Chapter 2 Exercise 2 – Node Distance

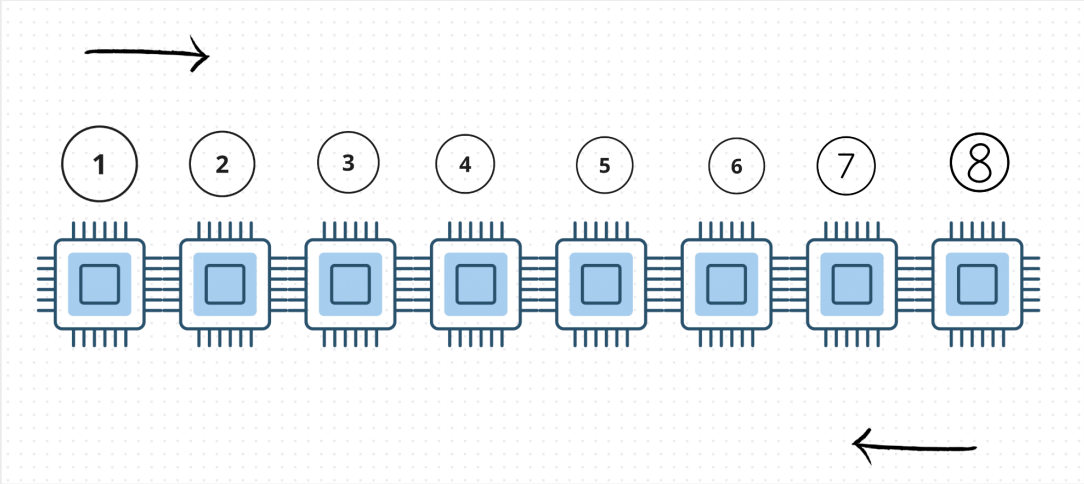
•You have a parallel algorithm that uses 8 processors numbered 1 through 8. Each processor needs to communicate with the (k+1) mod 8 and (k+4) mod 8 processor, where k is the ID of the processor sending the message.

•For example, processor 1 would communicate with processors 2 and 5. Processor 6 would communicate with processors 7 and 2.

•Assuming an equal number of messages are sent to both the (k+1) mod 8 and (k+4) mod 8 processors what is the average distance a message travels if the processors are connected in: a line, a ring, and a 2x4 mesh?

Answer:

Line Topology:



