



# **SNS COLLEGE OF ENGINEERING**

Kurumbapalayam (Po), Coimbatore – 641 107

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## **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**

**COURSE NAME :19IT301 COMPUTER ORGANIZATION AND  
ARCHITECTURE  
II YEAR /III SEMESTER**

**Unit 1- Arithmetic Operations**

**Topic 3 :Multiplication of positive numbers**



# Multiplication of unsigned numbers



					1	1	0	1	(13) Multiplicand M
					1	0	1	1	(11) Multiplier Q
					<hr/>				
					1	1	0	1	
				1	1	0	1		
			0	0	0	0			
		1	1	0	1				
		<hr/>							
	1	0	0	0	1	1	1	1	(143) Product P

**Product of 2  $n$ -bit numbers is at most a  $2n$ -bit number.**

**Unsigned multiplication can be viewed as addition of shifted versions of the multiplicand.**



# Multiplication of unsigned numbers (contd..)



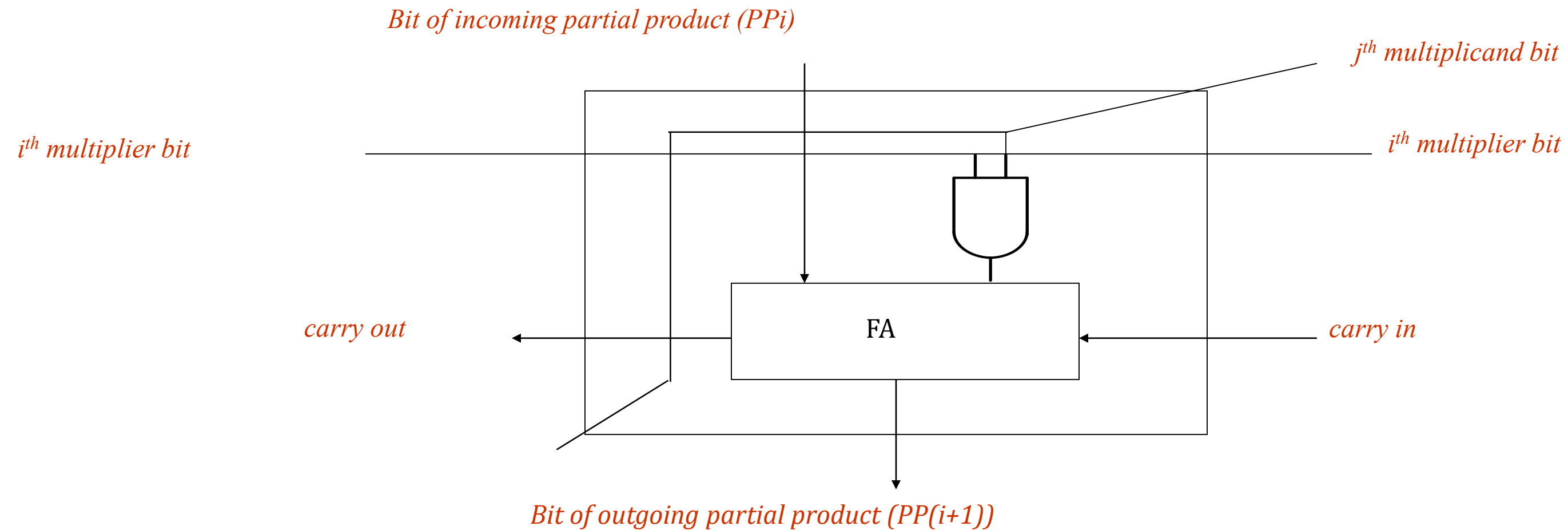
- We added the partial products at end.
  - Alternative would be to add the partial products at each stage.
- Rules to implement multiplication are:
  - If the  $i^{th}$  bit of the multiplier is 1, shift the multiplicand and add the shifted multiplicand to the current value of the partial product.
  - Hand over the partial product to the next stage
  - Value of the partial product at the start stage is 0.



