A brief introduction to programmable logic

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What is programmable logic?

- An electronic circuit which can:
  - implement a wide range of Boolean functions.
  - mimic a wide range of logic networks.
- The programming of this electronic circuit can be achieved in many ways;
  - Using fuses/anti-fuses.
  - Using bits of memory.

A fuse-programmable programmable logic array (PLA)

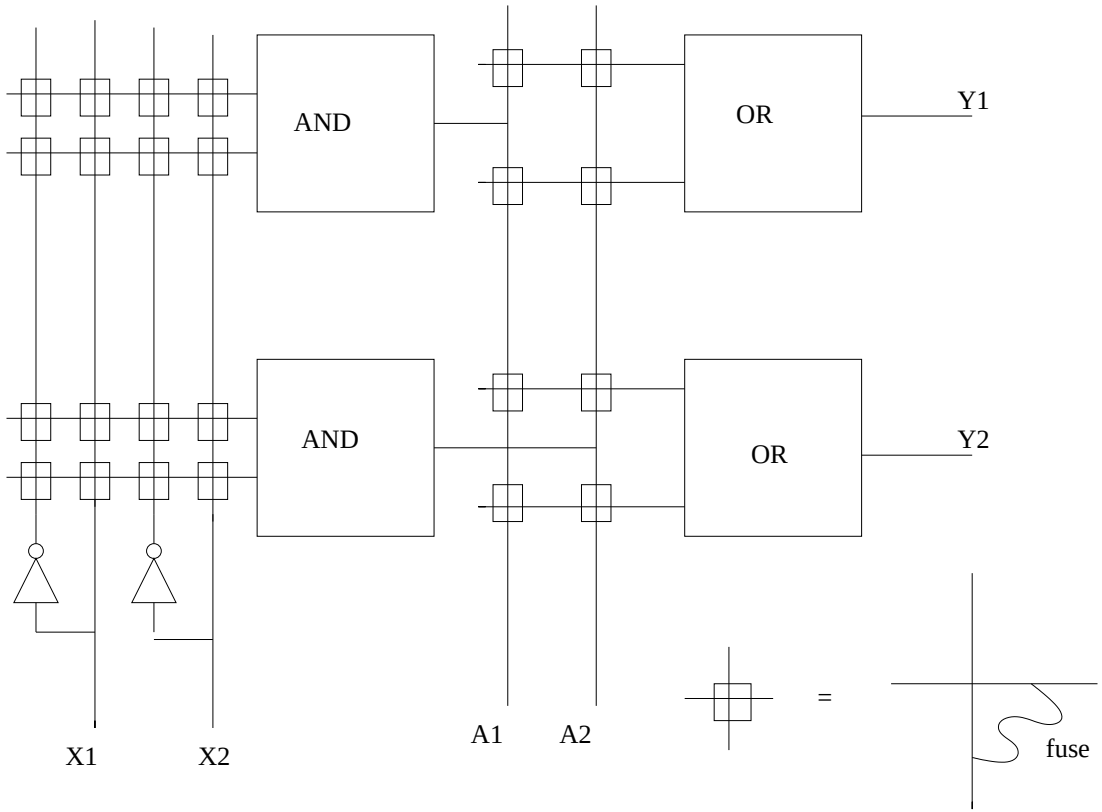

Figure: Fuse programmable PLA

A memory bit programmable lookup table

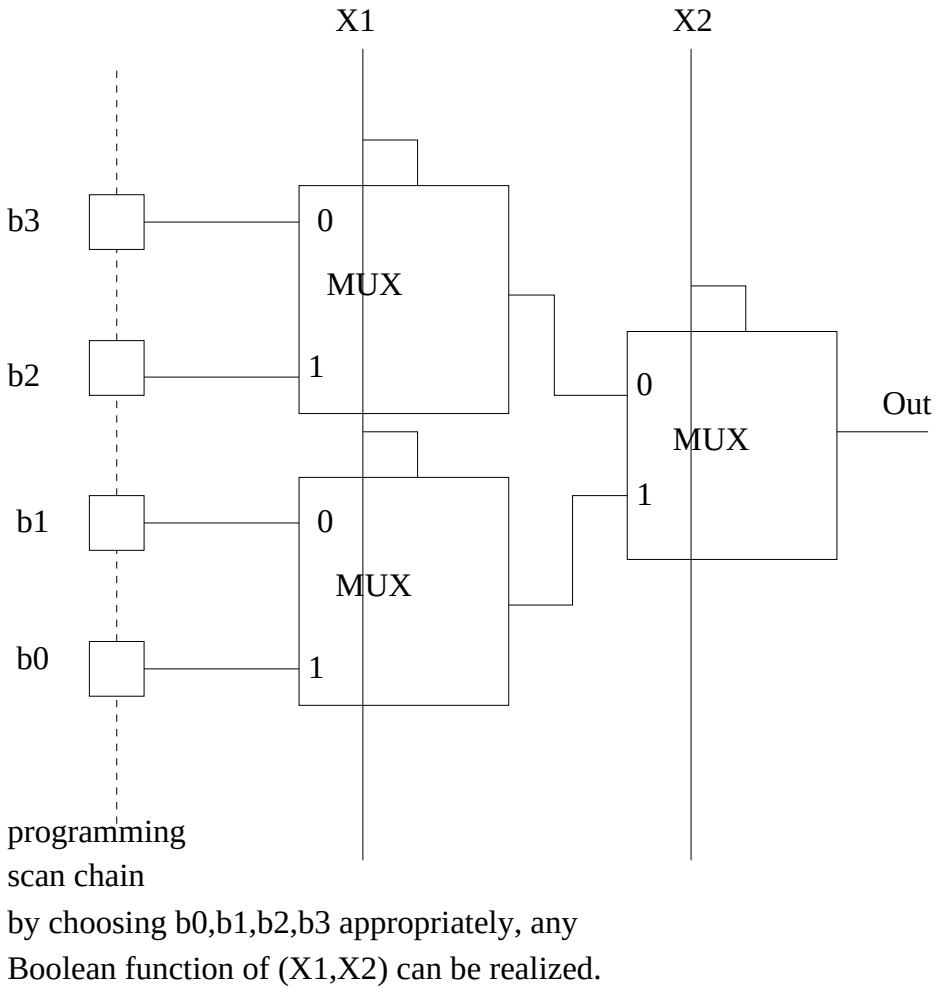

Figure: Memory bit programmable lookup table

