

Introduction to Interconnection Networks



Outline

- Design considerations
- Classifications of interconnection networks
 - Direct vs Indirect Networks
 - Irregular vs MINs vs Fat Trees
- Convergence of Direct and Indirect Networks

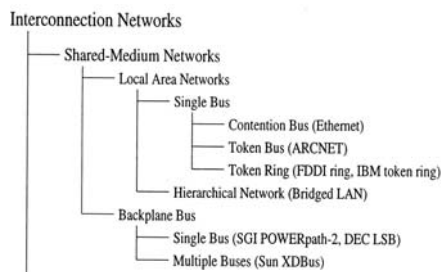
Design Considerations

- Performance Requirements (latency, throughput)
- Scalability
- Incremental expandability
- Partitionability
- Simplicity
- Distance Span (maximum clock rate, physical media)
- Physical constraints (packaging, wiring, and maintenance)
- Reliability and repairability
- Expected workloads
- Cost constraints

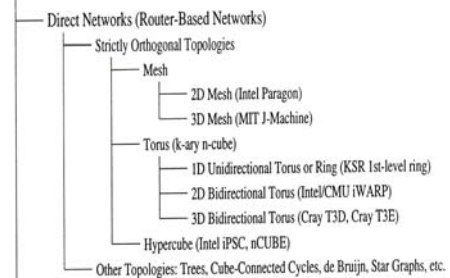
Classification of INs

- Four major categories
 - shared-medium networks
 - direct networks (router-based)
 - indirect networks (switch-based)
 - hybrid networks

Shared-Medium Networks



Direct Networks (Router-based)



Direct Networks

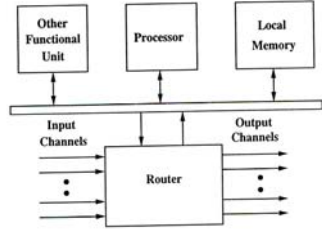


Figure 1.6: A generic node architecture

Orthogonal Topologies

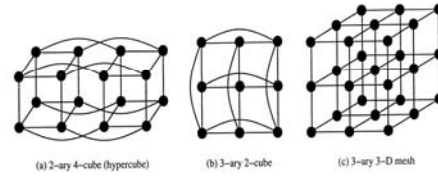
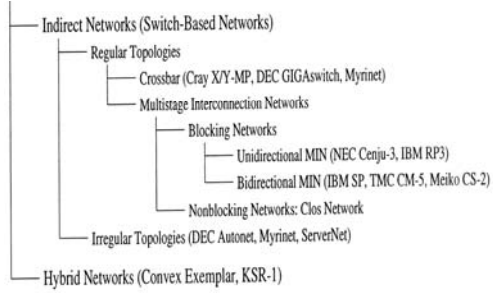


Figure 1.7: Strictly orthogonal direct network topologies

Indirect Networks (Switch-based)



Switch Architecture for MINs

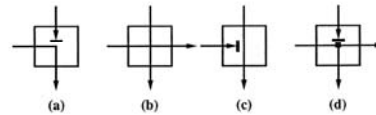


Figure 1.12: States of a switch point in a crossbar network

Generalized MIN Arch.

