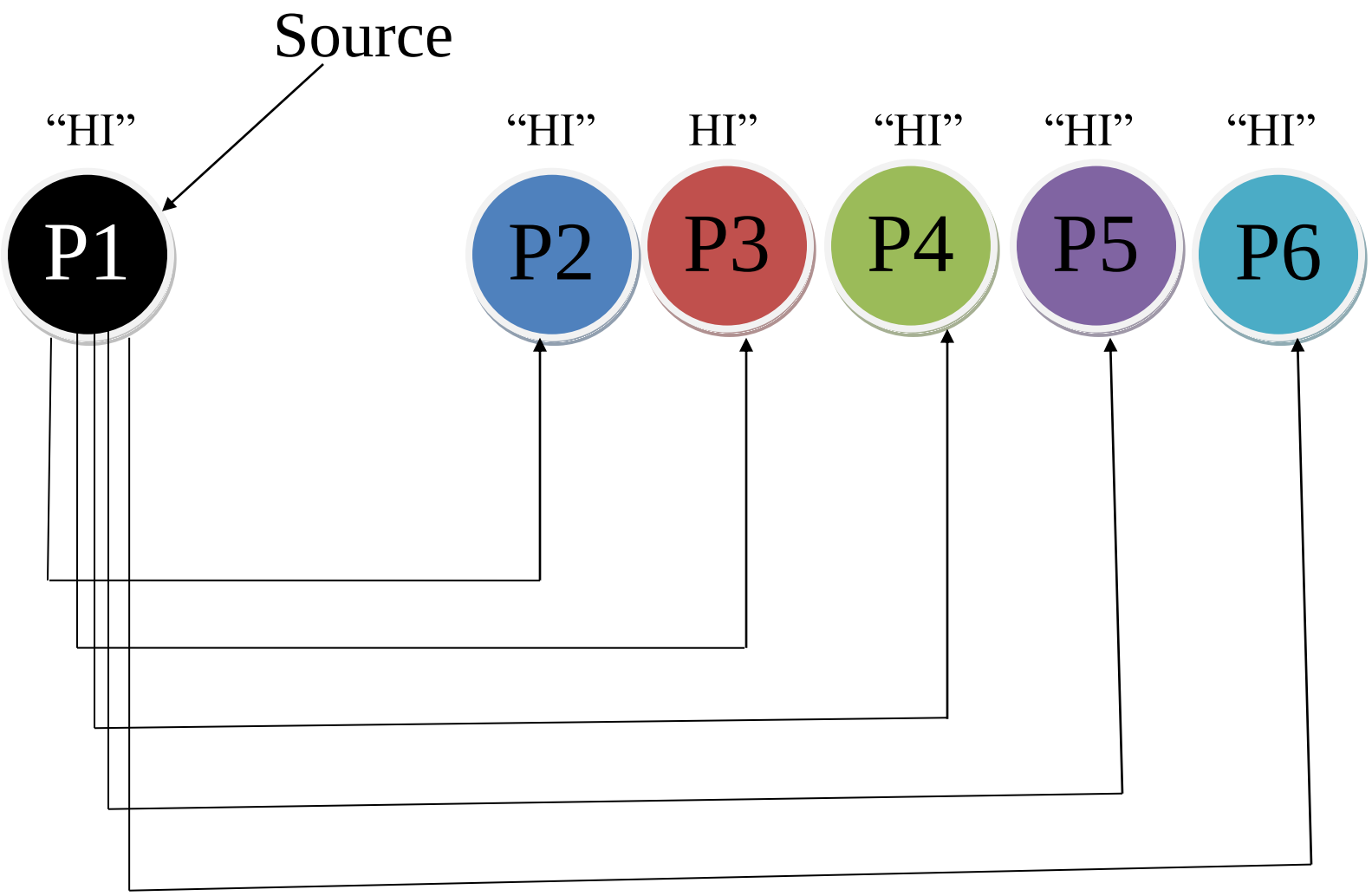
One-to-All Broadcast



- Applications :

  It is used in several important parallel algorithms including matrix-vector multiplication, Gaussian elimination, shortest paths, and vector inner product.

