ALM Exact Synthesis Problem Statement

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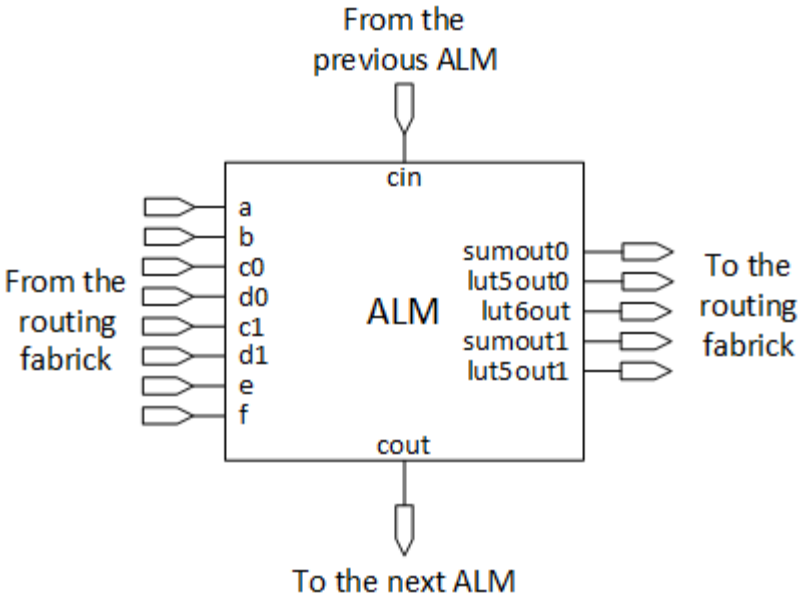
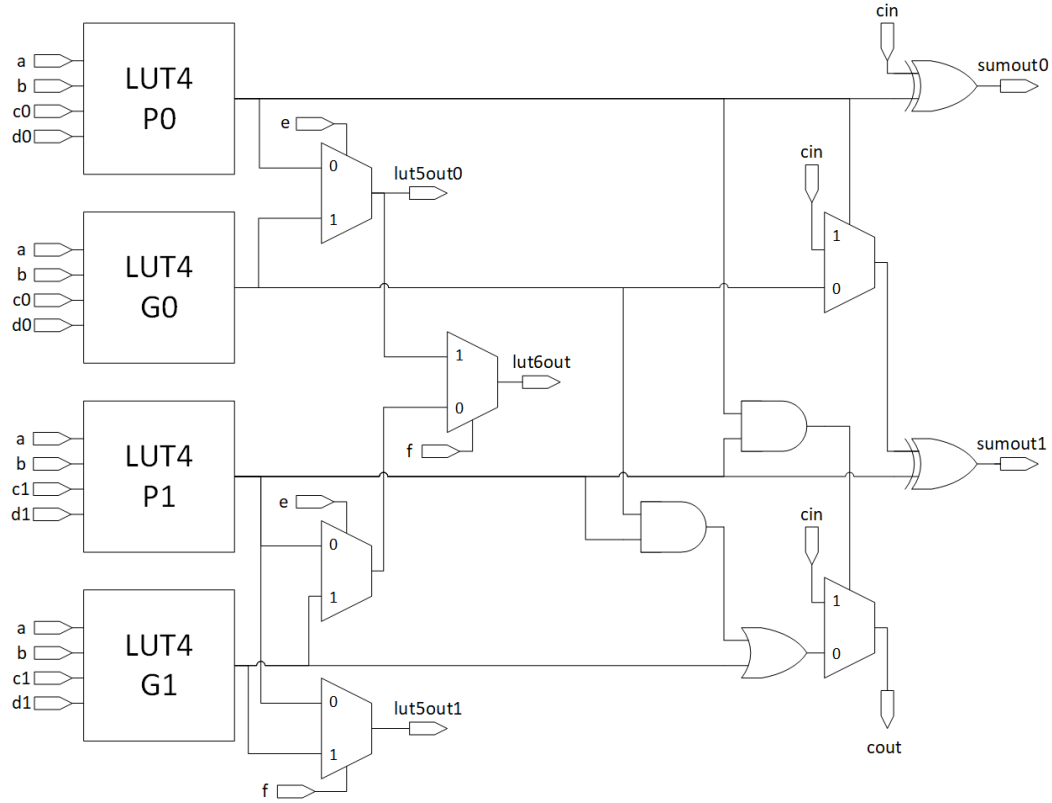
What is ALM?



- ALM stands for Adaptive Logic Module
- ALM is the smallest Stratix10 building block
- 8 inputs from the routing fabric: a, b, c0, c1, d0, d1, e, f
- 5 outputs to the routing fabric: sumout0, sumout1, lut5out0, lut5out1, lut6out (though no more than 4 of these outputs could be connected to the routing fabric)
- ALMs are arranged in a “chain”
- One direct input “cin” from the “previous” neighboring ALM
- One direct output “cout” to the “next” neighboring ALM

