

MIMD Parallel Computers

There are a very large number of parallel machines which bear the label MIMD. We shall choose a few significant machines for particular attention in this course:

- Multiprocessor SPARC workstations
 - a successful shared memory architecture.
- Machines based on the Inmos Transputer
 - because the Transputer is the first microprocessor designed as a building block for parallel machines.
- The CM-5 Connection Machine from Thinking Machines
- The Cray T3D
 - because they represent contrasting pragmatic approaches to massively parallel MIMD.

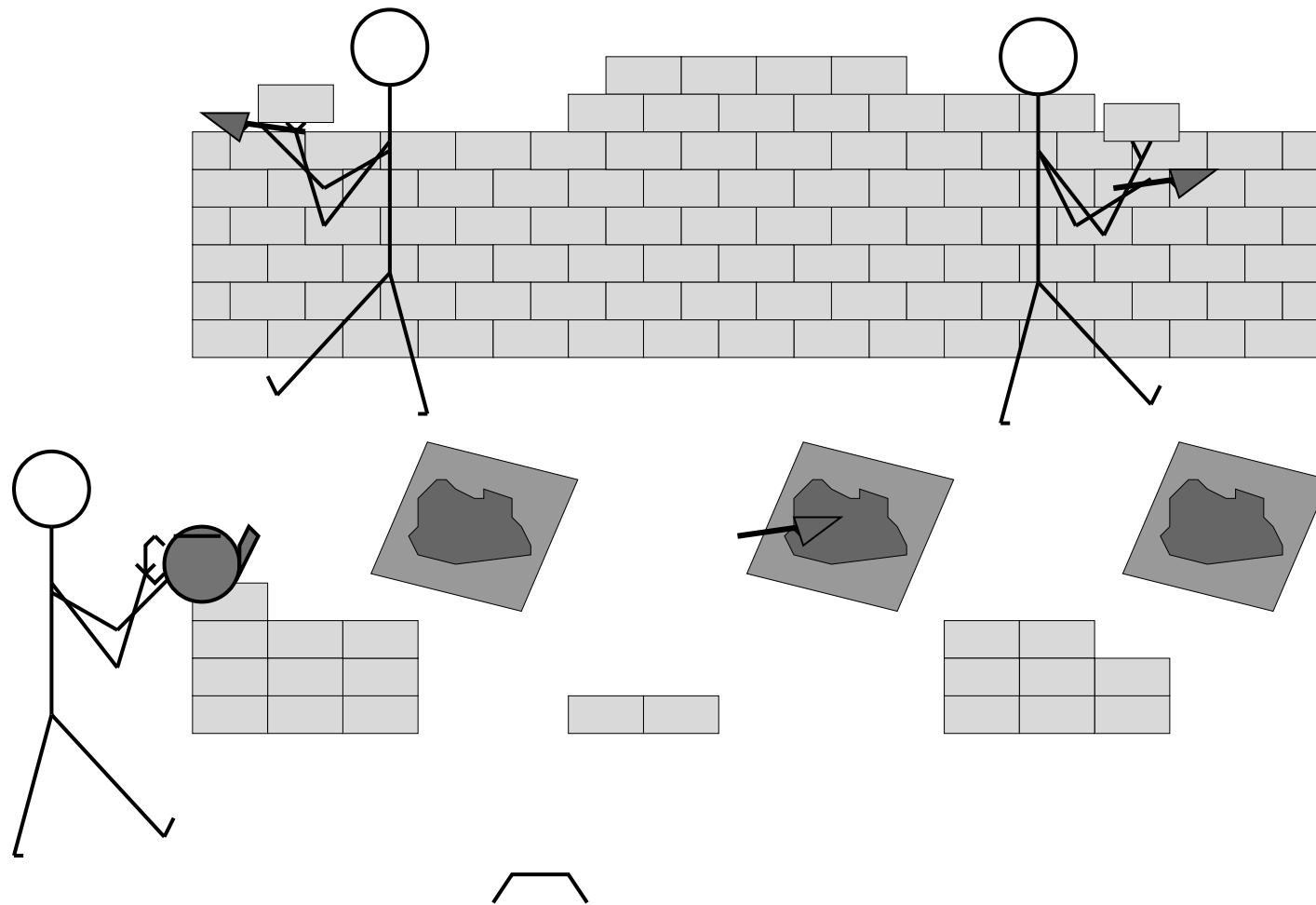
MIMD Parallel Computers

Features of MIMD machines

- MIMD machines typically consist of a number of PEs each of which is a computer in its own right.
- Each PE has a separate instruction stream which it follows independent of the actions of the others.
- In order to communicate and co-operate they may use shared memory locations or have other dedicated hardware.
- One PE may act as master in the co-ordination of tasks, or this co-ordinating role might be distributed amongst a number or all of the PEs.