- How it is done?

  Sequentially send p - 1 messages from the source to the other p - 1 processes

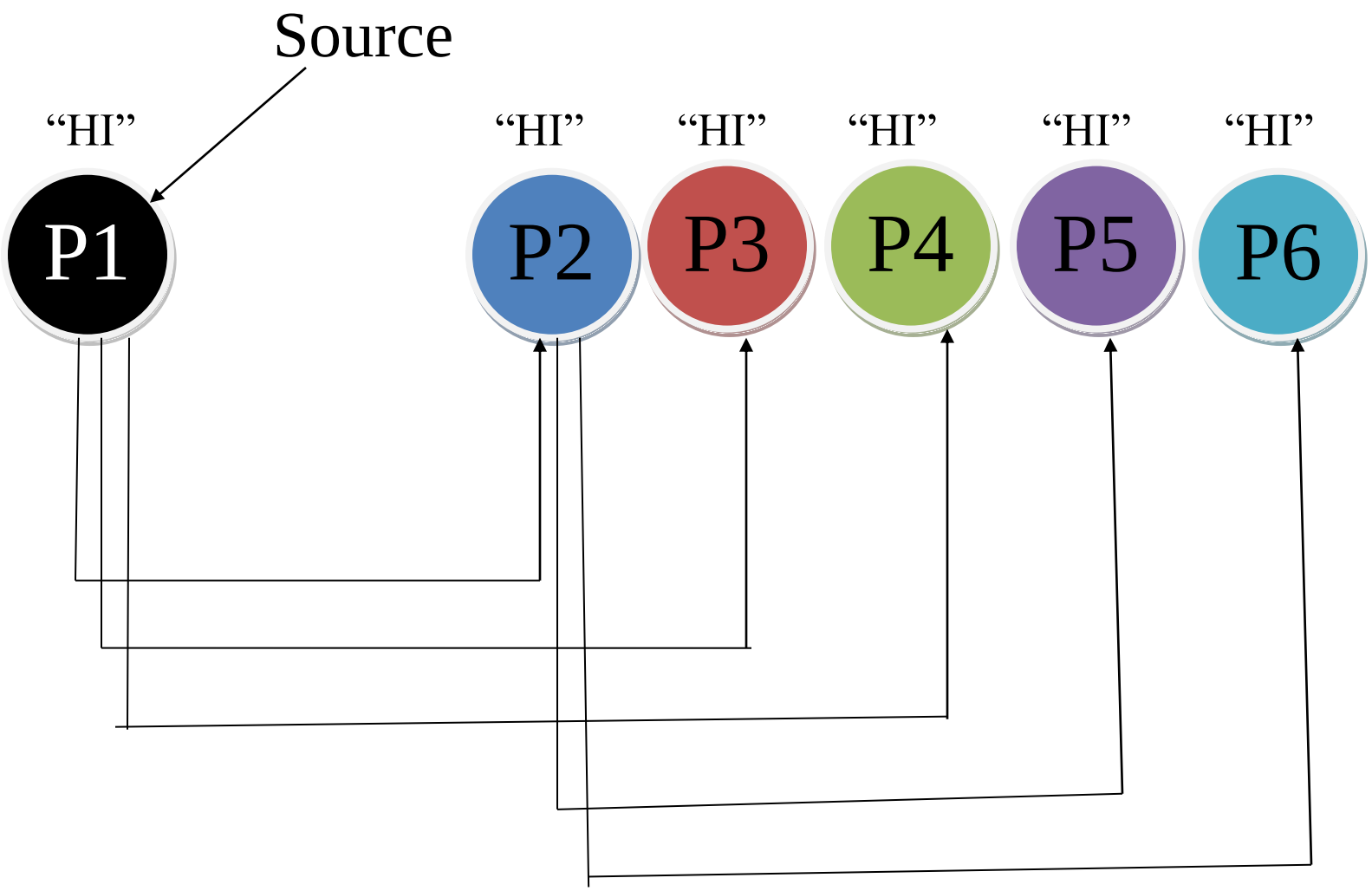
- Disadvantages

  1) Source process becomes a bottleneck
  2) The communication network is underutilized because only the connection between a single pair of nodes is used at a time