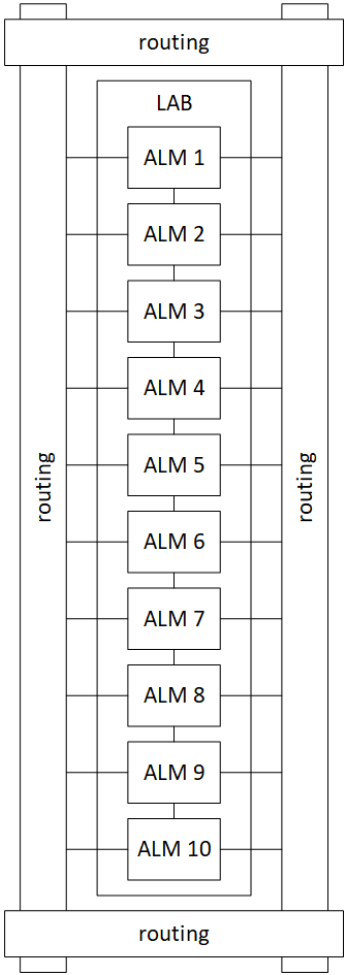
ALM inner structure



- All the components and connections inside ALM are fixed
- The only programmable part is four LUTMASKs
- Every LUT P0, G0, P1, G1 can be configured to implement any 4-input logic function
- Every output to the routing fabric could be registered (the registers are not shown on the picture)

LAB structure

- 10 ALMs are arranged into a bigger block called LAB (Logic Array Block)
- cin input of the first ALM is connected to 0; cin input of ALM 6 could be connected either to 0, or to cout of the previous ALM; all the other ALMs have cin connected to cout of the previous ALM; cout of the last ALM is not connected
- LAB also contains registers and the corresponding control signals (clocks, resets, etc.). They are not shown on the picture)



Problem statement

Given a function $f: B^n \rightarrow B^m$

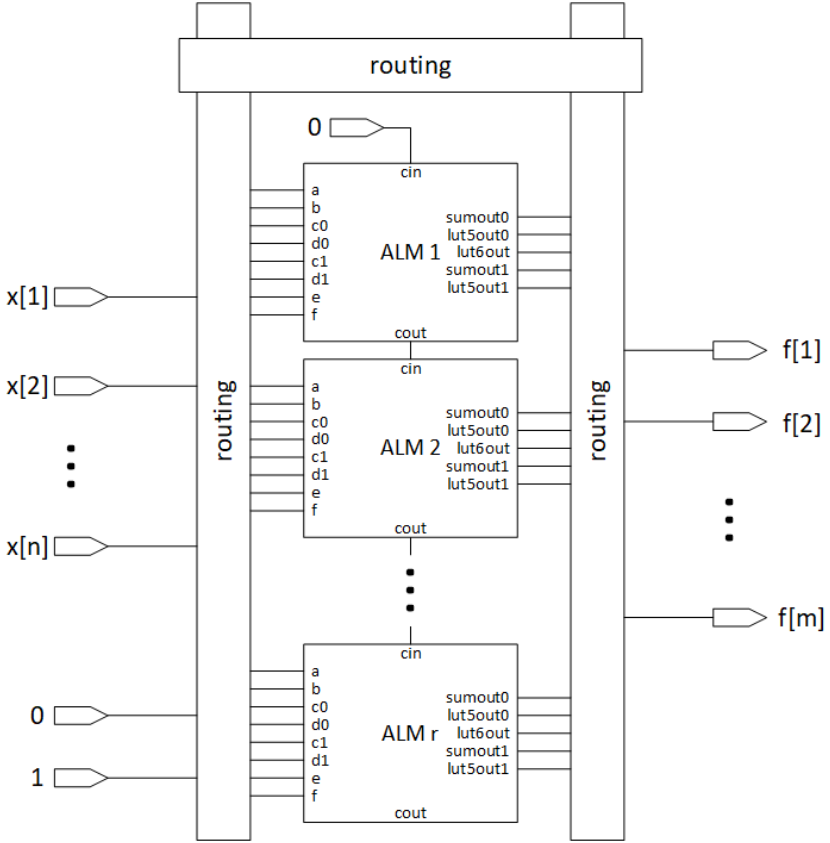
What is the minimum number r that allows to implement f using a chain of r ALMs?

ALM inputs could be connected to

- Primary inputs x[1], … , x[n]
- Constants 0 or 1
- ALM outputs (no directed cycles)

ALM outputs could be connected to

- Primary outputs f[1], … , f[m]
- ALM inputs (no directed cycles)

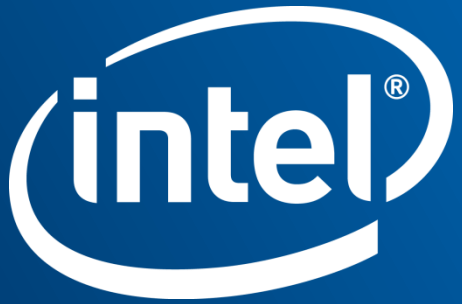


Narrow precision unsigned multipliers

- An important example of the target function f is unsigned multiplication
- Unsigned multiplier PxQ has P+Q inputs p[0],…,p[P-1], q[0], … , q[Q-1] and P+Q outputs z[0],…,z[P+Q-1], where z = p * q
- “Narrow precision” means that both P and Q are relatively small numbers: $2 \le P \le Q \le 10$

Project Goals

1. Describe ALM structure and constraints as constraint satisfaction problem (SMT, SAT, etc.)
2. Find minimum ALM-circuits for narrow-precision unsigned multipliers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