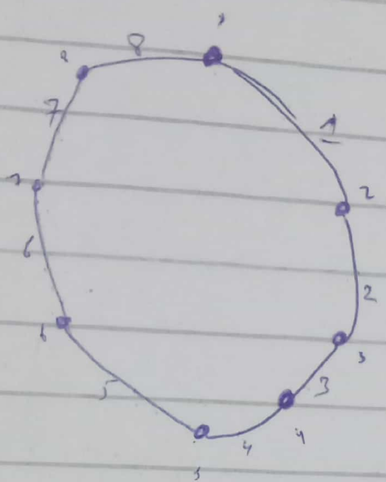
Roll No:- 0115-bscs-20
Section:- A1
Name:- Azhar ud Din

Ring Topology

Pg(01)



Total nodes in Ring Topology = P
= 8

Total links in Ring Topology = P
= 8

1) Cost:-
*:- If (P) is the number of nodes, then cost of Ring will be (P).

2):- Arc-connectivity:-
*:- Each nodes is connected

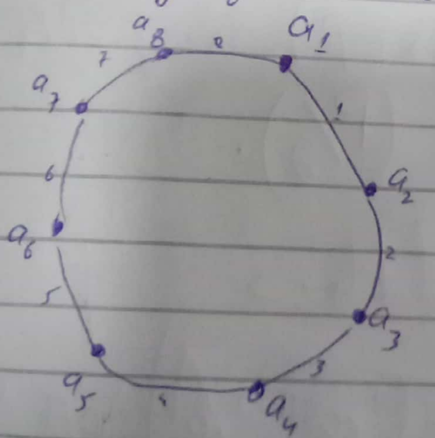
with two another neighboring nodes by two ~~single~~ links respectively.

So:- To remove a node the minimume links to break is (2).

Hence:- Arc-connectivity is (2).

3) :- Diameter:

As Diameter is $Max(Dist(a_i, a_j))$.
So, checking for even Number of nodes ring.



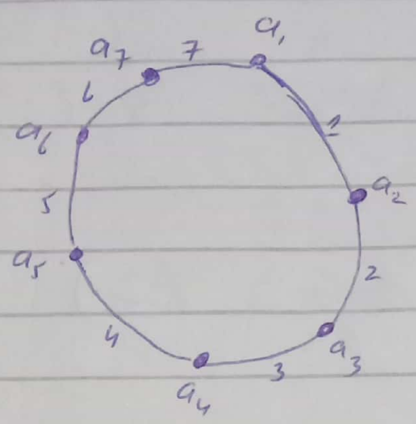
$Dist(a_1, a_2) = 1$
$Dist(a_1, a_3) = 2$
$Dist(a_1, a_4) = 3$
$Dist(a_1, a_5) = 4$
$Dist(a_1, a_6) = 3$
$Dist(a_1, a_7) = 2$
$Dist(a_1, a_8) = 1$

Here:- in (8) node Ring the Max-Distance b/w two nodes is $4 = Max(Dist(a_1, a_5))$ which is equal to total number of nodes in a ring = P Divided by (2)

Hence:- in even Number of nodes P rings
Diameter = $(P/2)$ Ans.

Now:-
checking Diameter of Ring Topology when Nodes are odd in total.

As:-

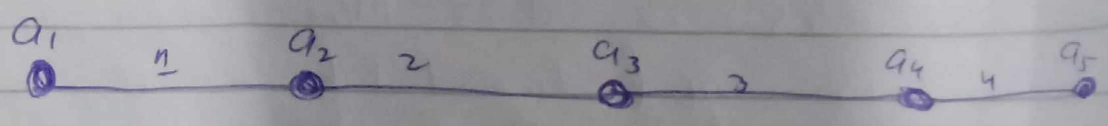


Dist$(a_1, a_2) = 1$
Dist$(a_1, a_3) = 2$
Dist$(a_1, a_4) = 3$
Dist$(a_1, a_5) = 3$
Dist$(a_1, a_6) = 2$
Dist$(a_1, a_7) = 1$

So:- In even nodes (P) Ring Topology, The Diameter is Max(a_1, a_4), Max(a_1, a_5)
$= 3$,

Hence:-
In even nodes (P) Ring Topology, The Diameter is $\left(P/2\right)$. Ans!

Bus Topology

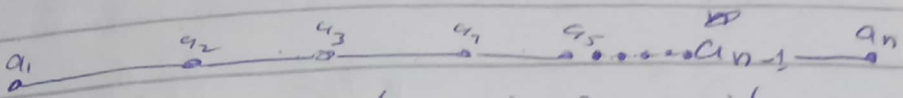


- Total nodes in Bus Topology = 5 P = P
- Total links in Bus Topology = P-1

Cost Bus Topology

In Bus Topology The distance b/w first node (a_1), and (a_n) is equal to the number nodes minus 1.