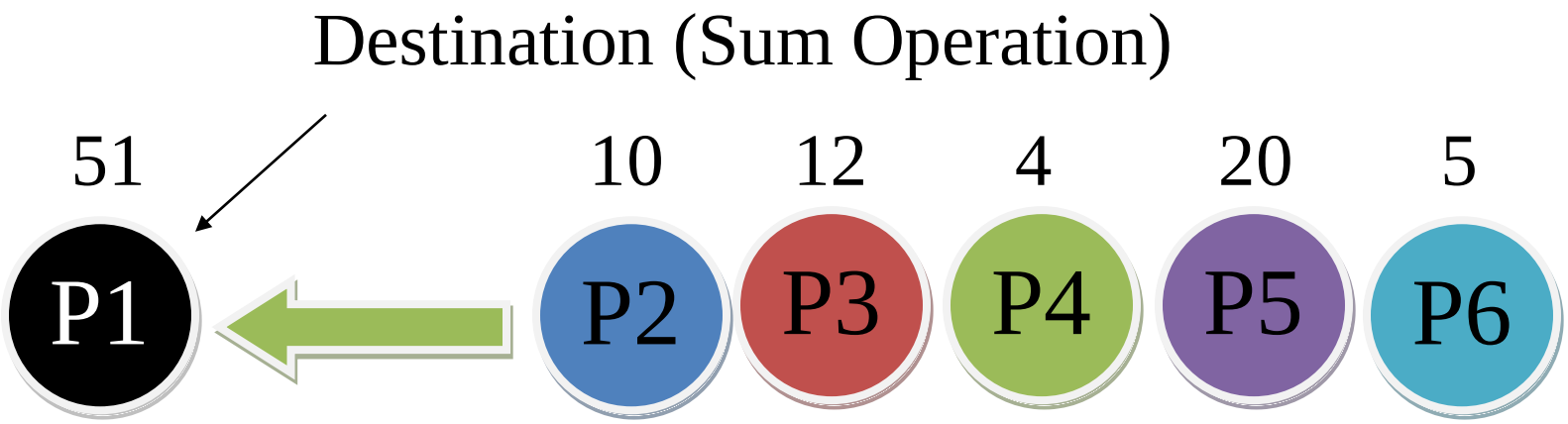
- Solution?