Now we can look at wall building by 'MIMD Construction Ltd.'.

MIMD Construction Ltd. - *Wall builders Co-operative*



Benefits of MIMD Architectures

- MIMD machines are more flexible.
 - Boundary Effects
 - - End workers behave differently without stopping the central workers.
 - Insufficient Work
 - - 1000 Slaves building a wall 500 bricks wide – 500 carry bricks 500 carry trowels.
 - Sequential Tasks
 - - Making the Tea – done by a single worker while the others build.

Due to this flexibility, MIMD machines are seen by many as the general purpose parallel computers of the future.

- MIMD machines are often built using standard sequential computer components (e.g. standard microprocessors).

As the sequential market is much larger than the parallel market these components are well understood and cheap.

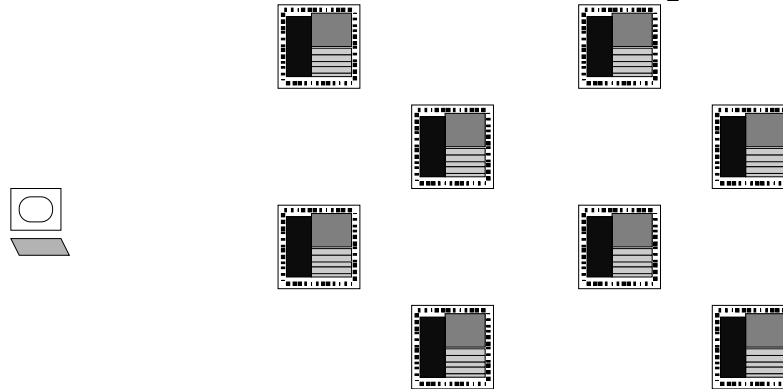
Problems with MIMD Architectures

- We must pay for increased flexibility. Each processing element must have an IPU although there will seldom be as many distinct strands of control as there are processors.
- Due to the independence of their PEs, MIMD machines are difficult to co-ordinate. Synchronization and distribution of control information are more complex than in SIMD machines.
- Inter-processor communication is made more difficult because the PEs do not operate in lockstep.
Frequently we may find that one PE will sit idle waiting for another to send data.
- MIMD machines are very difficult to program.
Along with multiple instruction streams come new programming concepts. The interaction of instruction streams can lead to deadlock and other such fatal software ailments.

MIMD - Processor size and number

Due to the overheads of an IPU and complex communications hardware, MIMD processing elements are generally of comparable size to SISD processors.

A typical machine will have relatively few, higher complexity processing elements.



The actual numbers of processors will then be limited by the budget and the efficiency of the communications network.

- Transputer machines containing as few as 8 processors with 32 bit floating point capability are common.
- For those with more money the CM-5 machine is potentially configurable to 16384 vector parallel nodes giving a total power of 2 TerraFlops.

MIMD - Exploiting Parallelism

- **Process Parallelism**

MIMD machines can exploit *Process Parallelism* since the task performed by one PE need not be related to that performed by another.

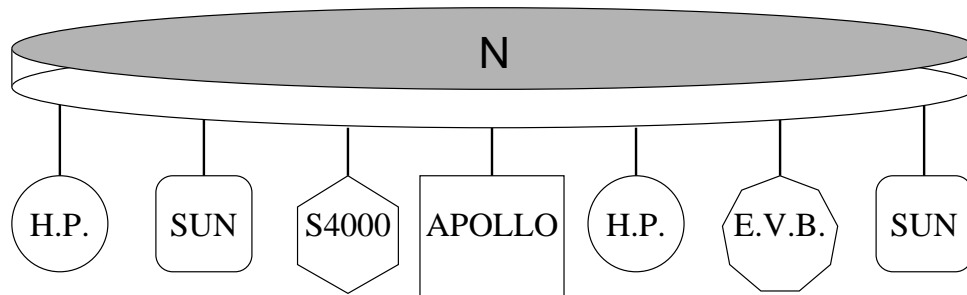
- **Data Parallelism**

MIMD machines can exploit *Data Parallelism* since it is a sub-set of *Process Parallelism*. Nevertheless, many MIMD machines include elements of SIMD architecture to improve performance on *Data Parallel* tasks.

