4.4 Multipliers (array-style)

Assuming unsigned binary numbers, an N-bit ***multiplier*** multiplies two N-bit numbers to yield a 2N-bit product. A multiplier by mimicking multiplication by hand. Each multiplier digit is multiplied with the multiplicand and appended with 0's based c location, yielding a partial product, all of which are summed to yield the product.

PARTICIPATION ACTIVITY 4.4.1: 4-bit array-style multiplier.

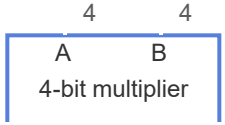
Start 2x speed

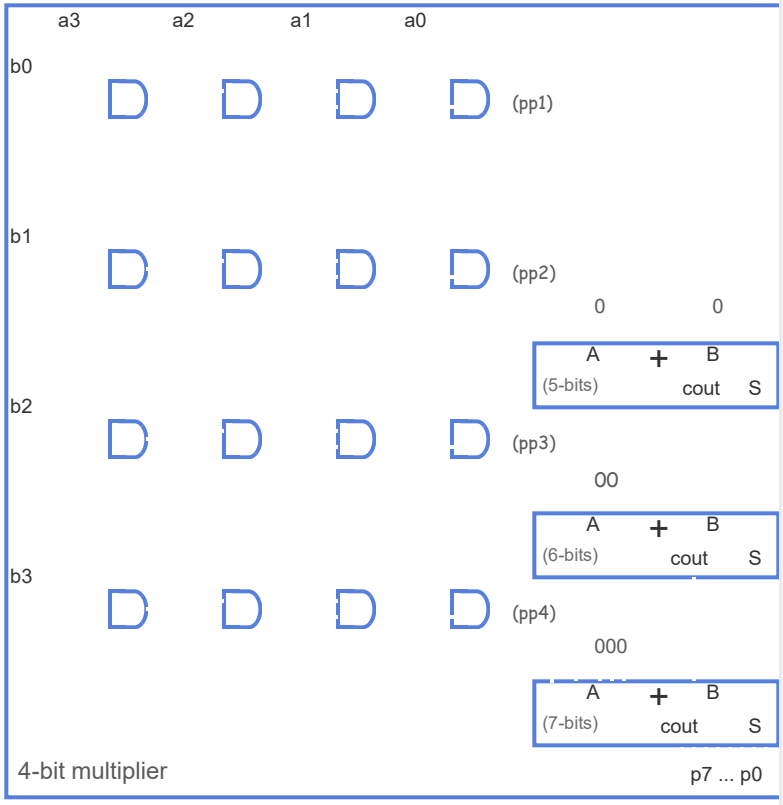
Note: ppx stands for partial product x

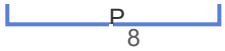
```
                0  1  1  0   (Multiplicand)
          x     0  1  0  1   (Multiplier)
                0  1  1  0
             0  0  0  0  0
          0  1  1  0  0  0
    +  0  0  0  0  0  0  0
    0  0  0  1  1  1  1  0   (Product)
```

```
                a3   a2   a1   a0
          x     b3   b2   b1   b0
                b0a3 b0a2 b0a1 b0a0  (pp1)
           b1a3 b1a2 b1a1 b1a0 0     (pp2)
      b2a3 b2a2 b2a1 b2a0 0    0     (pp3)
+ b3a3 b3a2 b3a1 b3a0 0    0    0     (pp4)
p7 p6   p5   p4   p3   p2   p1   p0   (Product)
```

Block symbol







PARTICIPATION ACTIVITY 4.4.2: Multiplying binary numbers.

Multiply the following 3-bit values. Include any leading zeros.

```
  010
x 110
---------
```

1) pp1 = ???

Check Show answer

2) pp2 = ????

Check Show answer

3) pp3 = ?????

Check Show answer

4) product = ??????

Check Show answer

PARTICIPATION ACTIVITY 4.4.3: Multiplier.

Assume a 4-bit array-style multiplier. (Note: Assume every gate input requires 2 transistors and ignore inverters.)

1) Which component performs 1-bit multiplication?
   - ○ AND gate
   - ○ Adder

2) The product is the sum of partial products.
   - ○ True
   - ○ False

3) What is the size (in transistors) used to compute all partial products?
   - ○ 16
   - ○ 64

4) What is the size (in transistors) of a 5-bit carry-ripple adder built from full adders, if a full adder has 50 transistors?
   - ○ 100
   - ○

- 250

5) What is close in size (in transistors) of a 4-bit array-style multiplier? Assume: 6-bit adder has 300 transistors, 7-bit adder has 350.
   - 250
   - 1000

6) What is the delay (in gate-delays) to compute all partial products?
   - 1
   - 4

7) What is the delay (in gate-delays) of a 5-bit carry-ripple adder built from full adders, assuming a full adder's delay is 2 gate-delays?
   - 2
   - 10

8) Which is closer to the total delay of a 4-bit array-style multiplier?
   - 10
   - 15

Provide feedback on this section