  Go for recursive doubling

Recursive Doubling

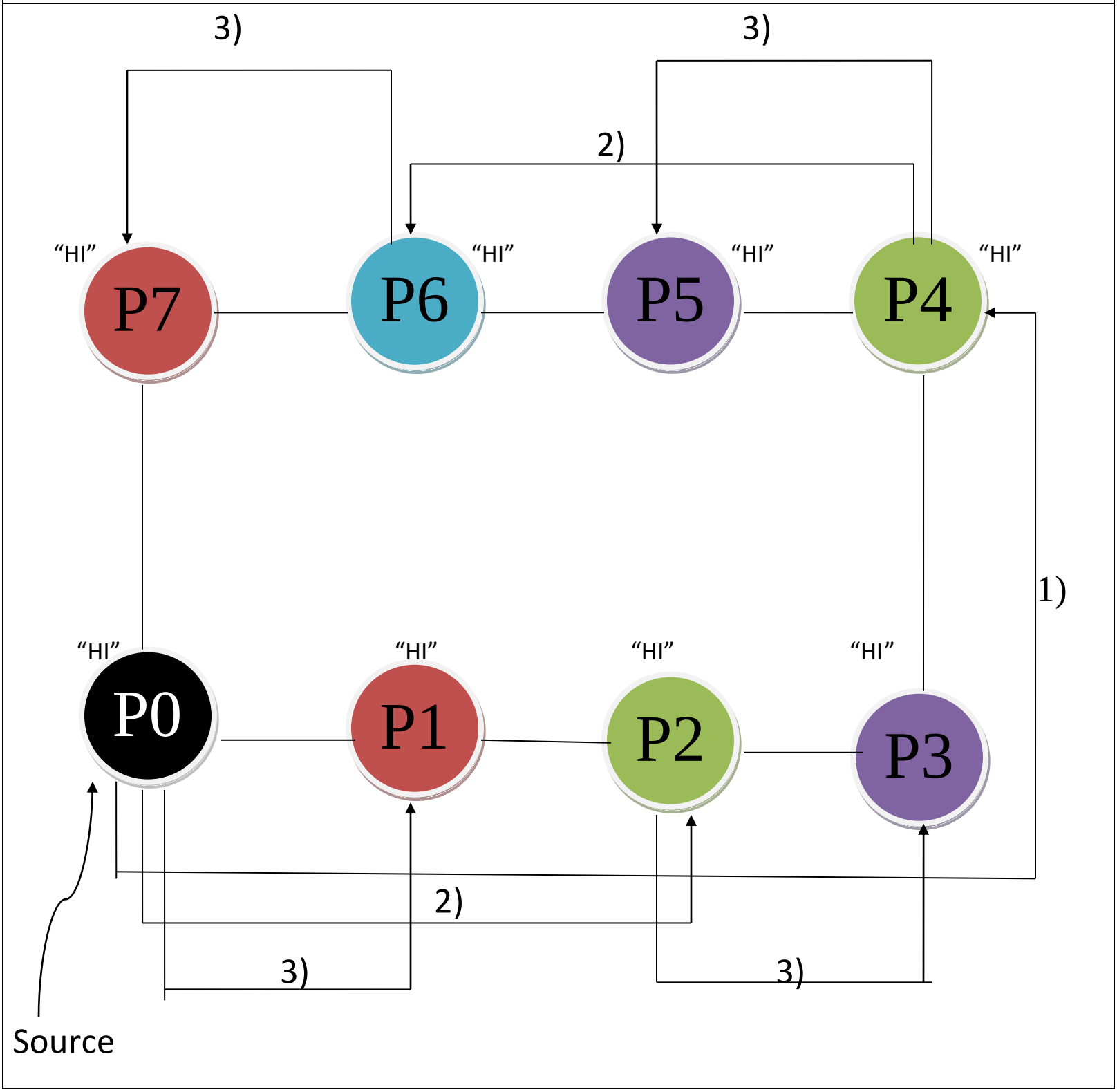


All-to-One Reduction



Reduction can be used to find the sum, product, maximum, or minimum of sets of numbers

