

# Programmable Logic Devices

ELEC 418

Advanced Digital Systems

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*Images Courtesy of Thomson Engineering*



# Programmable Logic Devices

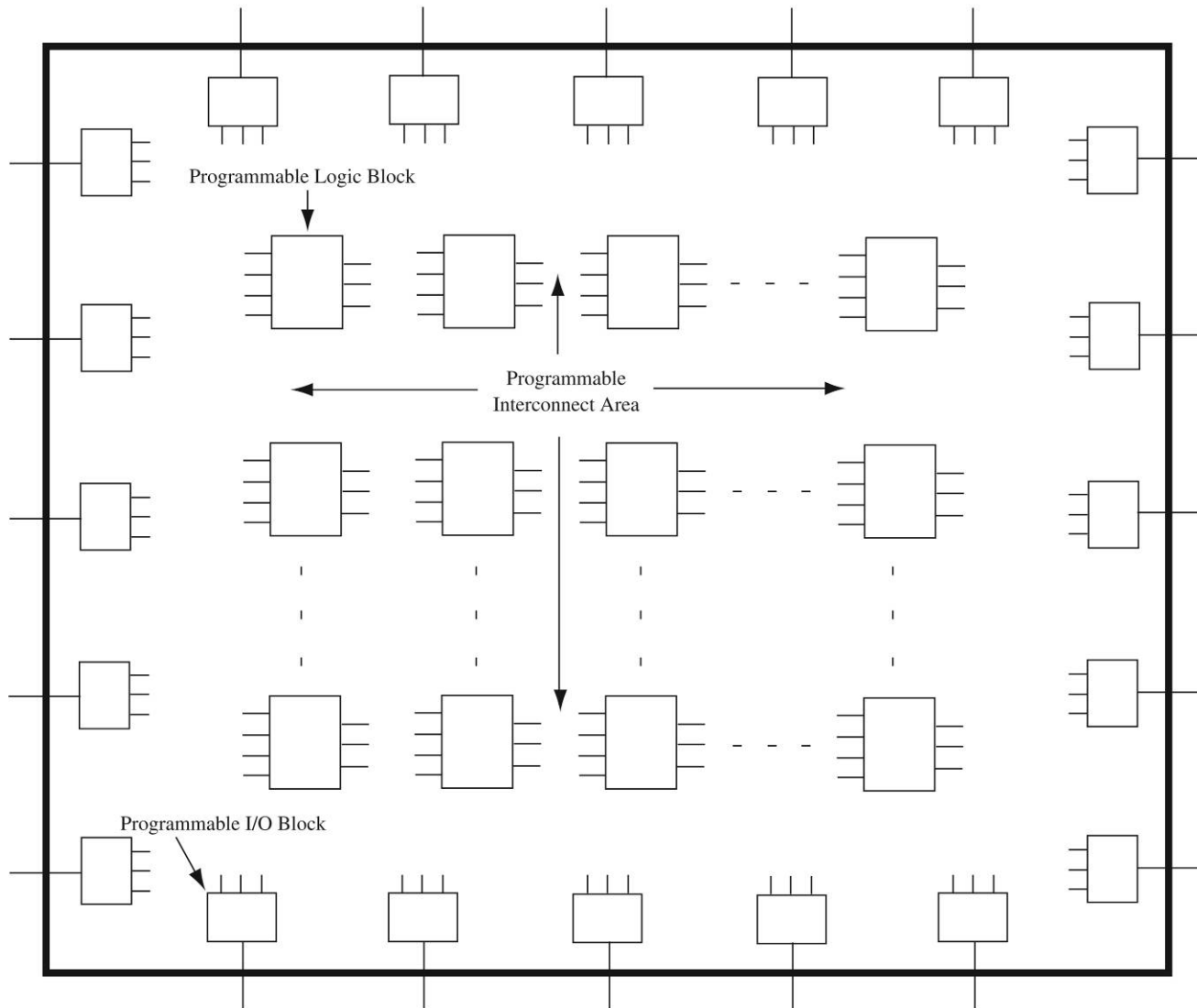
	SPLD	CPLD	FPGA
<b>Density</b>	Low Few hundred gates	Low to Medium 500 to 12,000 gates	Medium to High 3,000 to 5,000,000 gates
<b>Timing</b>	Predictable	Predictable	Unpredictable
<b>Cost</b>	Low	Low to Medium	Medium to High
<b>Major Vendors</b>	Lattice Semiconductor Cypress AMD	Xilinx Altera	Xilinx Altera Lattice Semiconductor Actel
<b>Example Device Families</b>	<b>Lattice Semiconductor</b> GAL16LV8 GAL22V10  <b>Cypress</b> PALCE16V8  <b>AMD</b> 22V10	<b>Xilinx</b> CoolRunner XC9500  <b>Altera</b> MAX	<b>Xilinx</b> Virtex Spartan  <b>Altera</b> Stratix  <b>Lattice</b> Mach ECP  <b>Actel</b> Accelerator