As:-

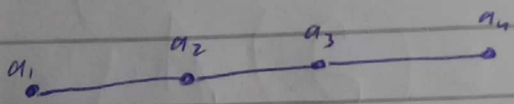


$Dist(a_1, a_2) = 1$, $Dist(a_1, a_3) = 2$, $Dist(a_1, a_4) = 3$
$Dist(a_1, a_5) = 4$, ~~Dist(a_1, a_6)~~ ...... $Dist(a_1, a_{n-1}) = a_{n-2}$

$$\boxed{Dist(a_1, a_n) = (a_n - 1)}$$

Thus:-
— cost of Bus Topology is equal to Total number of Nodes Minus (1), which can be Writen as, if P is node
$(P-1)$ Ans

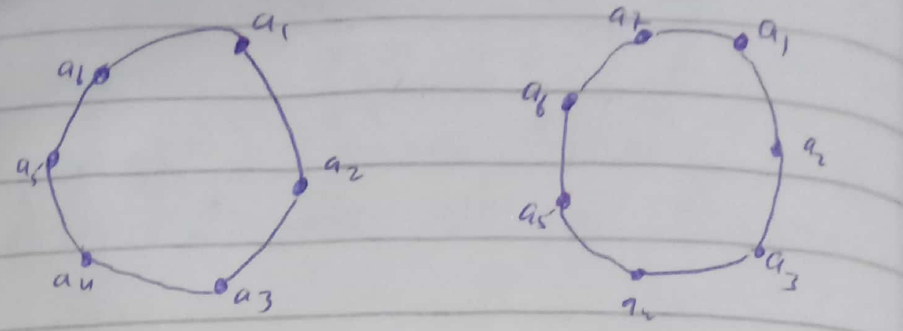
II:- Diameter Bus Topology

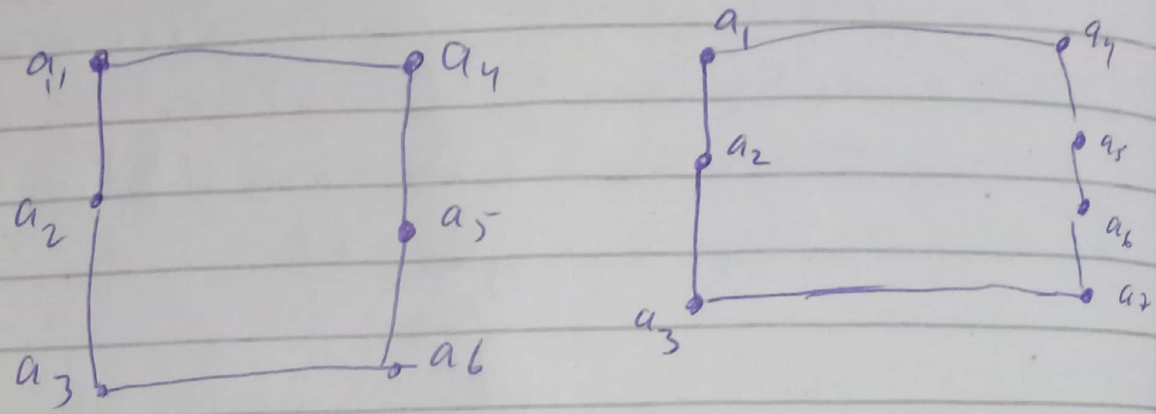


The $Max(Dist(a_i, a_j)) = 4 = a_{n-1}$

Thus,
if (P) is the Total number of nodes In Bus Topology, To travel from first node (a_1) to last node (a_n), The Links to traverse is $(P-1)$.

4) Bisection width Ring Topology



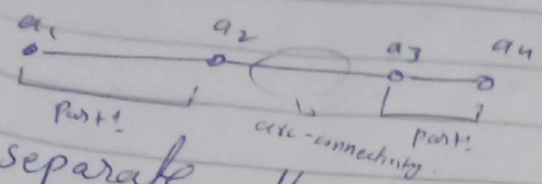


From Above Ring Topologys its is concluded that To break Ring Topology into parts, the (2) Links has to be breaken.

Thus:

Bisection width of Ring Topology = (2) Ans.

3) Arc Connectivity of Bus Topology.