Memory bit programmable switch-box

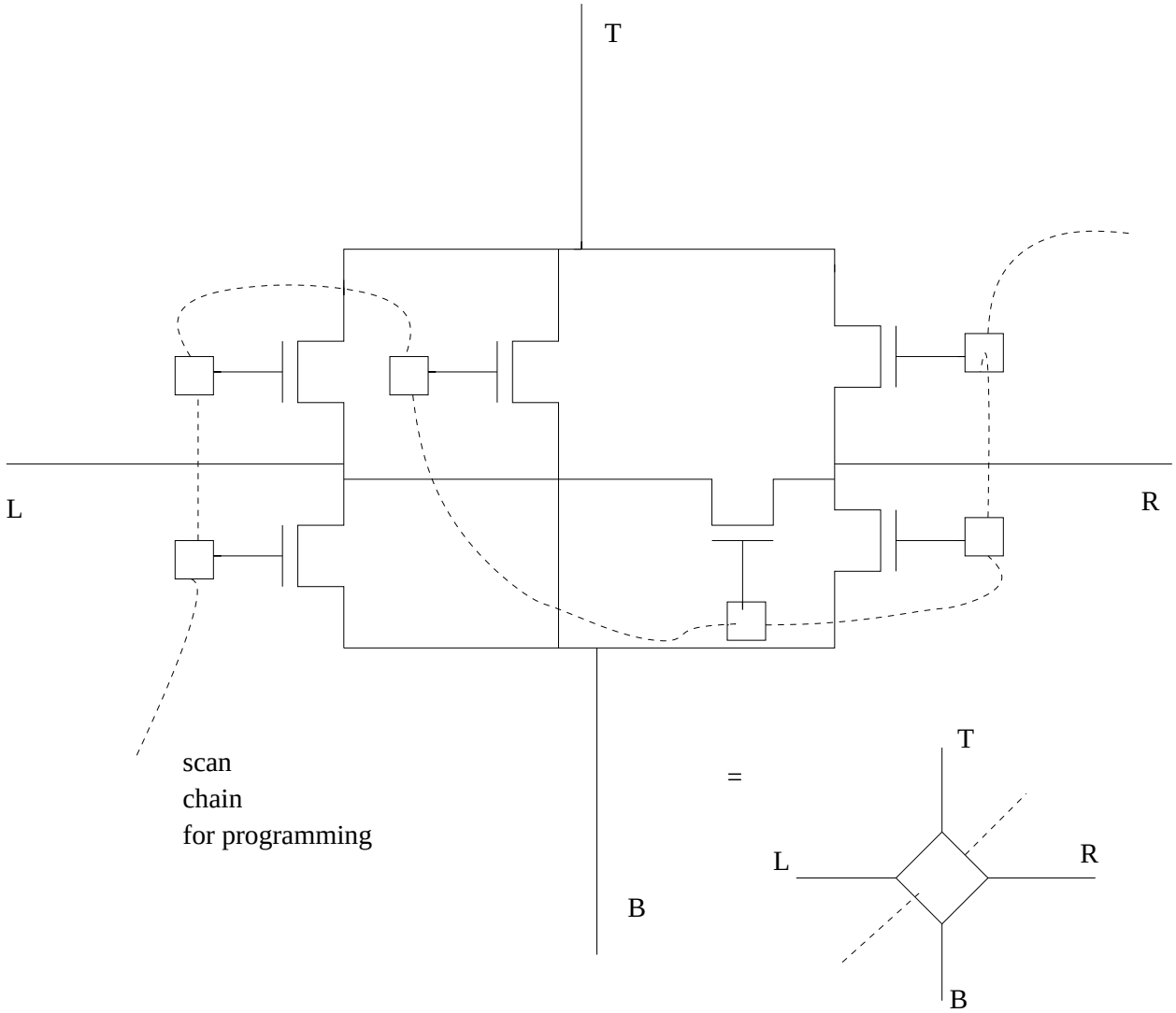

Figure: Memory bit programmable switch box

A complex programmable logic device (CPLD)

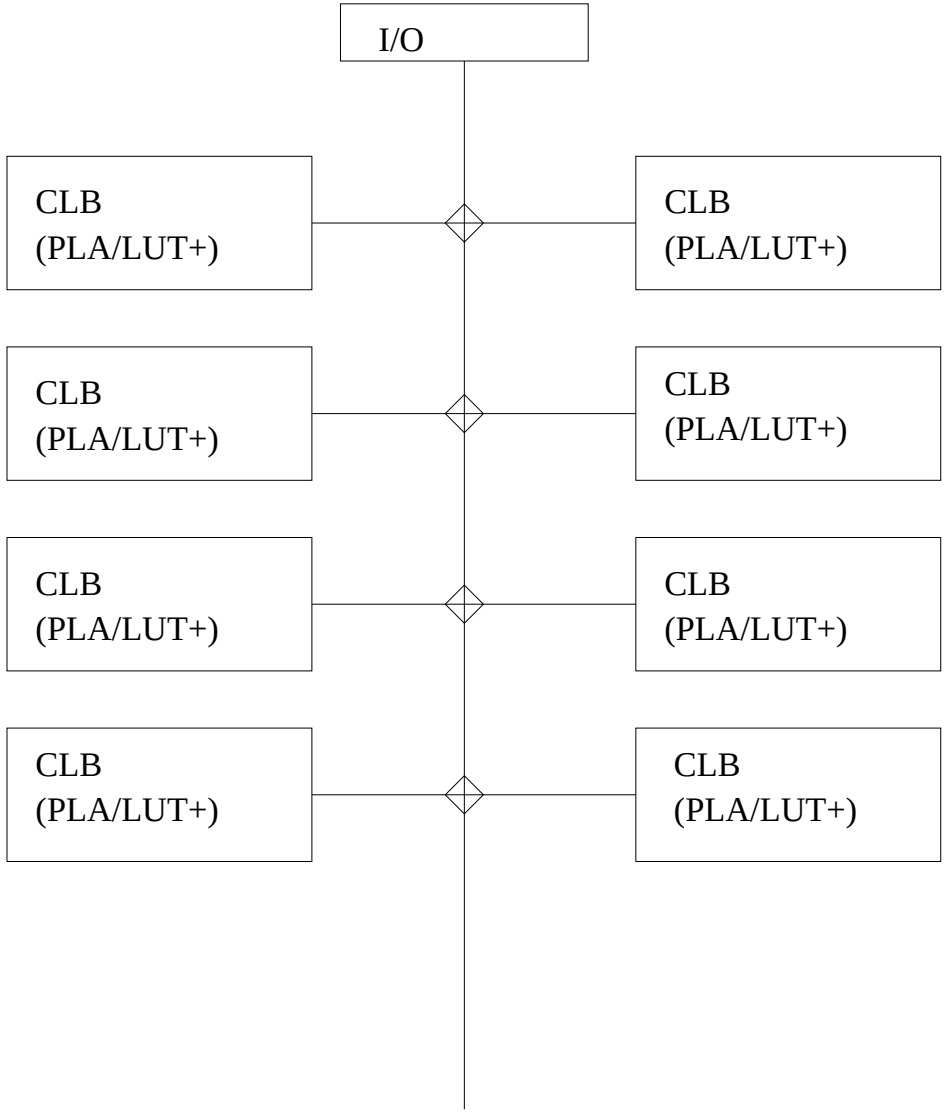

Figure: A complex programmable logic device

A field-programmable gate array (FPGA)

