Interconnection network (Section 6.8)

- To connect processors to memories or processors to processors

- **Issues**
  - Latency
  - Bandwidth
  - Cost (wires, switches, ports, …)
  - Scalability

- Topology has been a focus of architects

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Evaluating Interconnection Network topologies

- **Diameter**: The distance between the farthest two nodes in the network.
- **Average distance**: The average distance between any two nodes in the network.
- **Node degree**: The number of neighbors connected to any particular node.
- **Bisection Width**: The minimum number of wires you must cut to divide the network into two equal parts.
- **Cost**: The number of links or switches (whichever is asymptotically higher) is a meaningful measure of the cost. However, a number of other factors, such as the ability to layout the network, the length of wires, etc., also factor in to the cost.
Buses and crossbars

- Cost
- Latency
- Bandwidth
- Scalability

Each switch is a 2x2 switch that can be set to one of 2 settings.

Multistage networks

- A 2x2 switch or router

**Circuit switching:** circuits are established between inputs and outputs – arbitrate entire circuits.

**Packet switching:** packets are buffered at intermediate switches – arbitrate individual switches.

- **NxN Omega network:** log N stages, with N/2, 2x2 switches.
- **A blocking network:** some input-output permutations cannot be realized due to path conflicts.
2-D torus

- Diameter??
- Bisection bandwidth??
- Routing algorithms
  - x-y routing
  - Adaptive routing
- 2D mesh (without the wrap-around connections)

- Variants
  - 1-D (ring), 3-D.

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Hypercube interconnections

- An interconnection with low diameter and large bisection width.
- A q-dimensional hypercube is built from two (q-1)-dimensional hypercubes.
A 4-dimension Hypercube (16 nodes)

- Can recursively build a $q$-dimension network – has $2^q$ nodes

Fat tree networks

A fat tree networks using 2x2 bidirectional switches