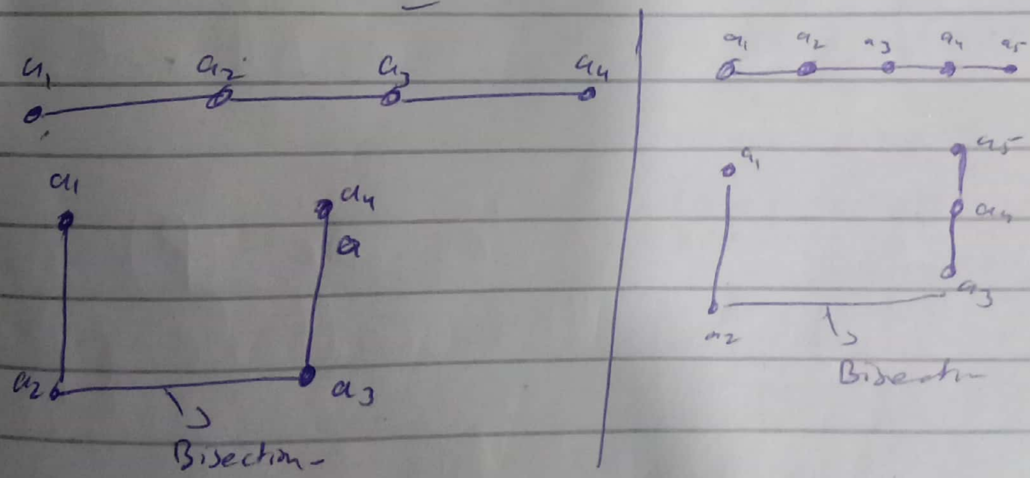


∴ To separate the (a_1, a_n) nodes from Networks The links required To remove is (1)

Thus :-
Two Divide The Network into two equal/ distinct part the minimum link required is (1).

So:
(Arc-connectivity = 1) Ans

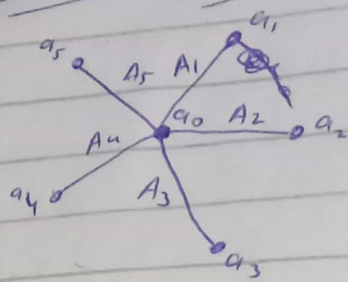
4) Bisection of Bus Topology



- From above Topologies it is concluded that divide Network of Bus Topology into two sections, a single links is required to break.

∴ Bisection of Bus Topology = (1) Ans

Star Topology



*:- In star Topolgy all nodes except center Node, connected to center node through one link.

*:- If nodes are (P), the (P-1) nodes will be connected to Pth node.

1) Cost :-

*:- As in above Star Topology each node(a_1, a_2, a_3, a_4, a_5) is connected to central node (a_0) through a link (A_1, A_2, A_3, A_4, A_5), the total links can be seen as much as Total surrounding Nodes to the central node.

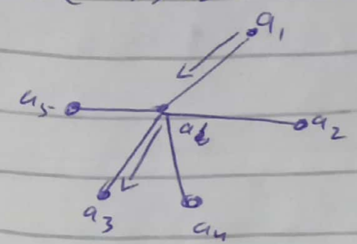
Thus :-

if total nodes are (P) in Star Topology, then there will be (P-1) links which are connecting to (a_1 ... a_n) nodes to (a_n) central node.

2) :- Diameter :-

* As from central node (a_n) to any node

$(a_1, a_2 \ldots a_{n-1})$, we can traverse/travel by a single link. Thus, To traverse/travel between $(a_1, a_2 \ldots a_{n-1})$, the one must pass through (a_n) the central node, so like this two links are included traversing between $(a_1, a_2 \ldots a_{n-1})$ node.



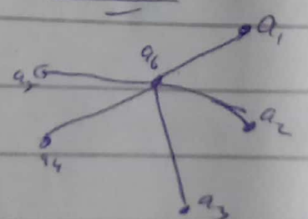
$Dist(a_1, a_3) = 2$, $Dist(a_1, a_2) = 2$, $Dist(a_1, a_4) = 2$
$Dist(a_1, a_5) = 2$, $Dist(a_1, a_6) = 1$

$$\boxed{Max(Dist(a_1, (a_1, a_2, a_3, a_4, a_5 \cdots a_{n-1}))) = 2}$$

Hence:-

The Diameter of star Topology = $\boxed{2}$

3):- Bisection width Star Topology



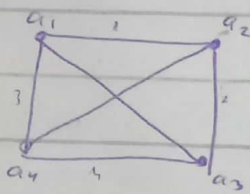
* In star Topology there is only one option to break a node/nodes from star Topology, is to disconnect that node from center node.

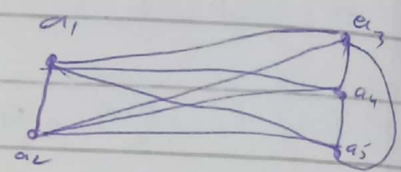
Thus, The Bisection width is (1), due to ~~the~~ one link to break only center and surrounding $(a_1, \ldots a_{n-1})$ nodes.

4) Arc-connectivity Star Topology

*:- To Disconnect a node from centeral node there is only one link required, as they are connected by link only.
Therefore,
Arc-connectivity is one.

Complete Connected Topology





*:- In completed Topology each node is connected to another node in Network.

*:- Thus, if total nodes are (P), then 1st node connected with other (P-1) nodes, and 2nd node connected with other (P-1) nodes and so on.

* In above 4 nodes complete Topology.

Total links = a_1 connection with others + a_2 connection with others ...... a_nth connection with others.