# Multiplication of unsigned numbers



Typical multiplication cell

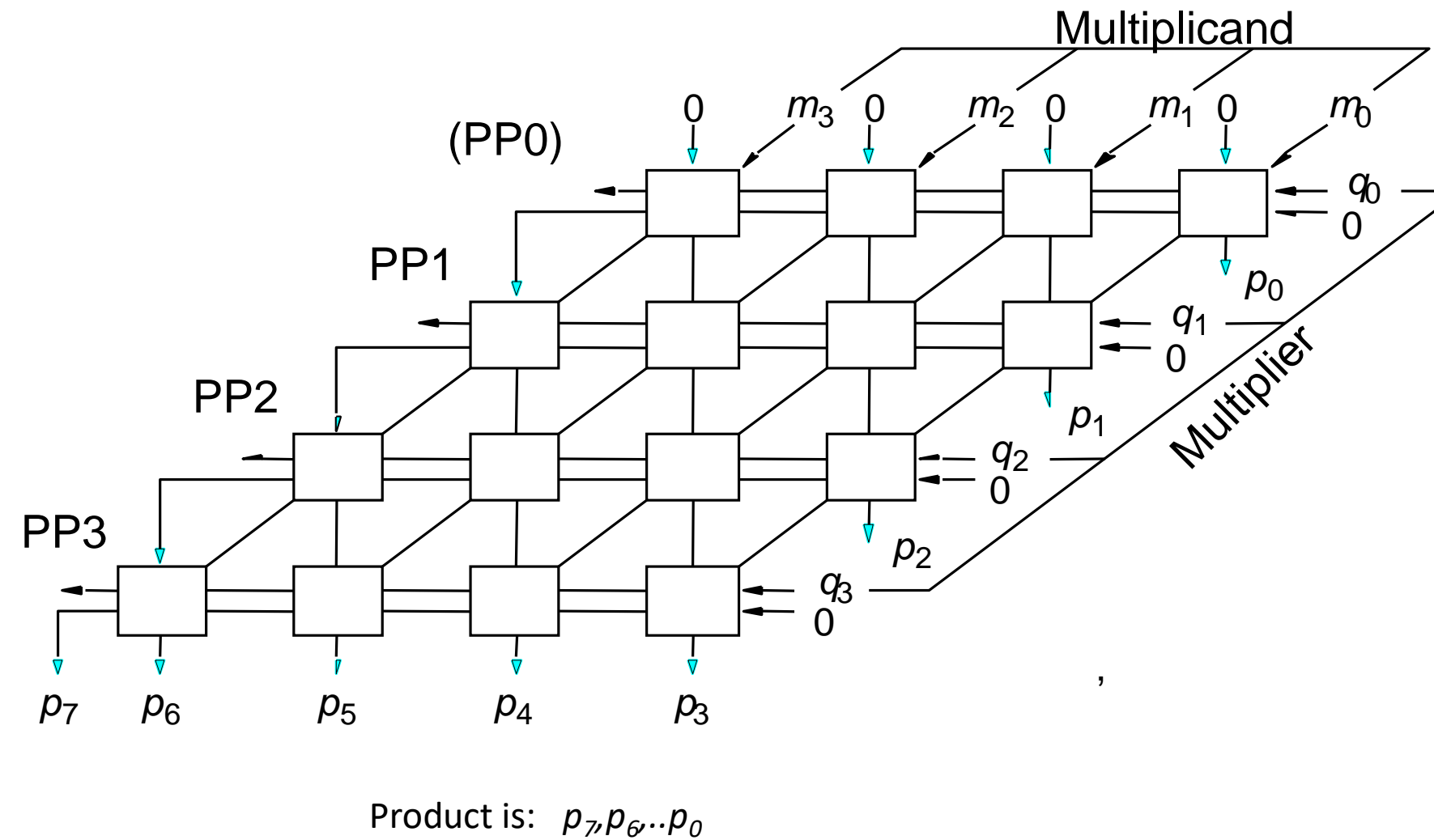




# Multiplication of unsigned numbers - Combinational array multiplier



Combinatorial array multiplier



Multiplicand is shifted by displacing it through an array of adders.



# Combinational array multiplier (contd..)



Combinational array multipliers are:

Extremely inefficient.

Have a high gate count for multiplying numbers of practical size such as 32-bit or 64-bit numbers.

Perform only one function, namely, unsigned integer product.

