

Fixed Interconnection Networks

- No shared memory
- Each processor is connected to some of the other processors
- Messages can be sent along the connections
- A message is a word
- Global clock
- In each step, each processor
 - Receives input into local store
 - Computes and updates local store
 - Generates output

Linear Array



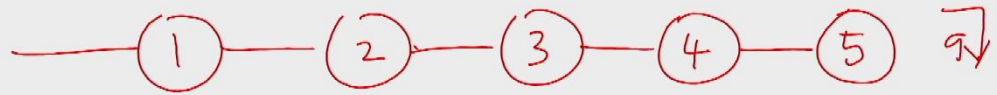
N processor
N-1 connections
degree ≤ 2

45213

0 1 2 3 4 5

○ ○ ○ ○ ○





Phase 1 : input from the
left neighbour
compare with stored
value
output larger to
right nbr
store smaller locally

- 1↓ LM pr has an element
- 2↓ LM pr has a message to the right
- 3↓ LM, 2LM have an element each
- 5↓ LM, 2LM, 3LM ——— " ———
- $(2N-1)^{\text{th}}$ step the sequence is sorted

Phase 2

Getting the values
from the left most
processor
No more input
start sending to the left



4↓



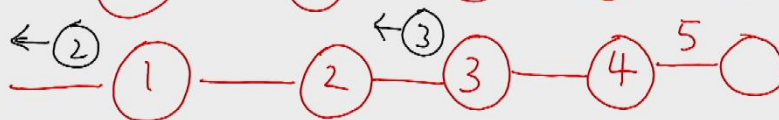
5↓



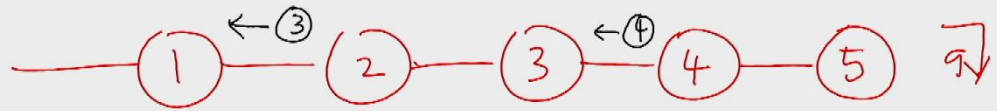
6↓



7↓



8↓



Phase 1 : input from the
left neighbour
compare with stored
value
output larger to
right nbr
store smaller locally

By the N^{th} step all the input
has come

1st output : $N+1$

2nd output : $N+3$

N^{th} output : $N + (2N-1) = \underline{3N-1}$

1st 2 5 8 1 6 4 3 7
 └───┘ └───┘ └───┘ └───┘

2nd 2 5 1 8 4 6 3 7
 └───┘ └───┘ └───┘

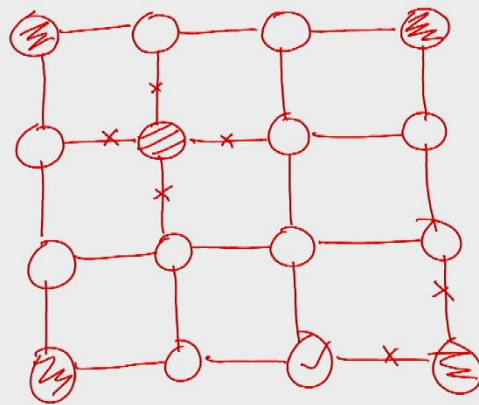
3rd 2 1 5 4 8 3 6 7
 └───┘ └───┘ └───┘ └───┘