= (a_1 links) + (a_2 links) + ... (a_n links)
= 3 + 3 + 3 + 3 = $\boxed{12}$

Now:- As we counted some links twice, this time once
(a_1 links) (a_2 links without counted links) + a_3 +
= 3 + 2 + 1 + 0
= $\boxed{6}$ ...

Now.

Suppose there are (p) number of nodes in a complet. connected Topology, and not skeping the node having (zero links)

Then

Total numbers of links $= (a_1 \text{ links}) + (a_2 \text{ links without added links}) + a_3 + \dots a_{n-1}$ $= p-1+p-2 \dots - 1 + 0$

=

using Arithematic series formula

$$\text{Total number of links} = \frac{\text{Total Number of nodes}}{2}\left(\text{first node links} + n^{th} \text{ node links}\right)$$

$$= \cancel{\ \ }$$

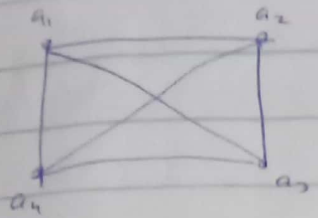
$$= \frac{P}{2}\left((P-1)+0\right)$$

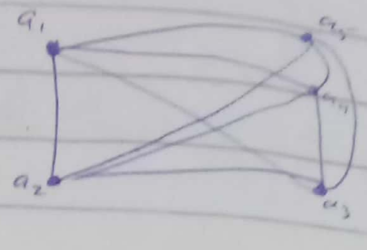
$$\boxed{\text{Total number of links} = \frac{P}{2}\left(P-1\right)}$$

1st) Cost

The cost is derived above which is $\boxed{\frac{P}{2}\left(P-1\right)}$ Ans1

Diameter of complete connected Topology

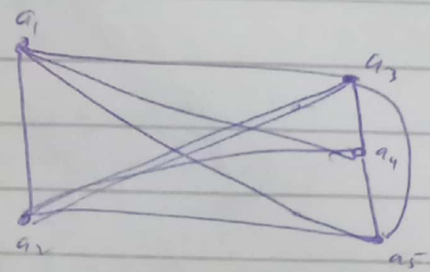




*: As The Distance between Any two nodes in a completed connected Topology is equal to (1) Therefore, Diameter is (1).

3rd) Arc-connectivity

*: ~~e~~ To



*: In above Network to remove any node, suppose (a_1), we have to remove all those links through it(a_1) node is connected with other nodes.

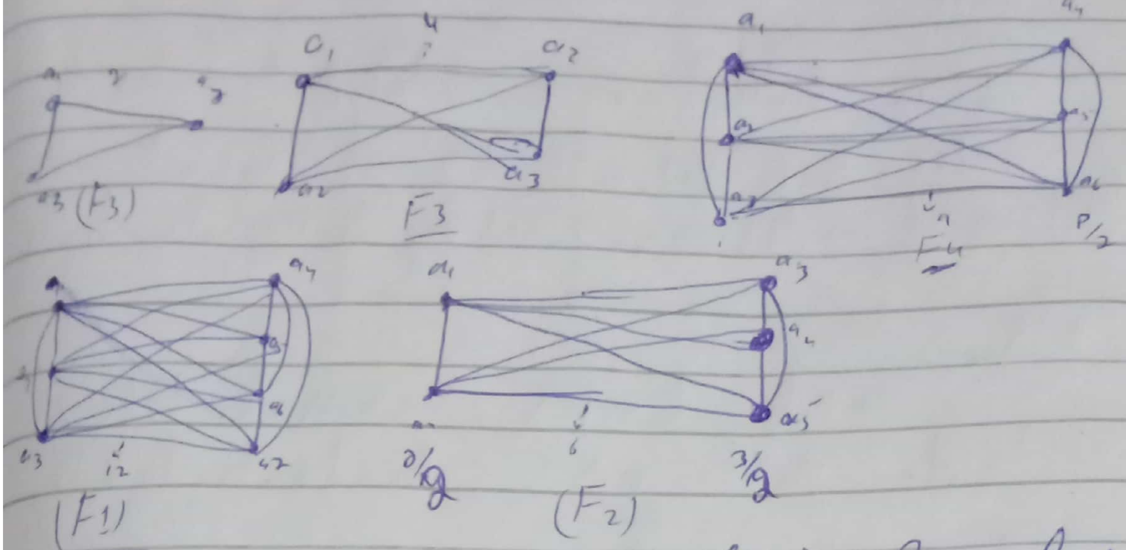
if removing (a_1) node, links required to remove = 4
if " (a_2) " " " " = 4
if " (a_3) " " " " = 4
⋮
if " (a_5) " " " " = $(5-1) = 4$
if " (a_p) " " " " = $(P-1)$