MIMD Parallel Computers

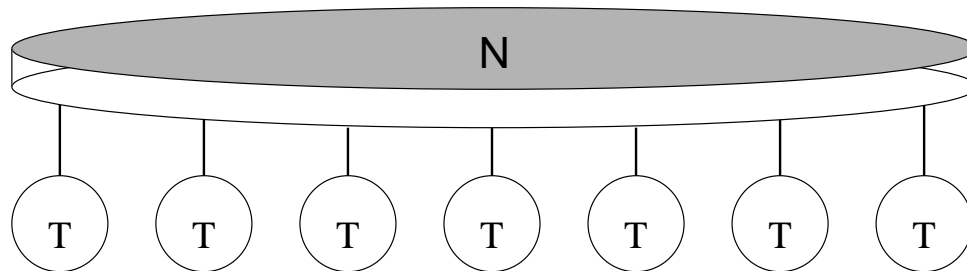
- Heterogeneous MIMD Machines

A MIMD parallel computer constructed of non-identical processing elements.
(350 various UNIX machines on Ethernet working together to solve a Prolog problem).

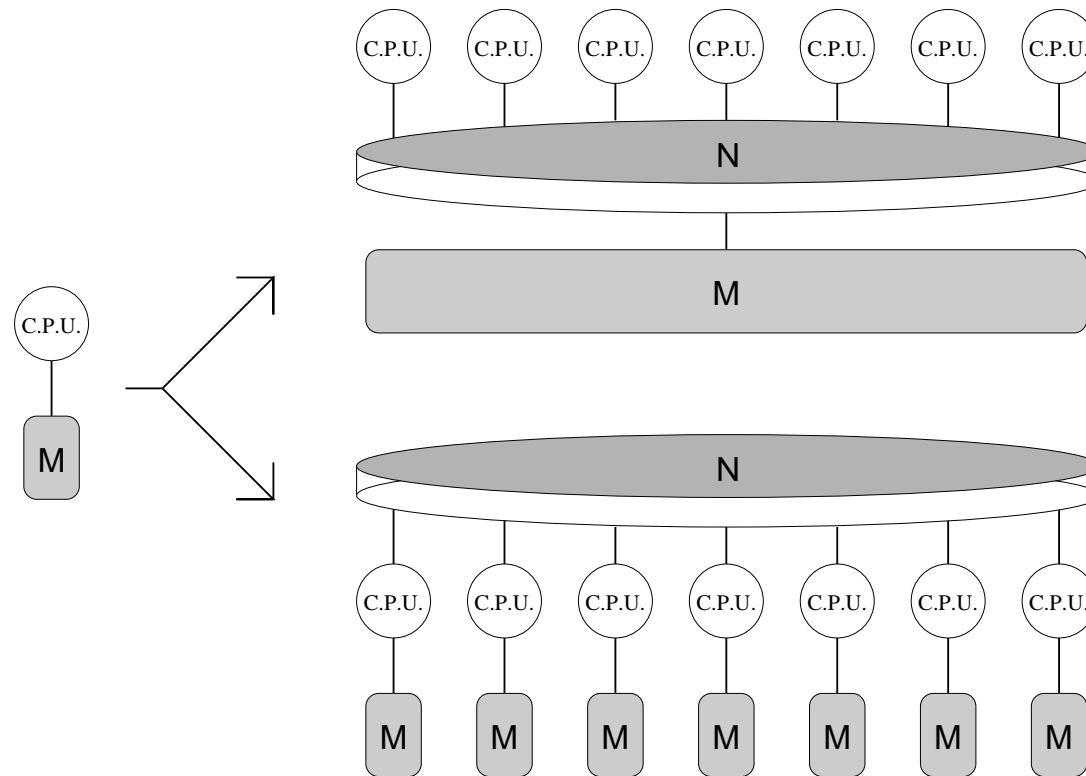


- Homogeneous MIMD Machines (Replicated MIMD Machines)

A MIMD parallel computer constructed of identical processing elements.



Memory Configuration in MIMD systems



- Shared Memory Multiprocessor Systems
- Distributed Memory Multiprocessor Systems