Jaringan Interkoneksi (Interconnection Networks)

Kudang B. Seminar

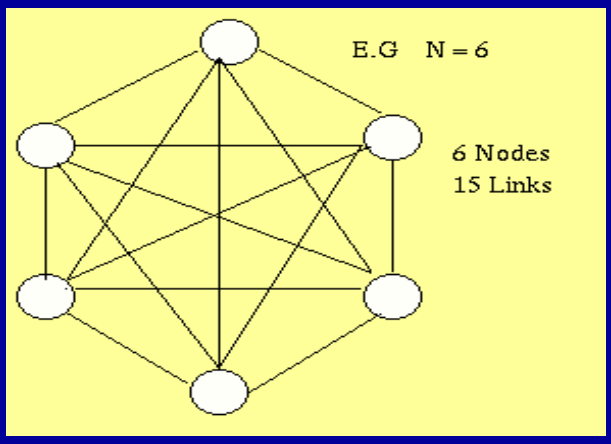
Mengapa Penting?

- Menentukan kinerja keseluruhan (*overall performance*) dari *multicomputer system*
- Menentukan pertimbangan desain jaringan pada *multicomputer system*
- Membantu analisis dan evaluasi jaringan pada *multicomputer system*

Jenis Jaringan Interkoneksi

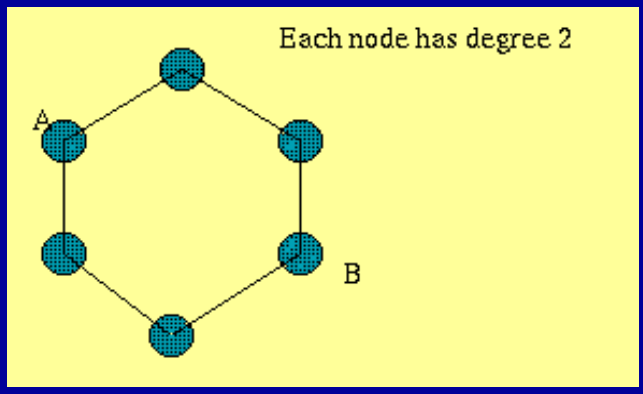
- Fully connected or all-to-all
- Rings
- Star
- Trees
- Mesh (Torus)
- Hypercube
- Hybrid

Fully connected or all-to-all



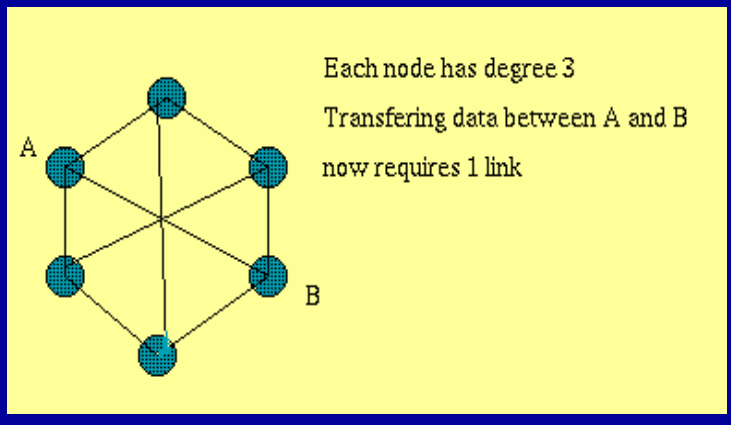
Each node has N-1 connections (N-1 nearest neighbours) giving a total of N(N-1) / 2 connections for the network.

Ring

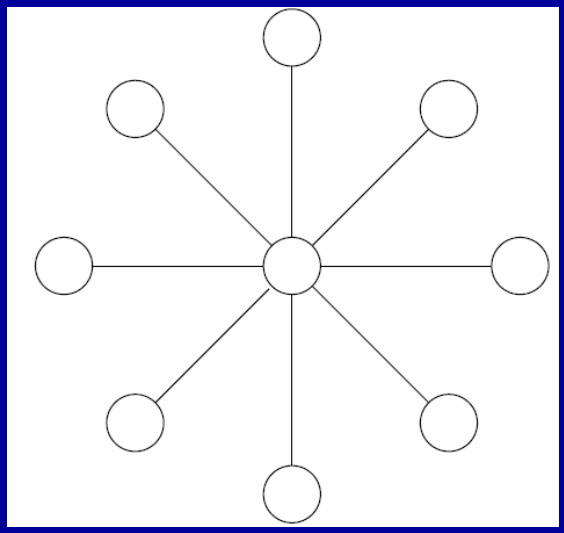


Data transfers may require N/2 links to be traversed e.g. A and B above. This can be reduced by using a chordal ring.