Thus:-

if there are (P) node in complete connected T

The links required to remove for (p^{th}) node = $(P-1)$ A

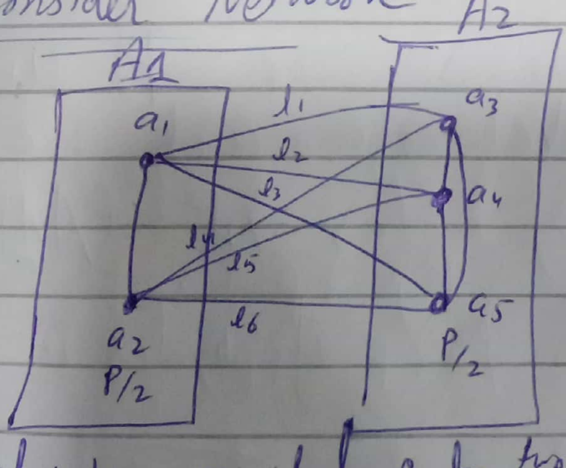
4th) Bisection width of complete connected Topology



There are Three (3) formulas used to find the bisection width of complete connected Topology.

1st) proving Bisection width $= \left(\frac{P^2}{4}\right)$.

Let's consider Network



Here Network Divided into two parts, $P/2$ each part consists of $(P/2)$ nodes.

In (A1) part each node is connected with (A2) part by one of links $(l_1, l_2, l_3, l_4, l_5, l_6)$

Q:- As:-

in A1 part:-

a_1 is linked with (A_2) part nodes (a_3, a_4, a_5) by links (l_1, l_2, l_3), and a_2 is linked with (A_2) part nodes (a_3, a_4, a_5) by links (l_4, l_5, l_6).

Thus:- Total links shared b/w (A1), (A_2) parts are ($l_1, l_2, l_3, l_4, l_5, l_6$) which are equal to the number of nodes in (A1) part multiplied with the number of nodes in (A_2) part.

as:
$$(a_1 + a_2)(a_3 + a_4 + a_5) = \text{Total links b/w } A1, A_2$$

Hence:-

if nodes are P in completely connected Network, and we put ($P/2$) part of nodes in (A1) part, and ($P/2$) half part of nodes in A_2 part,

Then,

Total Links b/w ($A1, A_2$)
Bisection width $=$ (A1) part nodes $\times$ (A_2)
$$= P/2 \times P/2 = \frac{P^2}{4}$$

2nd second method for bisection width calculation of complete connected topology

*:- if Total nodes(P) in Network are Even

then, Bisectional width $= (P/2)^2$

*:- If Total nodes (p) in Network are odd

then, Bisectional width $= \left[\left(\lfloor P/2 \rfloor + 1\right)^2 - \left(\lfloor P/2 \rfloor + 1\right)\right]$

In (F1) figure in other page,

Bisection width of 7th nodes $= \left[\left(\lfloor 7/2 \rfloor + 1\right)^2 - \left(\lfloor P/2 \rfloor + 1\right)\right]$

$= \left[(3+1)^2 - (3+1)\right]$

$= (4^2 - 4)$

$= 16 - 4$

$= \boxed{12}$ Ans

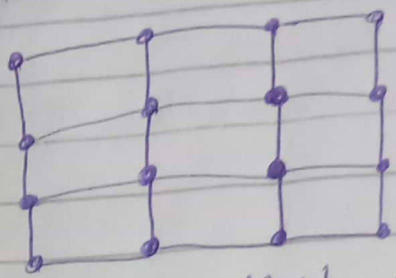
Bisection width of 8th nodes of completen $= (P/2)^2$

$= (8/2)^2 = (4)^2$

$= \boxed{16}$ Ans

6) "2D Mesh with No Wraparound"

1st)



2D-Mesh with (4x4)

Total Number of Nodes in 2D-Mesh of triangulars (rows No. = column No.) = P

Then total Number of Nodes in a row $= \sqrt{P}$

and total Number of Nodes in a column $= \sqrt{P}$

Total Number of links in a row / or column $= (\sqrt{P} - 1)$

Total Number of links in 2D Mesh (rows = columns)

(rows links) (columns links)

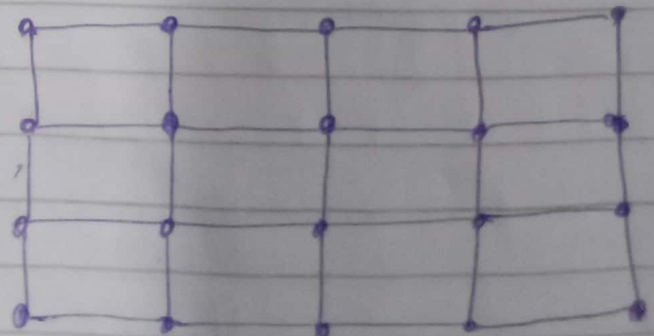
$$= \sqrt{P}(\sqrt{P} - 1) + \sqrt{P}(\sqrt{P} - 1)$$

$$= \sqrt{P}^2 - \sqrt{P} + \sqrt{P}^2 - \sqrt{P}$$

$$= (P - \sqrt{P}) + P - \sqrt{P}$$

$$= \boxed{2(P - \sqrt{P})}$$

2nd)



2D Mesh with (4x5)

* If in a 2D Mesh (rows No. != columns No.)