Improve gate efficiency by using a mixture of combinational array techniques and sequential techniques requiring less combinational logic.





# Sequential multiplication



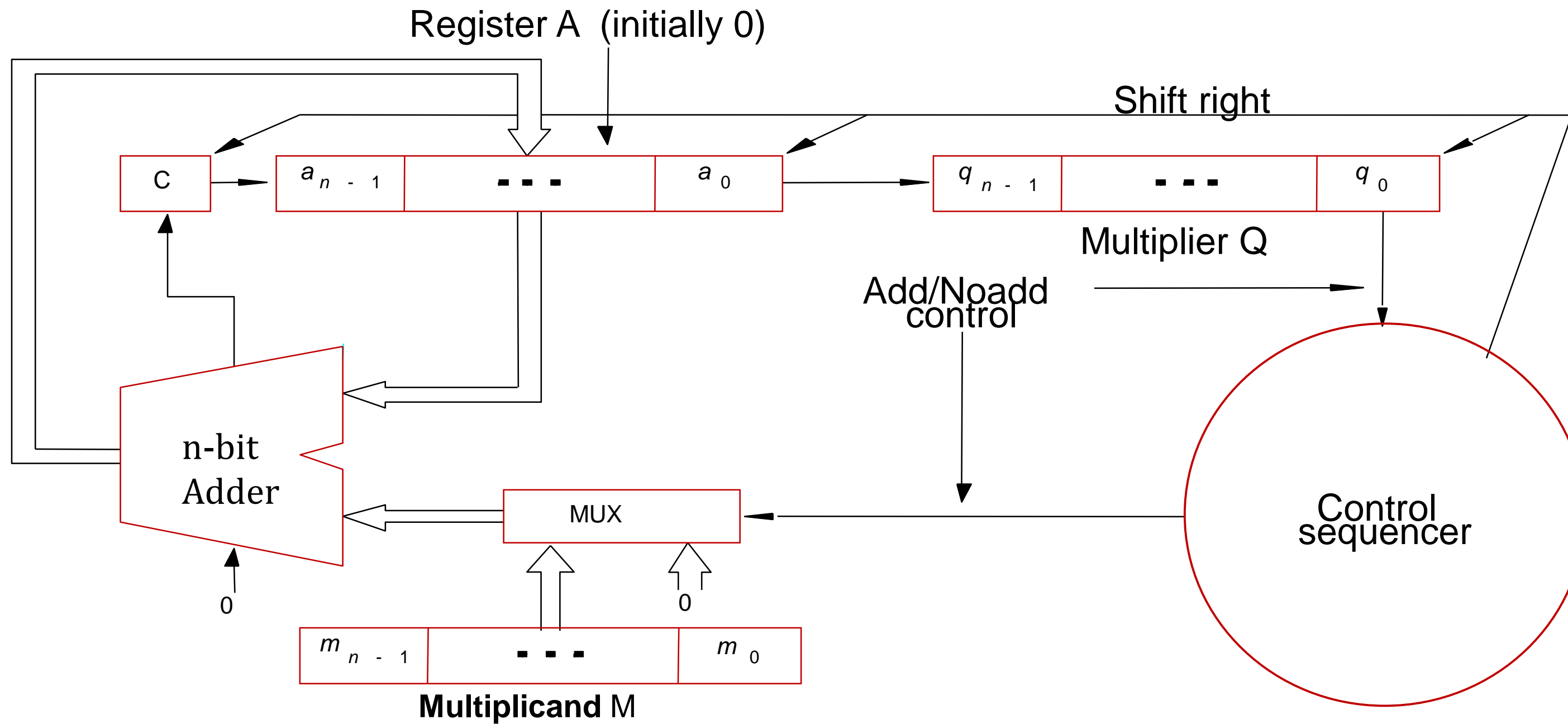
Recall the rule for generating partial products:

If the  $i$ th bit of the multiplier is 1, add the appropriately shifted multiplicand to the current partial product.

Multiplicand has been shifted left when added to the partial product.

However, adding a left-shifted multiplicand to an unshifted partial product is equivalent to adding an unshifted multiplicand to a right-shifted partial product.