# FPGAs

## ◆ Field Programmable Gate Arrays

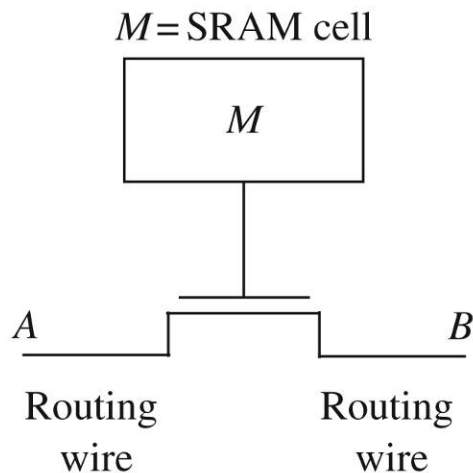
Vendor	FPGA Product	Capacity (Approx) in Gates/LUTs
Xilinx	Spartan-II	15K to 200K
	Spartan-IIE	50K to 600K
	Spartan-3	50K to 5M
	Virtex-5	19,200 to 207,360 LUTs
	Virtex	57,906 to 1,124,022
	Virtex-E	71,693 to 4,074,387
	Virtex-II	40K to 8M
Altera	ACEX 1K	56K to 257K
	APEX II	1.9M to 5.25M
	FLEX 10K	10K to 50K
	Stratix/Stratix II	10,570 to 132,540 logic elements