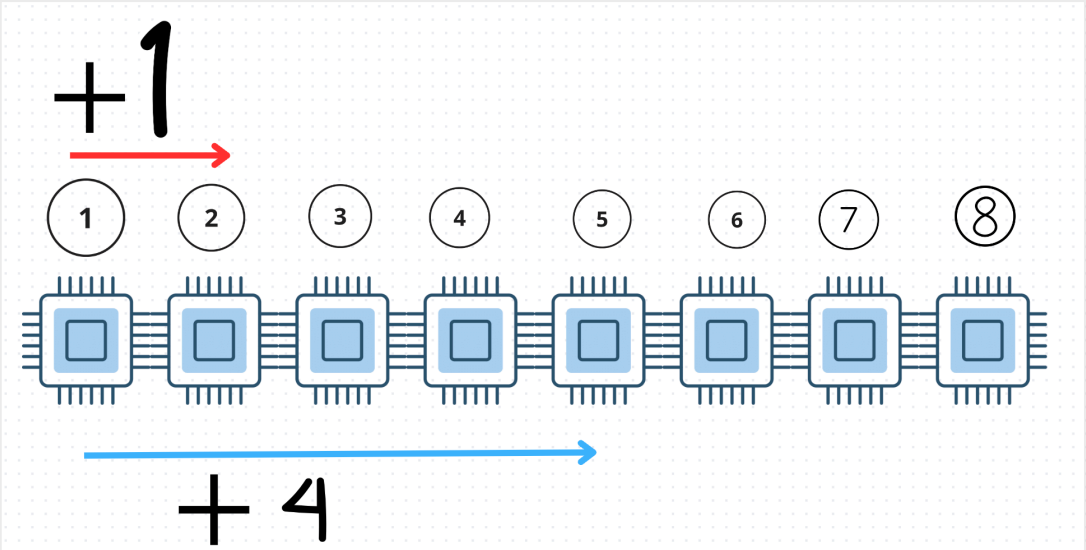
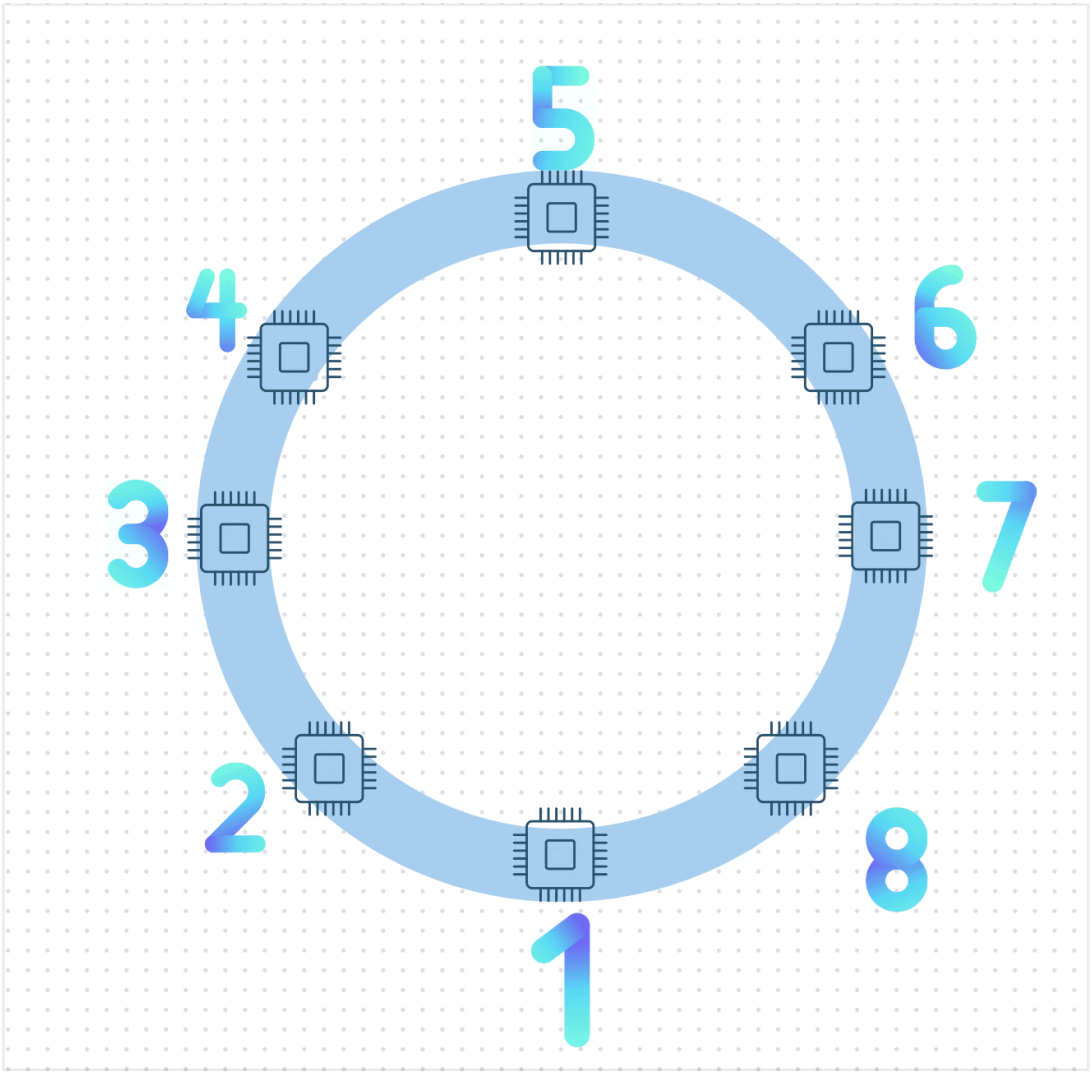


Diagram showing processors in a line.

- Assuming Processor 1 communicates with processors 2 and 5
- For each processor k , the distance to ((k+1) mod 8) is 1, and to ((k+4) mod 8) is 4. The average distance per communication is (1 + 4) / 2 = 2.5 steps.

