CSEE 4823 Advanced Logic Design
Handout: Lecture #9
10/4/16

Prof. Steven M. Nowick
nowick@cs.columbia.edu

Department of Computer Science (and Elect. Eng.)
Columbia University
New York, NY, USA

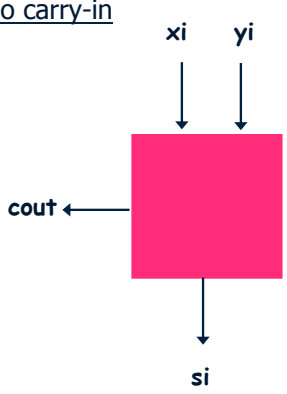
Ripple-Carry Adders (RCA)

Basic Building Blocks: Half Adder (HA)

Purpose: add two 1-bit operands with no carry-in

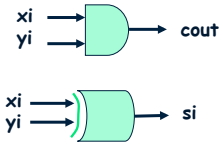
xi	yi	si	cout
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Truth Table



cout = xi yi

si = xi XOR yi



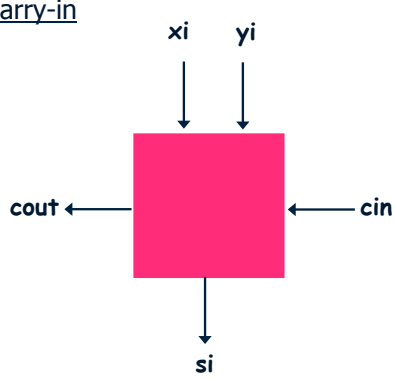
#3

Basic Building Blocks: Full Adder (FA)

Purpose: add two 1-bit operands with carry-in

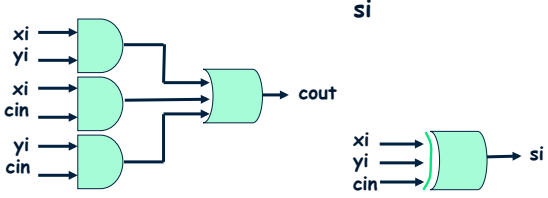
cin	xi	yi	si	cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Truth Table



cout = xi yi + xi cin + yi cin
= MAJORITY Function

si = xi XOR yi XOR cin
= ODD PARITY Function

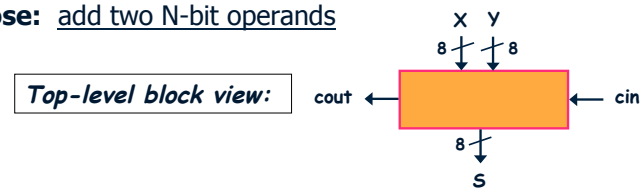


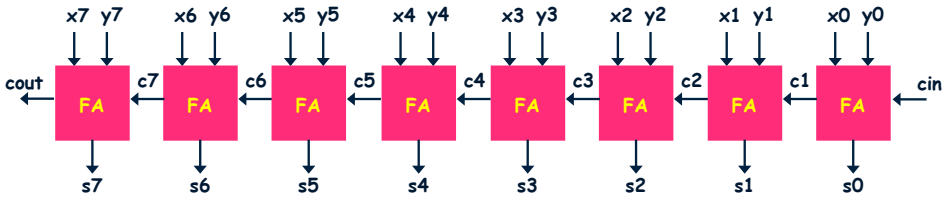
#4

Ripple-Carry Adder (RCA): 8-Bit Example

Purpose: add two N-bit operands

Top-level block view:





Detailed structural view:

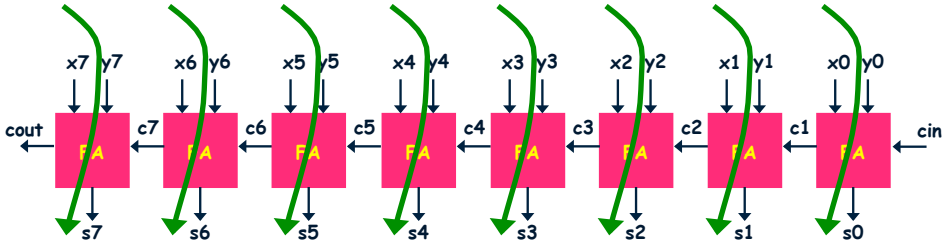
#5

Ripple-Carry Adder (RCA): Simulations

Example #1: best-case = no carry chain *(all carries are 0)*

Addition:

```
  00110010 =  49
+ 00000100 =   4
  00110110 =  53
```



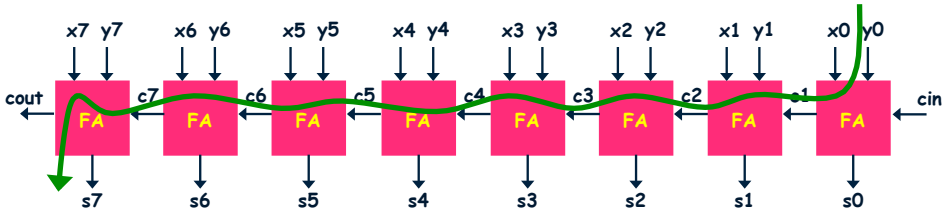
#6

Ripple-Carry Adder (RCA): Simulations

Example #2: worst-case = longest carry chain *(all carries are 1)*

Addition:

```
  00000001 =   1
+ 11111111 =  -1   (2s Complement Representation)
  00000000 =   0
```



#7