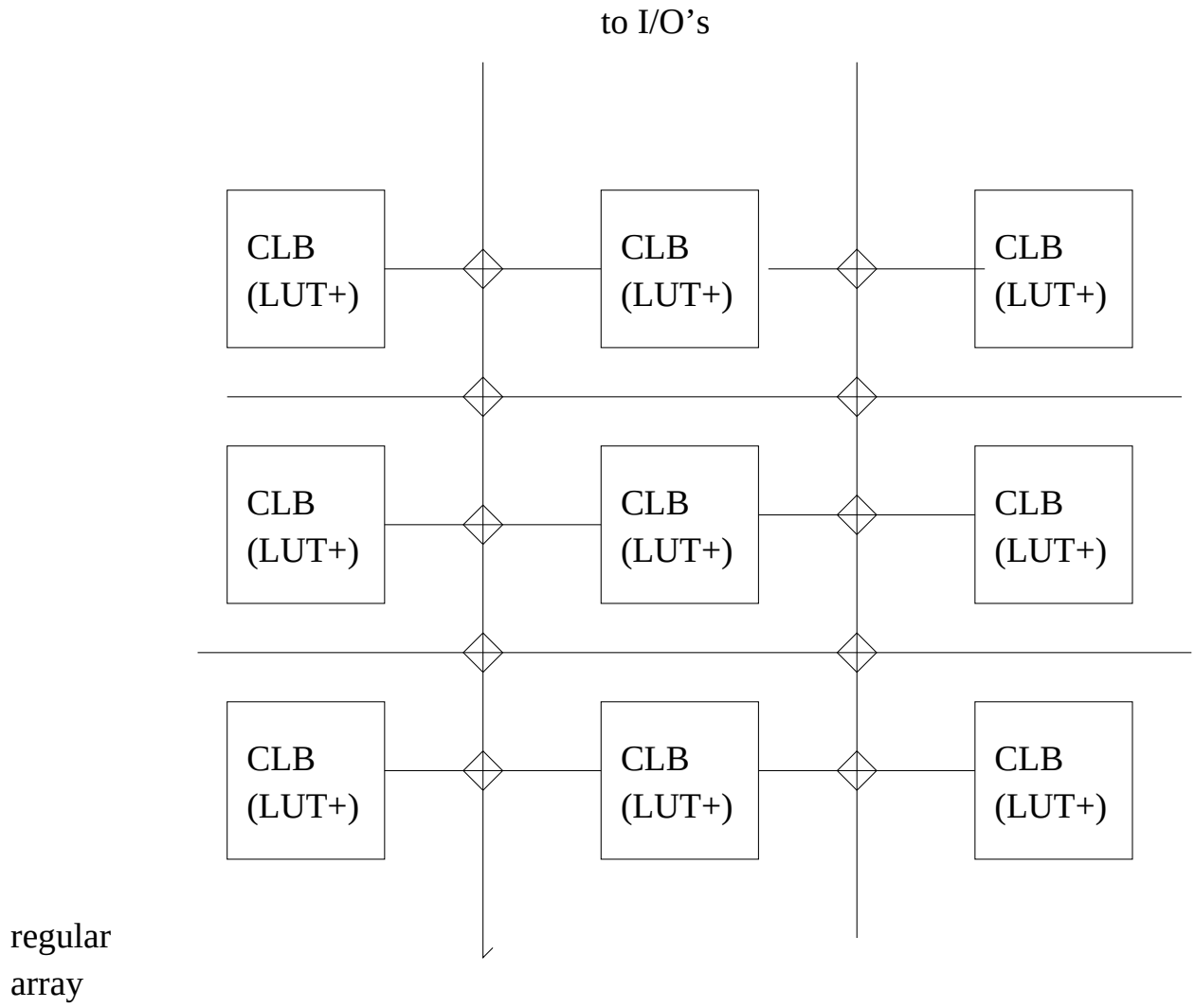

Figure: A fragment of an FPGA fabric

Implementation flow in a programmable device

1. Compile and analyse the VHDL.
2. Convert the VHDL to Boolean equations.
3. Convert the Boolean equations to a generic logic network (typically consisting of AND2, NOT, OR2 gates).
4. Map, place and route the generic logic network to the device fabric.
   - After completing this step, we know the exact delays.
5. Generate programming file.
6. Program the FPGA/CPLD.