Average distance = 1 + 4 /2 = 2.5 hops

Ring Topology:


5
6
4
7
3
8
2
1

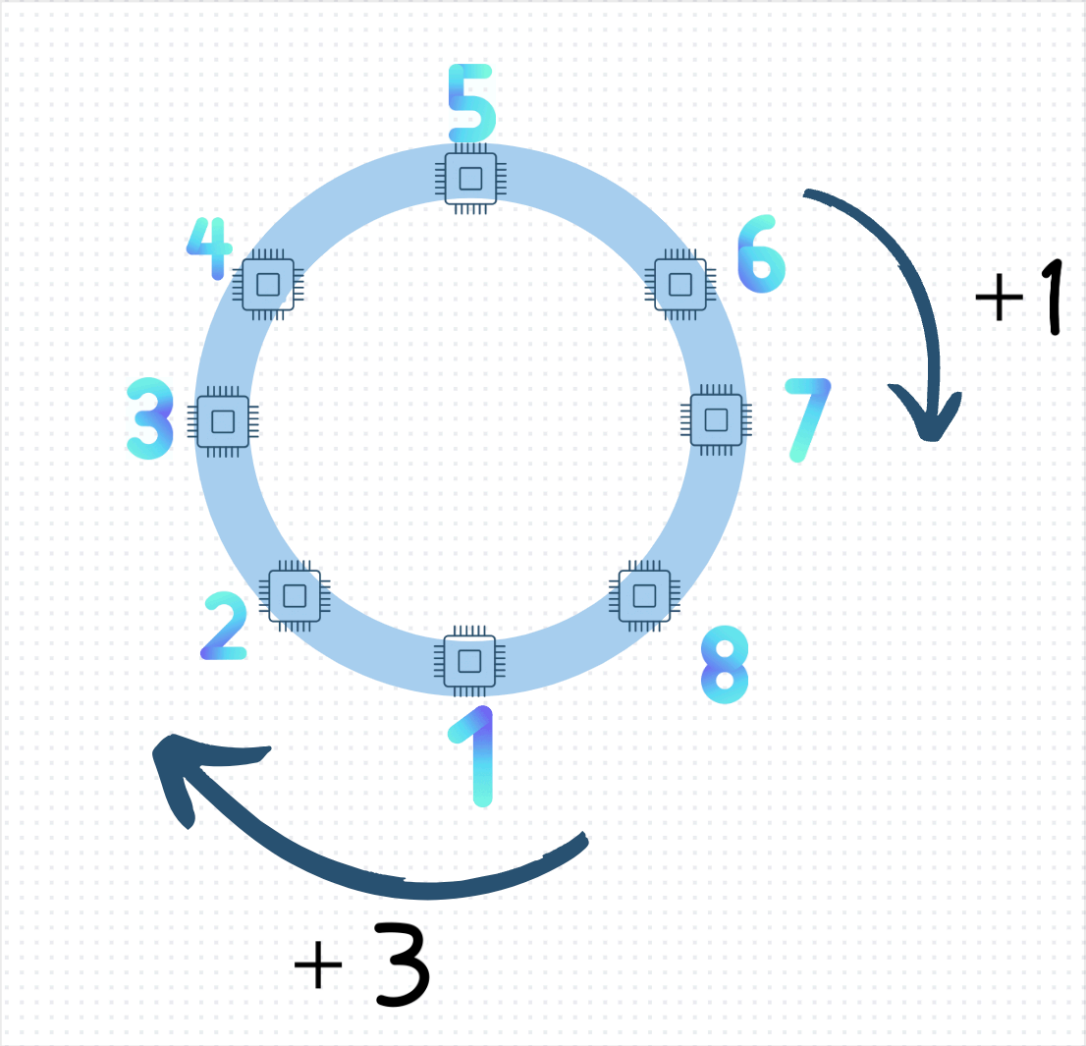
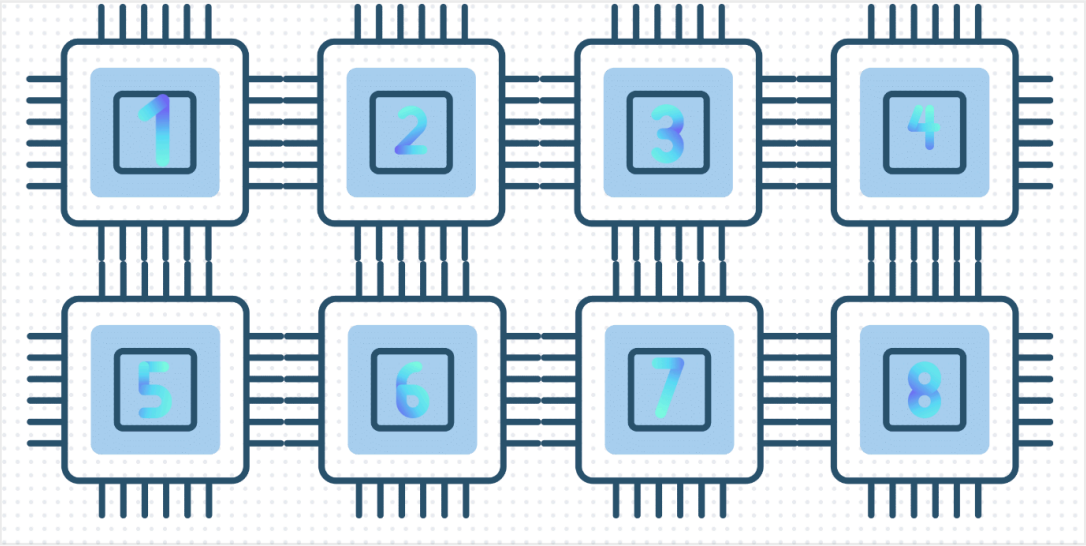


