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ASSIGNMENT

**Question**  
Briefly explain the following interconnection networks

1. The Crossbar Network
2. Cube Interconnection Network
3. Fat Tree Connection

ANS:

Networking strategy was originally employed in the 1950’s by the telephone industry as a means of reducing the time required for a call to go through. Similarly, the computer industry employs networking strategy to provide fast communication between computer subparts, particularly with regard to parallel machines.

1. The Crossbar Network: Crossbar networks allow any processor in the system to connect to any other processor or memory unit so that many processors can communicate simultaneously without contention. Crossbar networks are used in the design of high-performance small-scale [multiprocessors](https://www.sciencedirect.com/topics/computer-science/multiprocessors" \o "Learn more about Multiprocessors from ScienceDirect's AI-generated Topic Pages), in the design of routers for direct networks, and as basic components in the design of large-scale indirect networks. A crossbar can be defined as a switching network with N inputs and M outputs, which allows up to min{N, M} one-to-one [interconnections](https://www.sciencedirect.com/topics/computer-science/interconnection" \o "Learn more about Interconnection from ScienceDirect's AI-generated Topic Pages) without contention.
2. Cube Interconnection Network: An n-cube network, also called hypercube, consists of N=2n nodes; n is called the dimension of the n-cube network. When the node addresses are considered as the corners of an ndimensional cube, the network connects each node to its n neighbors. In an n-cube, individual nodes are uniquely identified by n-bit addresses ranging from 0 to N-1. Given a node with binary address d, this node is connected to all nodes whose binary addresses differ from d in exactly 1 bit.The interconnection supported by the n-cube provides a natural environment for implementing highly parallel algorithms, such as sorting, merging, fast Fourier transform (FFT), and matrix operations. Different networks, such as two-dimensional meshes and trees, can be embedded in an n-cube in such a way that the connectivity between neighboring nodes remains consistent with their definition.
3. Fat Tree Combination: One problem with the binary tree is that there can be heavy traffic toward the root node. Consider that the root node acts as the single connection point between the left and right subtrees.To reduce the effect of such a problem, the fat tree was proposed by Leiserson [LEI 85]. Fat trees are more like real trees in which the branches get thicker near the trunk. Proceeding up from the leaf nodes of a fat tree to the root, the number of communication links increases, and therefore the communication bandwidth increases. The communication bandwidth of an interconnection network is the expected number of requests that can be accepted per unit of time. The structure of the fat tree is based on a binary tree. Each edge of the binary tree corresponds to two channels of the fat tree. One of the channels is from parent to child, and the other is from child to parent. The number of communication links in each channel increases as we go up the tree from the leaves and is determined by the amount of hardware available.