

ALU Design

- The fundamental operation of arithmetic is addition.
- All others:
 - Subtractions
 - Multiplication
 - Division
- are all implemented in terms of addition.

N-Bit Ripple-Carry-Adder (RCA)

The N-bit ripple-carry adder is constructed from N full-adders,

A full adder takes inputs of (x,y,Cin). x, and y are single bit inputs while Cin is a single bit "Carry". It outputs (S, Cout), where S is a single bit addition and Cout is the outputted carry.

Using an AND+wired-OR and an n-bit RCA introduces huge gate delays as each Cout leads to each Cin. Instead of this a **Carry Lookahead** is used, The carry lookahead calculates the carry based on four sequential input bits x_1, y_1 to x_4, y_4 . This requires just two gate delays, as the carry is calculated ahead of time using the following

Carry Lookahead

$$C_{u+j} = g_i + p_i g_{i-1} + p_i p_{i-1} g_{i-2} + \dots + p_i p_{i-1} \dots p_0 C_0$$

- This requires just two gate delays:
 - One to generate g_i and p_i
 - Another to AND them
- Again we can use wired OR
- But, it requires AND gates with a fan in of n
- In practice we can only efficiently build single gates with a limited fan-in

Groups of Input Bits

- For example, let fan-in = 4 and define:
 - G_i^4 A carry out is generated in the i^{th} group of four input bits
 - P_i^4 A carry out is propagated by the i^{th} group of four input bits.