Then,

Let's: Number of rows $= P_r$

Number of columns $= P_c$

Total Number of nodes in a row $= P_c$
Total Number of nodes in a column $= P_r$
~~Total~~

Now:-
Total Number of links in a row $= P_c - 1$
Total Number of links in a column $= P_r - 1$

So,
Total Number of links in 2D Mesh (4×4)
= (Links in total rows) + (links in total columns)

$= P_r(P_c - 1) + P_c(P_r - 1)$

$= P_r(P_c) - P_r + P_c(P_r) - P_c$

$= 2(P_r)(P_c) - P_r - P_c$

$= \boxed{2(P_r)(P_c) - P_r - P_c}$ $\because P_r =$ rows Number, $P_c =$ column Number

(1st) Cost:-

*:- if columns No. = Rows No.
then $\boxed{2(P - \sqrt{P})}$ proved above!

*:- If columns No. != Rows No.
then $\boxed{2(P_r)(P_c) - P_r - P_c}$ $\because P_r =$ No. columns, $P_c =$ No. rows

2) Arc-connector:-

*:- If node is in first (or) last ~~row~~ rows or column of 2D Mesh.

Then:-

Ar-connector = 2

*:- If node is not in ~~rows~~ ~~other~~ first/last (or) rows/colum of 2D Mesh

Then

Ar-connector = 4

3) Bisection width 2D-Mesh

*:- If 2D-Mesh has (rows = colums)

then, Bisection width

$= \sqrt{p}$ $\quad \because \sqrt{p}$ = No. rows/(or) colum

*:- If 2D Mesh has (rows $\neq$ colu

Then:-

if No. columns (Pc) > rows No (Pr)

then

Bisection width = Pc

else if No. rows (Pr) > colums No. (P

then

Bisection width = Pr

4th) Diameter of 2D Mesh

*:- if 2D Mesh has (rows = columns)

Then

$$\text{Diameter} = \underbrace{2(\text{No. rows/column} - 1)}_{\text{Links in a row}} + \text{Links in } (\text{No. column}$$

$$= (\sqrt{P} - 1) + (\sqrt{P} - 1)$$

$$= 2(\sqrt{P} - 1)$$

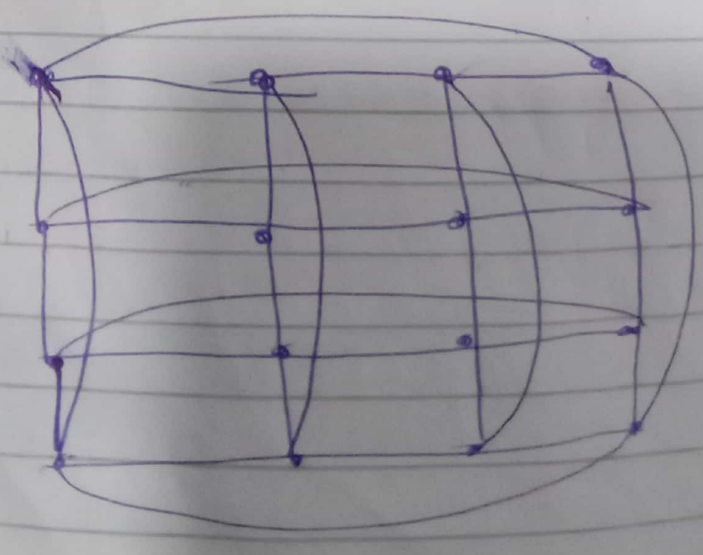
*:- if 2D Mesh has ~~No~~ (rows != columns)

Then:-

$$\text{Diameter} = \underbrace{(P_c - 1)}_{\text{Links in a rows}} + \underbrace{(P_r - 1)}_{\text{Links in column}}$$

$$= \boxed{P_c + P_r - 2}$$

"2D Mesh with wraparound"



Total number of nodes = P
Total Number of rows / columns = $\sqrt{P}$
Total Number of links in a row = $\sqrt{P}$
Total Number of links in a column = $\sqrt{P}$
Total Number of ~~of~~ links in total row/col = $\sqrt{P}(\sqrt{P})$

Cost

Total links in 2D: = Total links in rows + Total links in columns

$$= \sqrt{P}(\sqrt{P}) + \sqrt{P}(\sqrt{P})$$
$$= P + P$$
$$= \boxed{2P}$$

(ii) Diameter :—

~~Links in a row + Links in column~~

~~$= \sqrt{P}(\sqrt{P})$~~

Max distance in a row = 2
Max distance in a column = 2
If ~~Then~~ row/column = $\sqrt{P}$
Then:
Max distance in a row/column $(\sqrt{P})$ = $\boxed{\frac{\sqrt{P}}{2}}$

Thus

Diameter = Max Distance in row + Max Dis[tance] in colu[mn]

$$= \left\lfloor \frac{\sqrt{p}}{2} \right\rfloor + \left\lfloor \frac{\sqrt{p}}{2} \right\rfloor$$

$$= \boxed{2 \left\lfloor \frac{\sqrt{p}}{2} \right\rfloor}$$

3rd) Bisection width :-

*: If Number of Nodes in a row = √[p]
then to bisect the Network into two equal parts we have to break the links equal to the Number of rows/columns and the links with wraparound.