Ring (*lanjutan*)

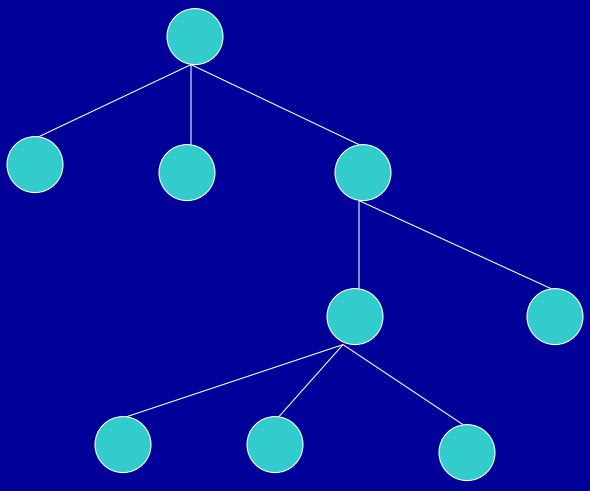


Star Topology

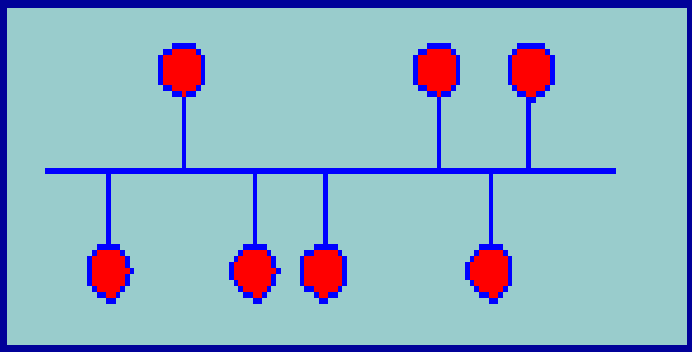


 # Nodes = n
 # Links = n-1

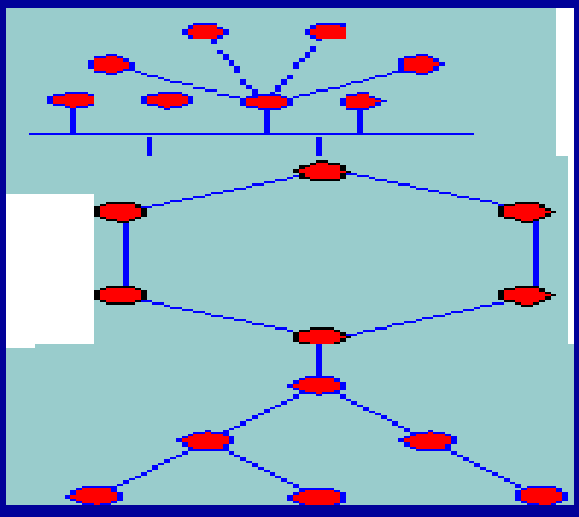
Tree Topology



Bus Topology



Hybrid Topology



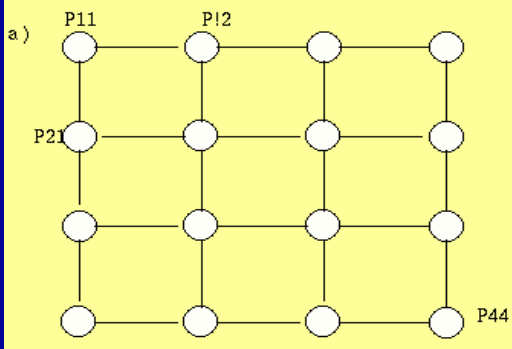
Mesh (Torus)

The nodes are arranged in a k dimensional lattice of width w, giving a total of w^k nodes; usually k=1 (linear array) or k=2 (2D array)

Communication is allowed only between neighbouring nodes. All interior nodes are connected to 2k other nodes.

