\overline{x_3}$	x_3	x_2
$\overline{x_2}$	$\overline{x_1}$	$\overline{x_2}$	x_3
$\overline{x_3}$	x_2	$\overline{x_1}$	x_2
x_1	x_2	x_3	x_1

XOR_3: 4x4

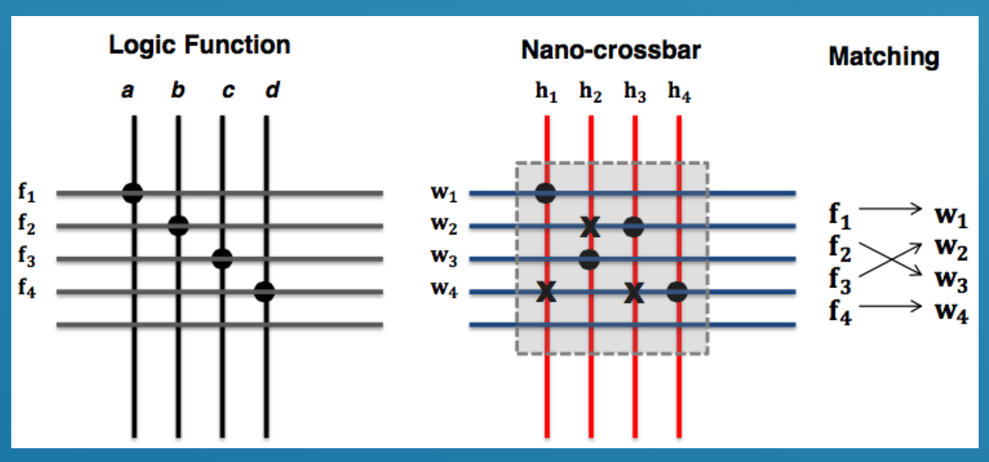
x_1	$\overline{x_3}$	$\overline{x_1}$
x_2	1	$\overline{x_2}$
$\overline{x_1}$	x_3	x_1

XOR_3: 3x3

x_1	x_1	$\overline{x_1}$	$\overline{x_1}$
x_2	$\overline{x_2}$	x_2	$\overline{x_2}$
x_3	$\overline{x_3}$	$\overline{x_3}$	x_3

XOR_3: 3x4

Defect Tolerant Mapping



These three network designs realize the same function XOR_3; but smallest network is the optimal solution for this function

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