As:-

Bisection width = (links in a row/colm) + (links [of] wrapa[round])

$$= 2\sqrt{p} + \sqrt{p}$$

$$= \boxed{2\sqrt{p}}$$

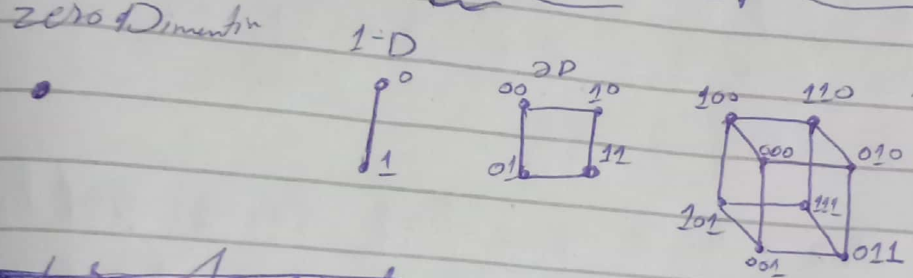
Cyth)

:- Arc-connectivity:-

To remove any node from network if either it is in first row/column or last row/column. is (4).

Arc-connectivity = 4

"Hypercube Topology"



Q:

~~Number of Nodes in hypercube = P~~

Number of Nodes(P) ~~Links~~ in hypercube = $2^{(\text{Dimention})}$

(P) is total Nodes . $P = 2^D$

Then

:- In hypercube each node is linked with those nodes that are in other dimention in Topology.

Ex:- in two dimention Topology (00) node is connected in other dimention nodes (01) and (10) only.

1st Cost:

Total links hypercube = first node (connection links with opposit adjacent dimention) + 2nd node (connection with opposit adjacent dimention node)

+ 3rd node (connection with adjacent nodes in other dimention) + ... nth node

*:- so cost of 3rd is:-

Cost with duplicate links count = (000) Node links + (001) Node Link + (010) Node Link + (011) Node Link

+ (100) Node Link + (101) Node Link + (110) Node Link + (111) Node Link.

$= 3 + 3 + 3 + 3 + 3 + 3 + 3 + 3$

$= \boxed{56}$

Now As we have counted some links twice, we will count once the repeating count links.

cost = (000) Node Links with opposit dimention nodes + (001) Node Links without Links counted in (000) + (010) Node Link without Links counted in (000, ...)

+ .... + (111) Node links without Links counted in (000 .... 110).

$= 3 + 2 + 2 + 1 + 2 + 1 + 1 + 0$

$= \boxed{12}$

Hence:- If Dimention is (D) then total nodes will be 2^D.

cost = 1st node with opposit dimention + 2nd Node with opposit dimention unique + ... Nth node with opposit dimention ...

~~Applying~~ Arithemat series:

$$\text{cost} = \frac{\text{Numbers of Nodes}}{2}\left(\text{First Node Links} + \text{N}^{th}\text{ Node Links with d..}\right)$$

$$= \frac{P}{2}\left(\log P + 0\right)$$

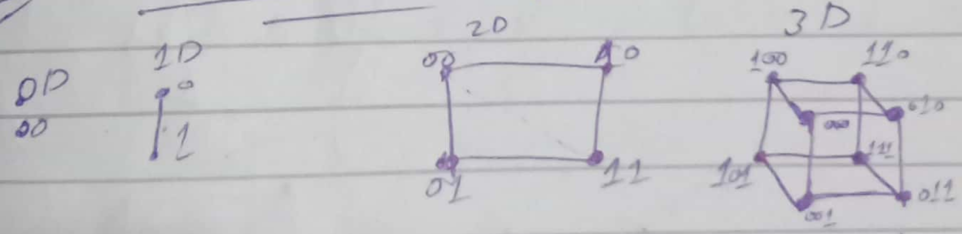
$$= \boxed{\frac{P(\log P)}{2}}$$

$\because \log_2 P = D$

D = Dimention

• Hence :- Each Node will make link with adjacent Node which are in other dimention in Network. As if, Dimention = 3 then each Node will make link with (x, y, z) adjacent dimention Node

2nd) :- Diameter:



* It is the Maximum Distance of one Node in 1st dimention "to the Node that is in further/last dimention.