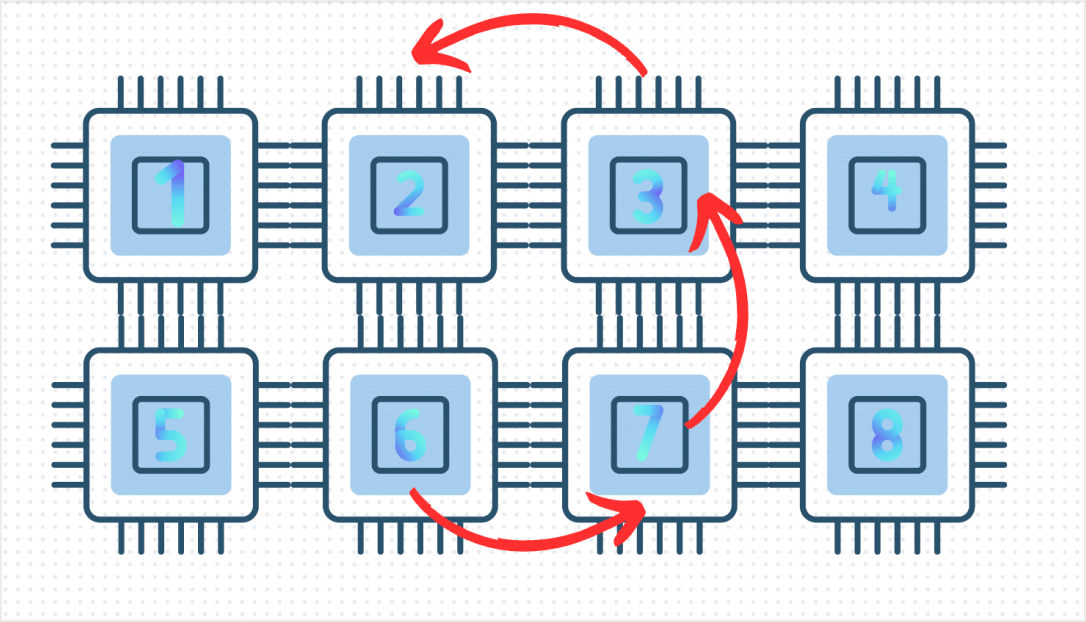
Diagram showing processors in a ring.
For example :
Processor 6 communicates with processors 7 and 2.

- Distance from processor 6 to 7 is 1 hop.
- Distance from processor 6 to 2 is **3 hops** (instead of 4, due to wrap-around from 8 to 1 to 2).
- The distances are either the same or shorter due to the ring structure. For example, instead of traveling 4 hops from processor 6 to 2, we can wrap around and travel 3 hops. Therefore, the average distance is lower compared to the line topology

Average distance = 1 +3 / 2 = 2 hops

2x4 Mesh:





** note after moving to p7 it can also go back to six then 2 as an option

Diagram showing processors in a 2x4 grid.

[1,2,3,4]
[5,6,7,8]

For example:

- **Processor 1 communicates with processors 2 and 5.**
  - Distance from processor 1 to 2 is 1 hop (horizontal).
  - Distance from processor 1 to 5 is 1 hop (vertical).
- **Processor 6 communicates with processors 7 and 2.**
  - Distance from processor 6 to 7 is 1 hop (horizontal).
  - Distance from processor 6 to 2 is 3 hops (1 up to row 1, and then 2

left).

The distances in the mesh depend on both horizontal and vertical hops. Based on the examples:

- **Processor 1 has distances of 1 hop and 1 hop.**
- **Processor 6 has distances of 1 hop and 3 hops. <— I will show this one on diagram above**

Thus, the average distance for the mesh is:

Average distance = 1 + 3 / 2 = 2 hops . ** note this is with my configuration of the processors; any other configuration will most likely have different outcomes