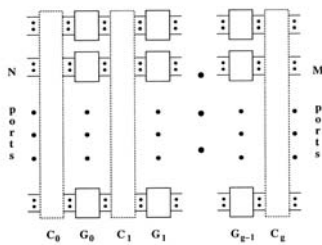
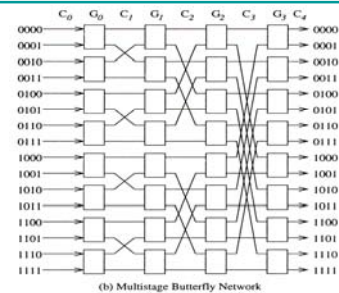
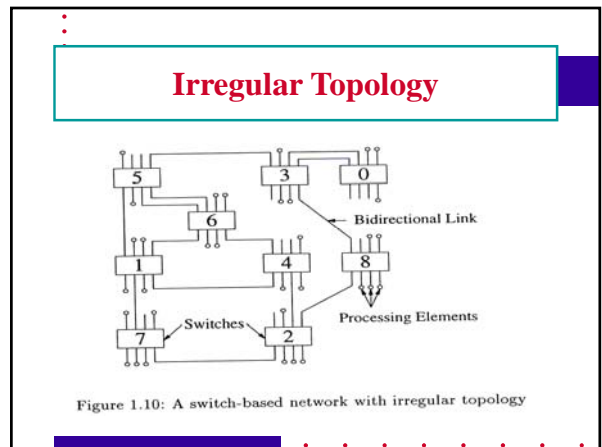
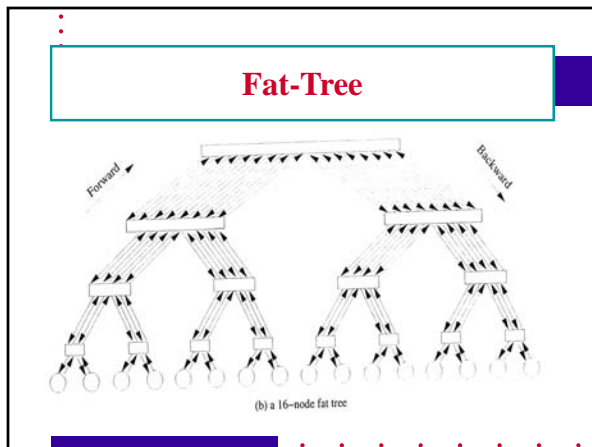
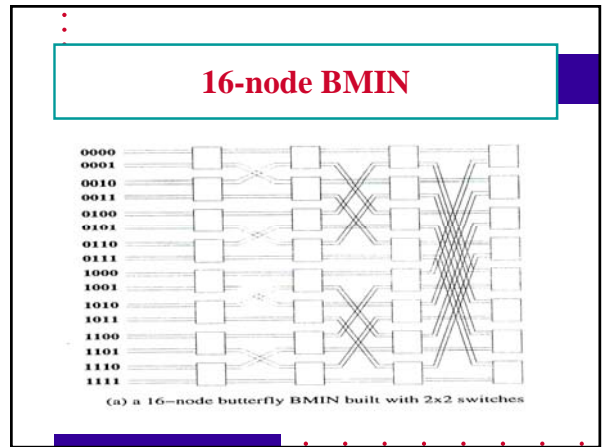
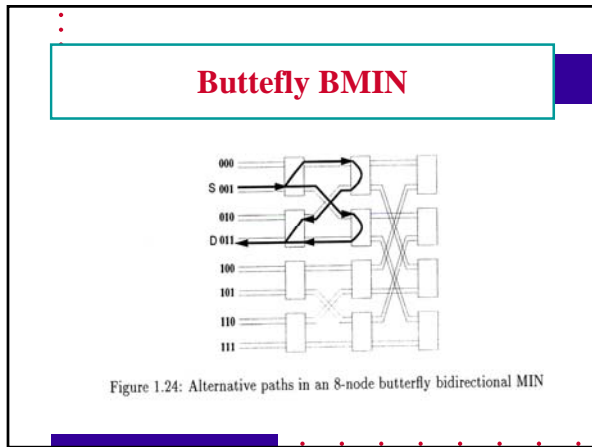
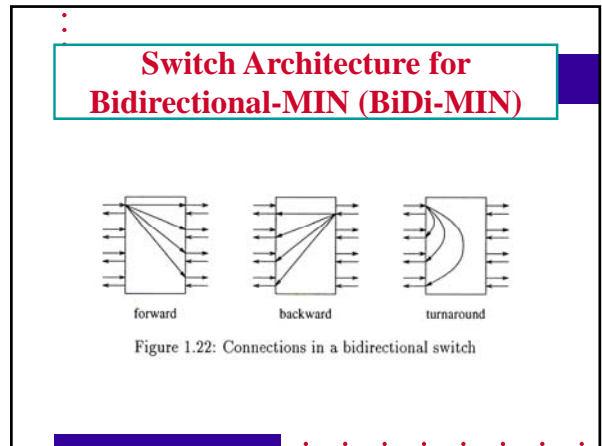
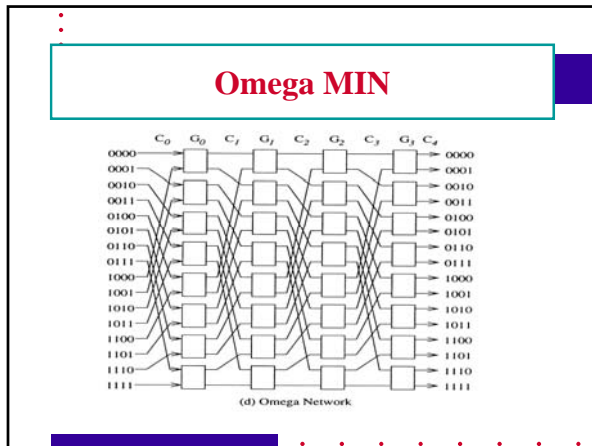


Figure 1.13: A generalized MIN with N inputs, M outputs, and g stages

Butterfly MIN



(b) Multistage Butterfly Network



Hybrid Network and Convergence

- Hybrid/Hierarchical Networks
 - Cray T3D
 - two processors connected to each node
 - SGI origin
 - two processors connected to a Hub (a node)
 - multiple nodes connected to hypercube (up to 64 nodes)
 - fat hypercube architecture (intermediate routers do not have any node connected to them)
 - NUMA-Q
 - hierarchical ring
 - SMP clusters
 - bus within a node and regular/irregular across nodes
 - Multi-core clusters
 - QPI/HT inside a node
 - Commodity network (fat-tree, hypercube, combined fat-tree/hypercube outside)
- Direct Networks
 - a node connected to each router
- Indirect Networks
 - switches at the intermediate stages are not connected to nodes