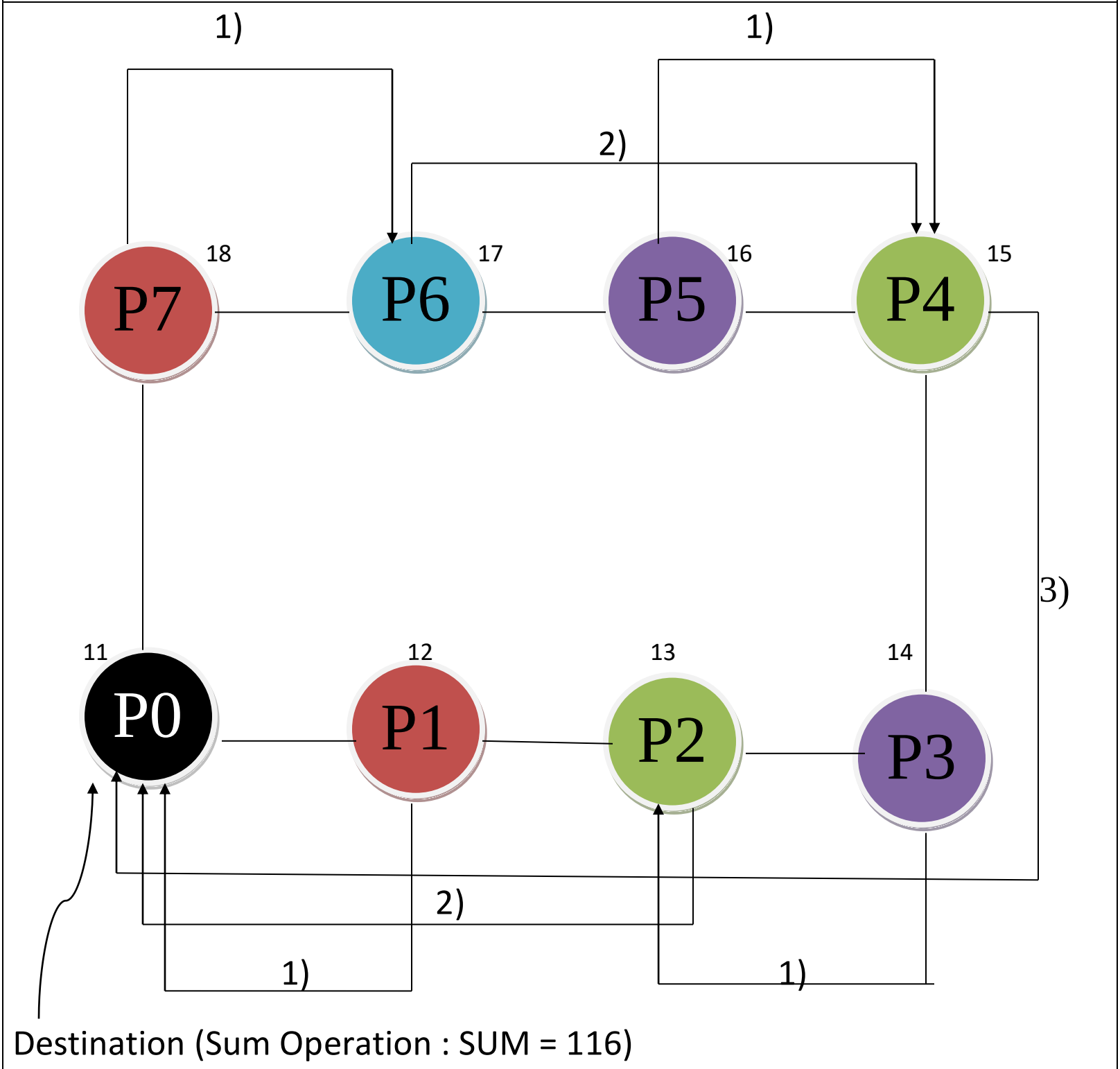
Ring / Linear Array (One-to-All Broadcast)



Message “HI” from the source node P0 is passed to all other nodes in the ring in following 3 steps :

1) P0 to P4
   Distance : 4
2) P0 to P2, P4 to P6 , in parallel
   Distance : 2
3) P0 to P1, P2 to P3, P4 to P5, P6 to P7 , in parallel
   Distance : 1

Ring / Linear Array (All-to-One Reduction)



Sum of all numbers at all nodes in the ring is calculated in the following 3 steps :

Step No.	Node No.	Reduction Operation	Data at respective nodes
1.	P0 = P0+P1 = 11 + 12 = 23	P0 ← P1	P0 : 11 P1 : 12 P2 : 13 P3 : 14 P4 : 15 P5 : 16 P6 : 17 P7 : 18
	P2 = P2+P3 = 13 + 14 = 27	P2 ← P3	
	P4 = P4+P5 = 15 + 16 = 31	P4 ← P5	
	P6 = P6+P7 = 17 + 18 = 35	P6 ← P7	

2.	P0 = P0+P2 = 23 + 27 = 50	P0 ← P2	P0 : 23 P1 : 12 P2 : 27
	P4 = P4+P6 = 31 + 35 = 66	P4 ← P6	P3 : 14 P4 : 31 P5 : 16 P6 : 35 P7 : 18
3.	P0 = P0+P4 = 50 + 66 = 116	P0 ← P4	P0 : 50 P1 : 12 P2 : 27 P3 : 14 P4 : 66 P5 : 16 P6 : 35 P7 : 18

Result of the sum at node P0 by all to one reduction method = 116