* in 2D to travel from (00 – 11), one must go traverse to (01) Node y-Dimention, and then traverse to (11) Node Z-Diment:

* in 3D to travel from (000 – 111), one must traverse to (001) Node y-D, then (011) X-D, then (111) –

Thus:-

Diameter = Number of Dimention in a Topology

$= D$ (or) $\log P$

$= \boxed{\log P}$ = Dimentions in Topology

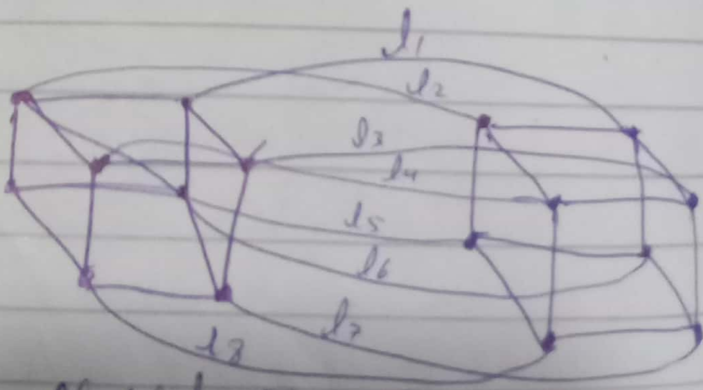
3rd) Bisection:-

*:- If A hypercube has (P) total Nodes, and ($\log P$) is the No. Dimention of hypercube. ~~then~~

Then:-

Bisection is all those Links that links the two ($P/2$), ($P/2$) sub Dimentions adjacent Nodes.

As:-



No. Nodes(P) = 16

Bisection links in 4D $= P/2$

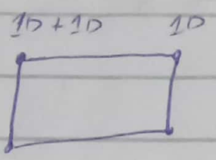
$= 8$

Hence Bisection = $\boxed{P/2}$

4th) Arc-connectivity

*: To remove a node from hyper cube, we have to break all of it adjacent Node links in other dimension that it has made.

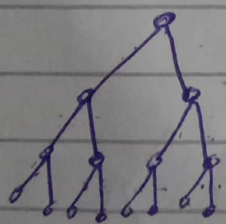
Thus:-



Arc-connectivity = $\boxed{\log p}$

= number of links the node made with our other adjacent Node in the Dimension.

Complete Binary Tree



	Nodes
Level = 0	$2^0 = 1$
level = 1	$2^1 = 2$
level = 2	$2^2 = 4$
level = 3	$2^3 = 8$

* Number of Nodes in each level = $2^{\text{Level No.}}$

Total Number of Nodes $= \sum_{L=0}^{Nth-1} 2^{(L-1)} = 2^L$

Hence, if 3 Levels:-

Then Total Nodes $= 2^0 + 2^1 + 2^2 = \sum^{3-1} 2^L$

* 1st Cost :-

Total number of links in Tree = (Total Number of Nodes) − 1

cost = P − 1 ∵ P = total nodes

* 2nd Diameter :-

Diameter = two Times the Number of Levels in C.Tree

= 2L ∵ L = Levels.

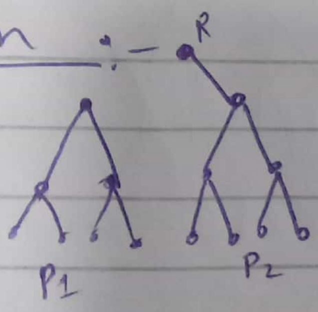
2L = $\boxed{\cancel{\log P}}$ ∵ P = total Num of Nodes

$= 2\log_2\left(\frac{P+1}{2}\right)$ $\because L = \log_2\left(\frac{P+1}{2}\right)$

$3 = \log_2\left(\frac{15+1}{2}\right)$

$3 = \log_2 8$

* 3rd Bisection :-



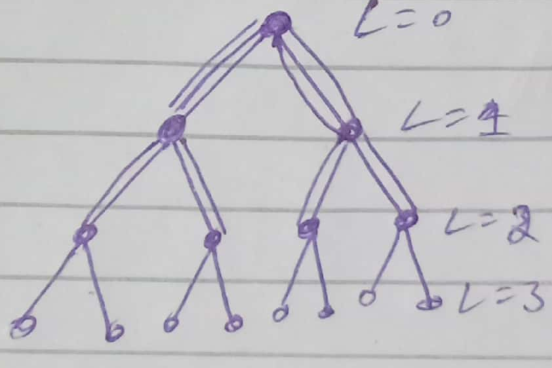
*:- Hence to break a tree into two parts (1) link is required.

4th) :- Arc-connectivity

To remove a node with minimum links is (1), as ~~is~~ possible by remove leaf Node.

$\longleftrightarrow$

Fated Tree Topology



Node	Links
2^0	$2^0 +$
2^1	$2^1 + 2^3$
2^2	$2^2 + 2^2$
2^3	2^3