nCUBE Overview

- Distributed-memory MIMD
- History
  - nCUBE 1 — 1985
  - nCUBE 2 — 1989
    - 34 GFLOPS, scalable
    - ?–8192 processors
  - nCUBE 3 — date?
    - 1–6.5 TFLOPS, 65 TB memory, 24 TB/s hypercube interconnect, 1024 3 GB/s I/O channels, scalable
    - 8–65,536 processors
- Operation
  - Can be partitioned into “subcubes”
  - Programming paradigms: SPMD, cooperative processing between subcubes, client/server

nCUBE 3 Processor

- 0.6 µm, 3-layer CMOS, 2.7 million transistors, 50 MHz, 16 KB data cache, 16 KB instruction cache, 100 MFLOPS
  - Argument against off-the-shelf processor: shared memory, vector floating-point units, aggressive caches are necessary in workstation market but superfluous here
- ALU, FPU, virtual memory management unit, caches, SDRAM controller, 18-port message router, and 16 DMA channels
  - ALU for integer operations, FPU for floating point operations, both 64 bit
    - Most integer operations execute in one 20ns clock cycle
    - FPU can complete two single- or double-precision operations in one clock cycle
  - Virtual memory pages can be marked as “non-resident”, the system will generate messages automatically for that data

nCUBE 3 Interconnect

- Hypercube interconnect
  - Added hypercube dimension allows for double the processors, but processors can be added in increments of 8
  - Wormhole routing + adaptive routing around blocked or faulty nodes
- ParaChannel I/O array
  - Separate network of nCUBE processors for load distribution and I/O sharing
  - 8 computational nodes (nCUBE processors plus local memory) connect directly to one ParaChannel node, and can also communicate with those nodes via the regular hypercube network
  - ParaChannel nodes can connect to RAID mass storage, SCSI disks, etc.
    - One I/O array can be connected to more than 400 disks

nCUBE 3 Software

- Parallel Software Environment
  - nCX microkernel OS — runs on all compute nodes and I/O nodes
  - UNIX functionality
  - Programming languages including FORTRAN 90, C, C++, as well as HPF, Parallel Prolog, and Data Parallel C

MediaCUBE Overview

- Emphasized on their web page; for delivery of interactive video to client devices over a network (from LAN-based training to video-on-demand to homes)
  - MediaCUBE 30 = 270 1.5 Mbps data streams, 750 hours of content
  - MediaCUBE 3000 = 20,000 & 55,000

Silicon Graphics
POWER CHALLENGEarray Overview

- Distributed-memory / ccNUMA shared-memory MIMD
- "Small" supercomputers
  - POWER CHALLENGE — up to 144 MIPS R8000 processors or 288 MISP R1000 processors, with up to 109 GFLOPS, 128 GB memory, and 28 TB of disk
  - POWERnode system — shared-memory multiprocessor of up to 18 MIPS R8000 processors or 36 MIPS R1000 processors, with up to 16 GB of memory
- POWER CHALLENGEarray consists of up to 8 POWER CHALLENGE or POWERnode systems
  - Programs that fit within a POWERnode can use the shared-memory model
  - Larger program can span POWERnodes

Silicon Graphics
POWER CHALLENGEarray Programming

- Fine- to medium-grained parallelism
  - Shared-memory techniques within a POWERnode, using parallelizing FORTRAN and C compilers
- Medium- to coarse-grained parallelism
  - Shared-memory within a POWERnode or message-passing between POWERnode
  - Applications based on message-passing will run within a POWERnode, and libraries such as MPI or PVM will use the shared-memory instead
- Large applications
  - Hierarchical programming, using a combination of the two techniques

Silicon Graphics
Origin 2000 Overview

- ccNUMA shared-memory MIMD
- Various models, 2–512 processors, 16 GB – 1 TB memory, 6–200 GB/s peak I/O bandwidth
  - Largest model also supports 96 PCI cards and 160 Ultra SCSI devices
  - Processing node board contains two R10000 processors, part of the shared memory, directory for cache coherence, node interface, and I/O interface
- ccNUMA (SGI says they supply 95% of ccNUMA systems worldwide)
  - Crossbar switches that scale upwards
- Packaged solutions for business (file serving, data mining), Internet (media serving), & high-performance computing