Logic network mapped, placed and routed in FPGA

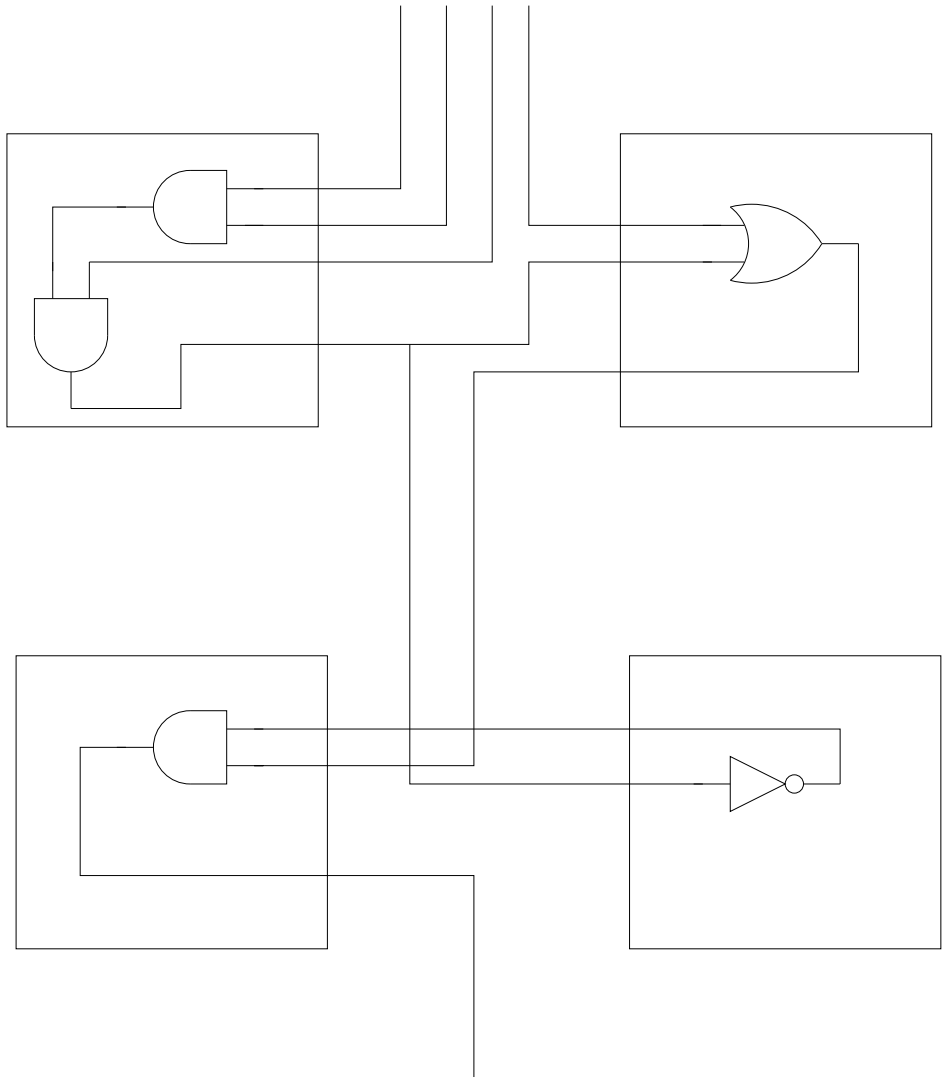

Figure: Illustration of a mapped, placed and routed logic network

Real FPGAs

https://www.intel.com/content/dam/www/programmable/us/en/pdfs/literature/wp/wp-01003.pdf

https://www.xilinx.com/support/documentation/user_guides/ug474_7Series_CLB.pdf

Real FPGAs

- Lots and lots of CLBs.
- Embedded memory.
- Embedded PLL/DLL.
- Embedded micro-processor(s).
- High-speed interfaces.
- cost range: from Rs. 5000 to Rs. 1,50,000.