4th 1 2 4 5 3 8 6 7
 └───┘ └───┘ └───┘

5th 1 2 4 3 5 6 8 7
 └───┘ └───┘ └───┘ └───┘

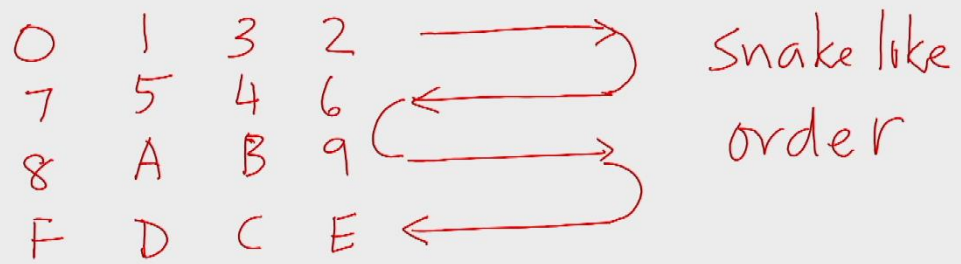
 1 2 3 4 5 6 7 8

The odd-even transposition sort
 N steps



interior : 4
 Corner : 2
 the rest : 3

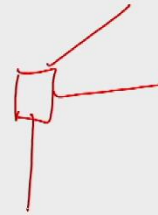
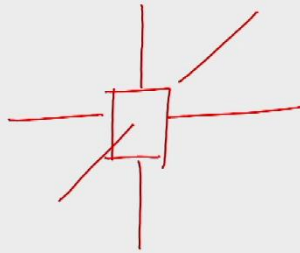
4	B	7	2	→	2	4	7	B
9	A	0	E	←	E	A	9	0
6	1	D	3	→	1	3	6	D
C	5	F	8	←	F	C	8	5
					↓	↓	↓	↓
2	↓	1	3	6	0	→	3	↓
	2	4	7	5	←		7	5
	E	A	8	B	→		8	A
	F	C	9	D	←		F	D
							↓	↓
							↓	↓



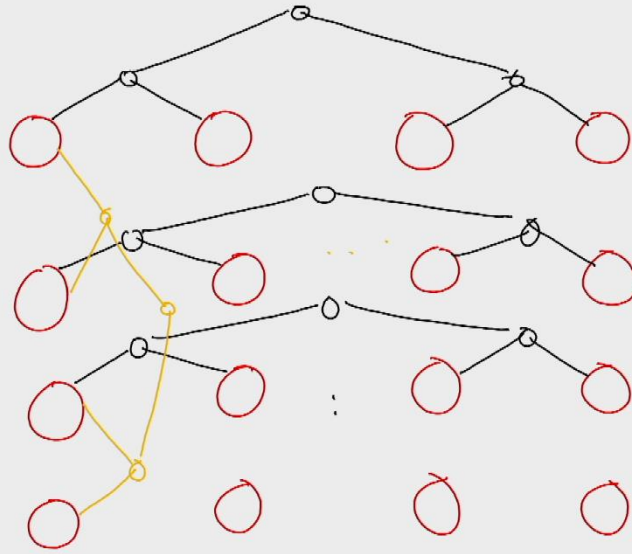
$\sqrt{N} \times \sqrt{N}$ mesh
 $O(\sqrt{N} \log N)$ steps

3D-mesh

degree : 6



2D Mesh
of trees



Hypercube

H_0



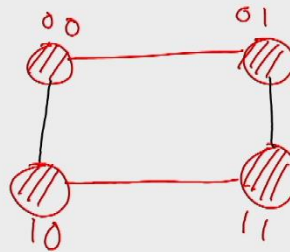
$$2^0 = 1$$

H_1



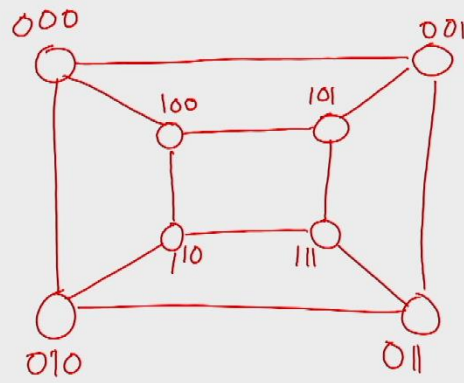
$$2^1 = 2$$

H_2



$$2^2 = 4$$



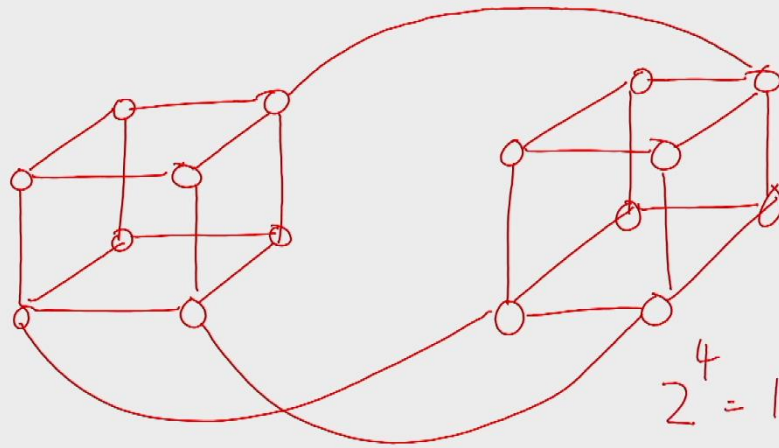


H_3

$$2^3 = 8$$



H_4



$$2^4 = 16$$



N -node hypercube
dimension of $\log_2 N$
degree : $\log_2 N$



Butterfly
Cube connected cycles
De Bruijn Graphs
Shuffle exchange graphs