# Organization of FPGAs

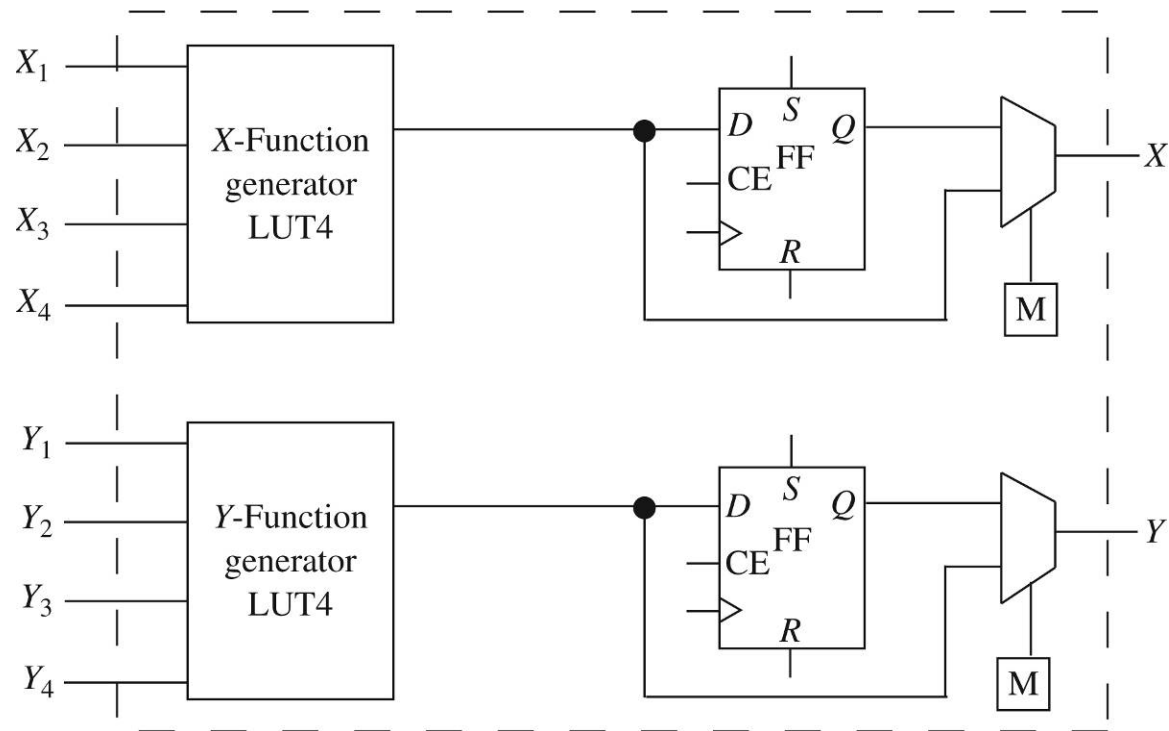


# FPGA Programming

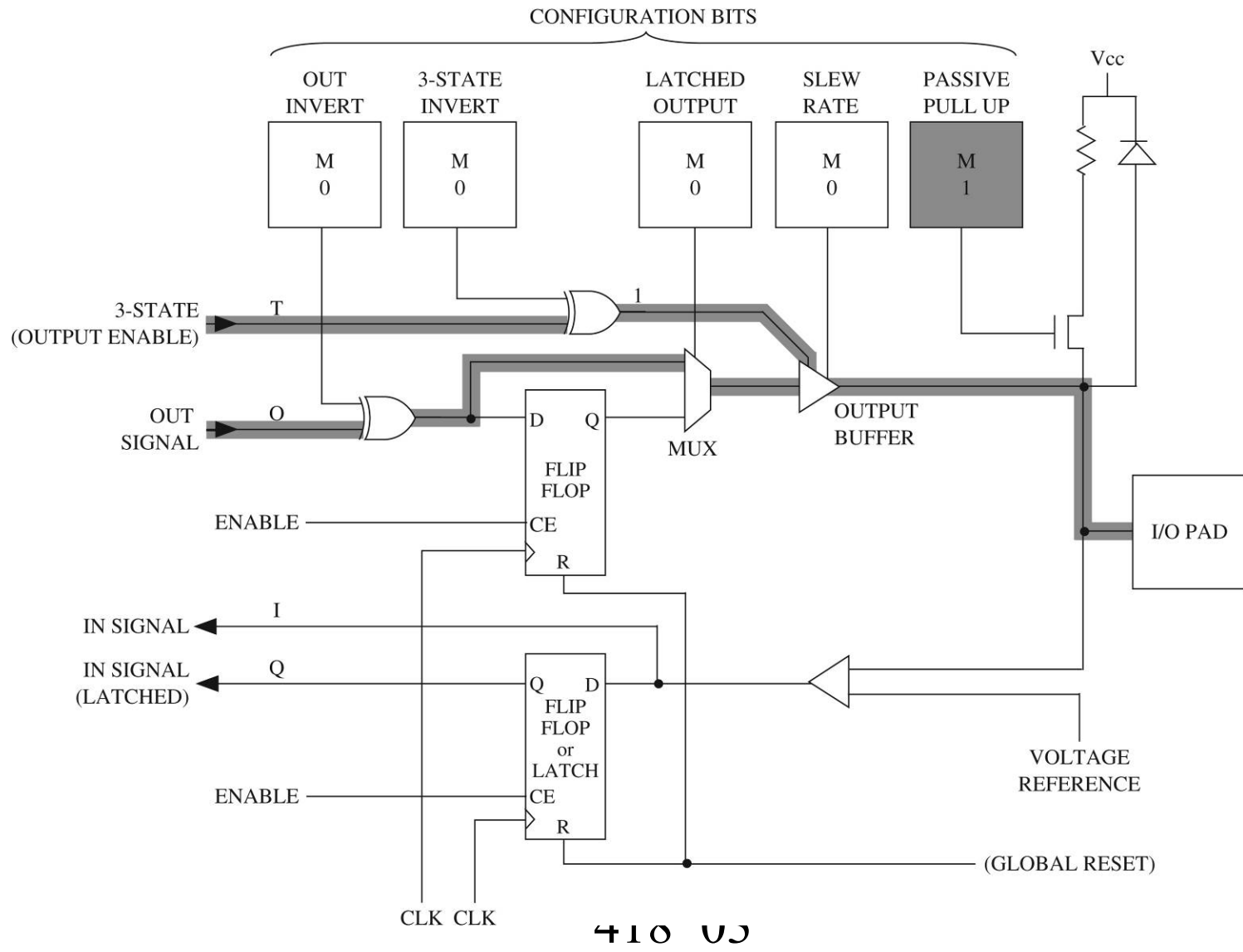
## ◆ Programmable Interconnect



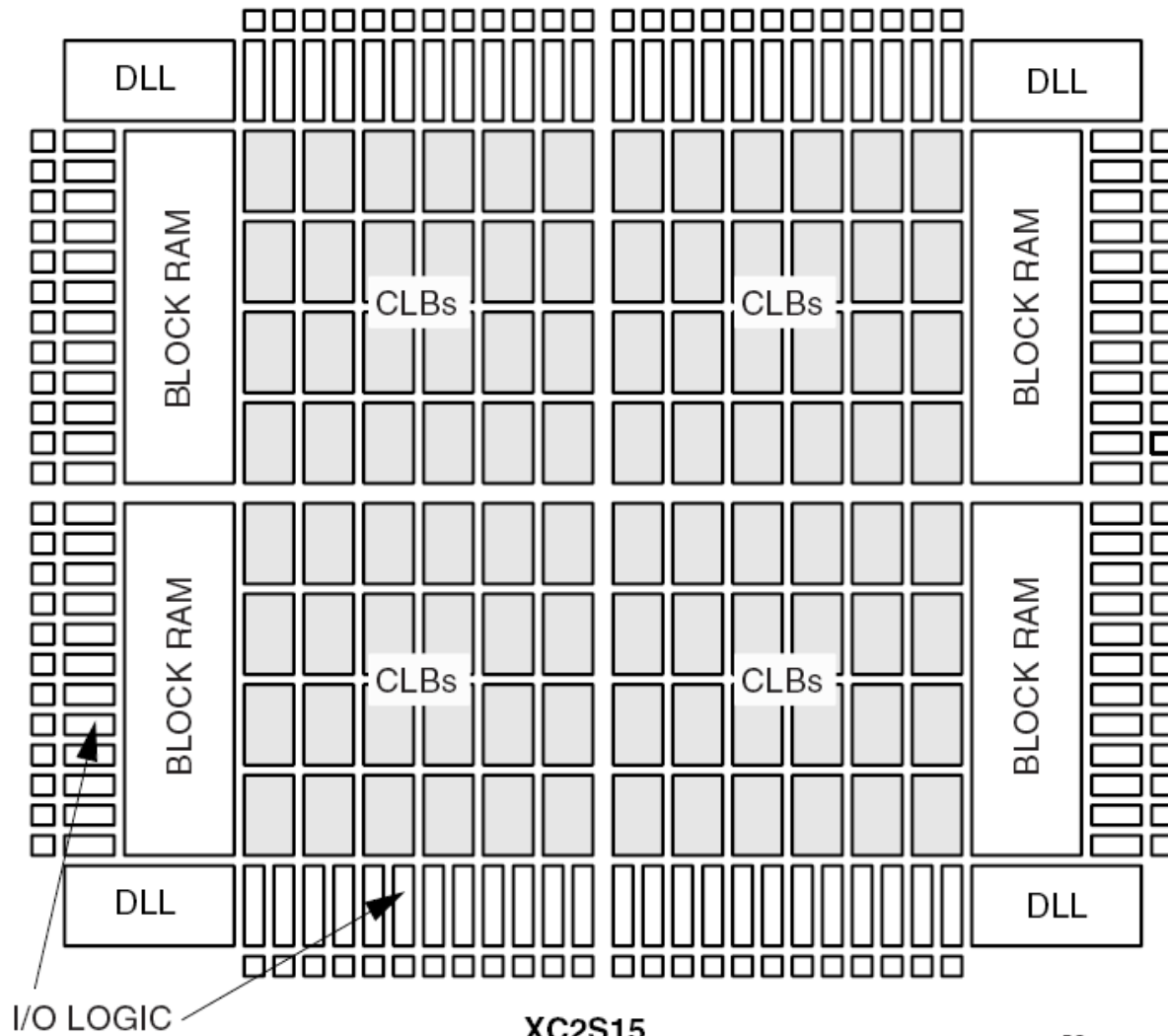
## ◆ Programmable Logic Block



# Programmable I/O Block



# Spartan-II FPGA



XC2S15  
418\_03

DS001\_01\_091800

# Specialized Components

- ◆ Dedicated Memory
  - Block RAM
- ◆ Dedicated Arithmetic Units
  - Fast-Carry Logic
  - Dedicated Multipliers
- ◆ Embedded Processors
- ◆ Digital Signal Processing Blocks



# FPGA Applications

- ◆ Rapid Prototyping
- ◆ Medium-Speed Final Product
- ◆ Reconfigurable Systems
- ◆ Glue Logic
- ◆ Hardware Accelerators

# FPGA Design Flow

- ◆ VHDL Model
- ◆ VHDL Simulation
- ◆ Synthesis
- ◆ Mapping
- ◆ Place and Route
- ◆ Programming File
- ◆ Configure and Test

# Summary

- ◆ FPGAs
  - Programmable Interconnect
  - Programmable Logic Block
  - Programmable I/O Block
  - Specialized Components
  - Applications
  - Design Flow