EXAMPLE

a)

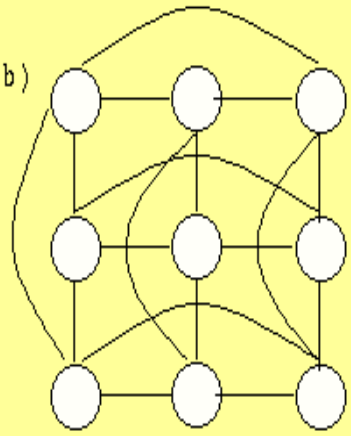


2D mesh of width 4 with no wraparound connections on edge or corner nodes

corner nodes have degree 2
edge nodes have degree 3

Mesh (*lanjutan*)

b)

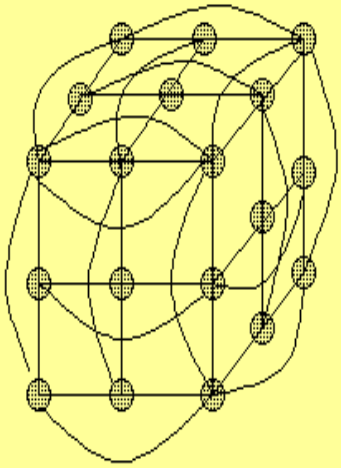


2D mesh of width 3 with wraparound connections between nodes on same row or column

Edge and corner nodes have degree 4

Mesh (*lanjutan*)

C)



k = 3 w = 3

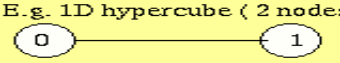
i.e. 3 ^ 3 = 27 nodes

with wraparound connections

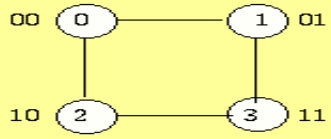
all nodes have degree 6 (2k)

Hypercube Connection (Binary n-Cube)

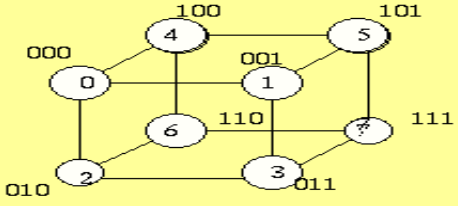
E.g. 1D hypercube (2 nodes)



E.g. 2D hypercube (4 nodes)



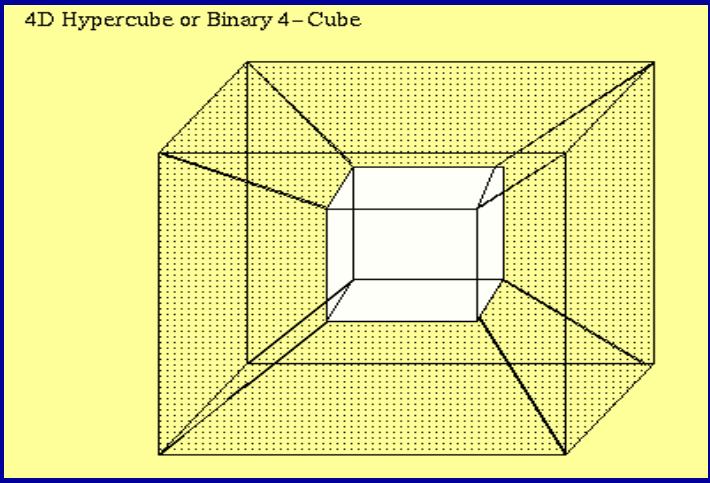
E.g 3D hypercube (8 nodes)



Consists of N = 2^k nodes arranged in a k dimensional hypercube

The nodes are numbered 0 , 1, ...2^{k-1} and two nodes are connected if their binary labels differ by exactly one bit.

Hypercube Connection (*lanjutan*)



K dimensional hypercube is formed by combining two k-1 dimensional hypercubes and connecting corresponding nodes i.e. hypercubes are recursive. Each node is connected to k other nodes i.e. each is of degree k

Metrics for Interconnection Networks

- Network connectivity
- Network diameter
- Narrowness
- Network expansion increments

Network Connectivity

- measures the resiliency of a network and its ability to continue operation despite disabled components
- connectivity is the minimum number of nodes or links that must fail to partition the network into two or more **disjoint networks**
- The larger the connectivity for a network the better the network is able to cope with failures

Network Diameter

- the maximum internode distance i.e. it is the maximum number of links that must be traversed to send a message to any node along a shortest path.
- The lower the diameter of a network the shorter the time to send a message from one node to the node farthest away from it

Narrowness

- **This is a measure of congestion in a network**
- **Partition the network into two groups of processors A and B where the number of processors in each group is Na and Nb and assume Nb < = Na**
- **count the number of interconnections between A and B call this I**
- **Maximum value of Nb / I for all partitionings of the network is the narrowness of the network.**
- **If the narrowness is high (Nb > I) then if the group B processors want to send messages to group A congestion in the network will be high (since there are fewer links than processors)**

Network Expansion

- Indicate the ease (flexibility) of network expansion
- Indicate the cost of network expansion
- An 8 node linear array can be expanded in increments of 1 node but a 3 dimensional hypercube can be expanded only by adding another 3D hypercube. (i.e. 8 nodes)