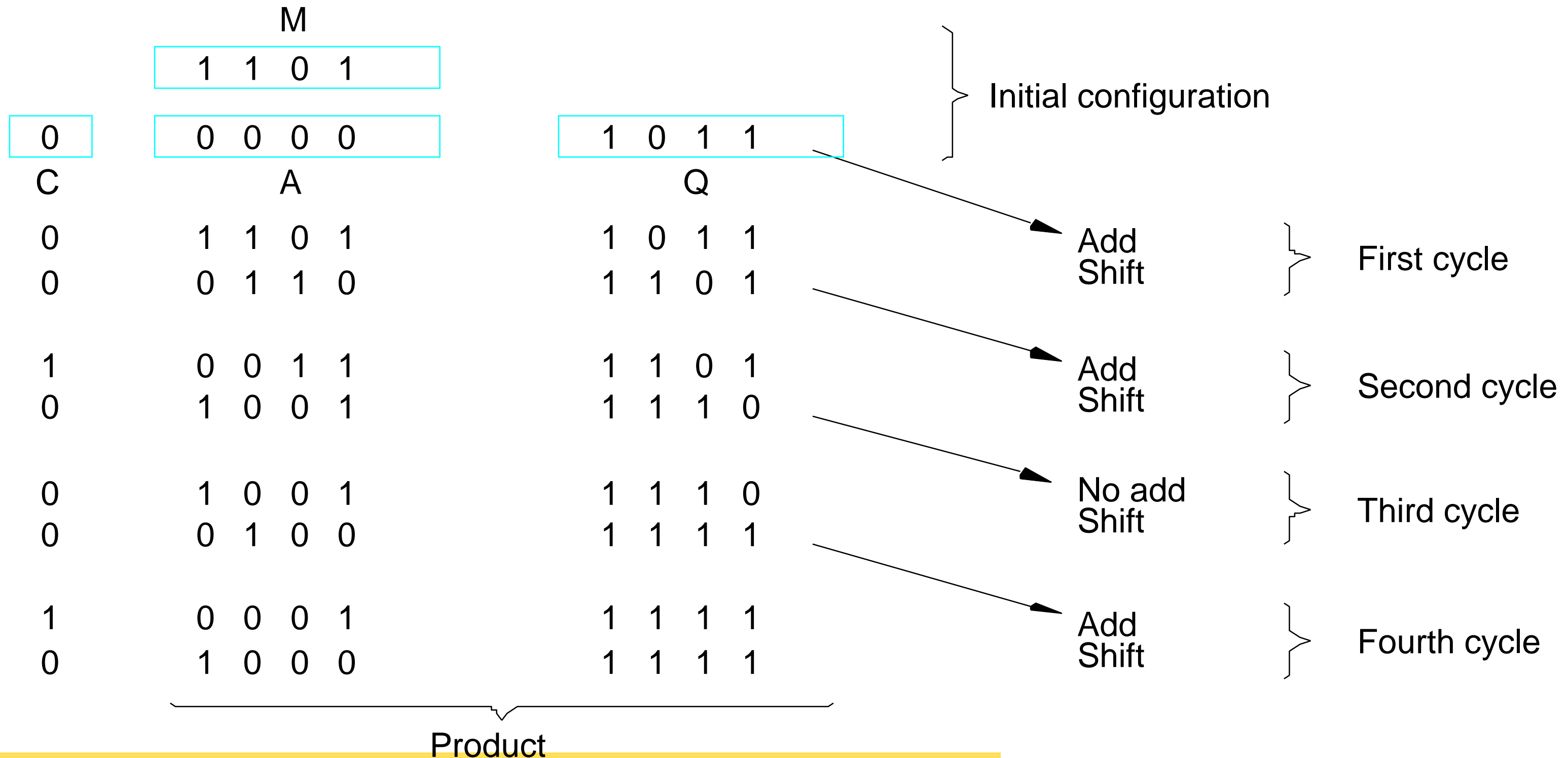
# Multiplication of unsigned numbers -Sequential Circuit Multiplier







# Sequential multiplication (contd..)





# Assessment



a). What is signed and unsigned number?

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b) Compare array multiplier and sequential ckt multiplier





# Reference



1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization”, McGraw-Hill, 6<sup>th</sup> Edition 2012.