

Classification of Parallel Computers

Parallel computers can be classified by their datapath architecture and their control unit architecture.

Datapath Classification

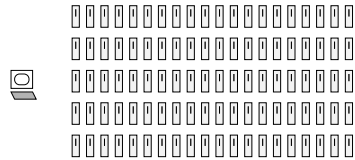
Parallel computers have traditionally been divided into

- *Pipelined Vector Computers*
- *Replicated Parallel Computers*

Although this distinction is still clear, there are an increasing number of machines that are

Replicated Parallel Pipelined Vector Computers.

Replicated Parallel Computers.



Replicated parallel machines will have a number of identical processing elements. These processing elements must "communicate and co-operate" in order to solve problems.

This description leads us to a number of questions:

- What constitutes a processing element?
- How many processing elements of what complexity?
- How do they communicate?
- How do they co-operate?

Replicated Parallel Computers – Summary of Issues

What constitutes a processing element?

What parts of our sequential computer do we replicate?

- Do we replicate control structures or keep central control?
- Do we replicate memory or keep common memory?

We have already suggested that not replicating screen and keyboard is likely to be a good move. We will see that decisions made here can greatly effect the overall architecture of a parallel machine.

Replicated Parallel Computers – Summary of Issues

How many processing elements of what complexity?

Given that we have a limited budget, how should we spend our money?

- We could have *many simple* processing elements.
- We could have *fewer complex* processing elements.

In the spectrum of replicated parallel machines we have machines with very large numbers of tightly coupled small processors, and machines with relatively few loosely coupled large processors.

There are as many opinions on what constitutes a good parallel machine as there are research groups working in the field.

Replicated Parallel Computers – Summary of Issues

How do they communicate?

What systems do we provide to transfer data around our parallel machine?

- What network topology do we use?
- What Message Passing system do we use?

Data transfer is often the weakest part of a parallel computer, we must consider it carefully.

Replicated Parallel Computers – Summary of Issues

How do they co-operate?

This last question deals with the difficult task of getting a number of machines to solve a single problem.

- Programming - How much can the compiler do for us?
- Should there be some central co-ordinator?
 - How would it communicate with the replicated processing elements?

Parallel machines are notoriously difficult to program

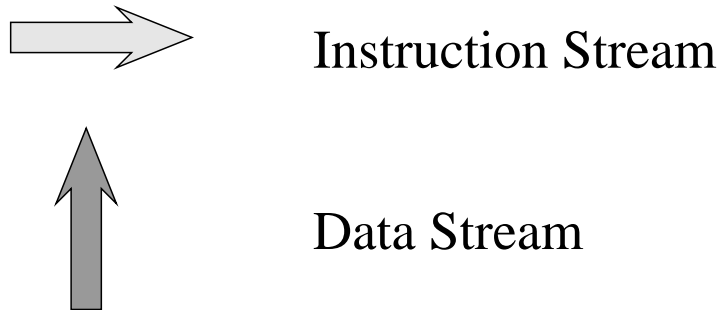
Further Machine Classification

Flynn's Taxonomy

No introduction to parallel architecture would be complete without a look at Flynn's Taxonomy.

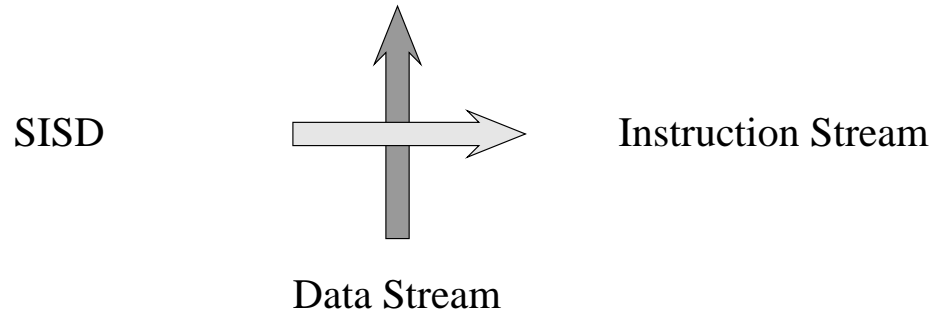
Flynn classifies computers according to how the machine relates its instructions to the data being processed.

A stream is defined as a sequence of items (instructions or data) as executed or operated on by a processor.



Flynn's Taxonomy

SISD - Single Instruction Stream / Single Data Stream

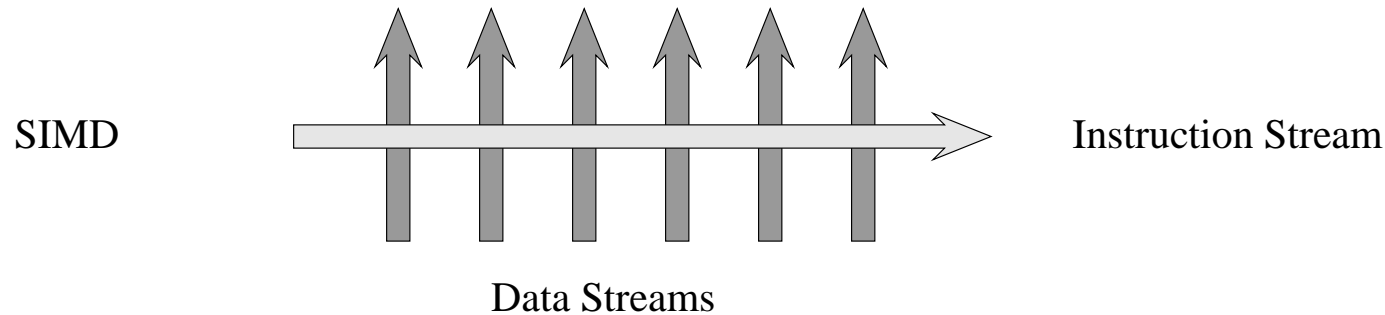


- This is a conventional sequential machine.
- There is a single instruction stream and thus in practice a single instruction processing unit.
- Each arithmetic instruction results in one arithmetic operation.

(Example: Sinclair ZX81)

Flynn's Taxonomy

SIMD - Single Instruction Stream / Multiple Data Stream

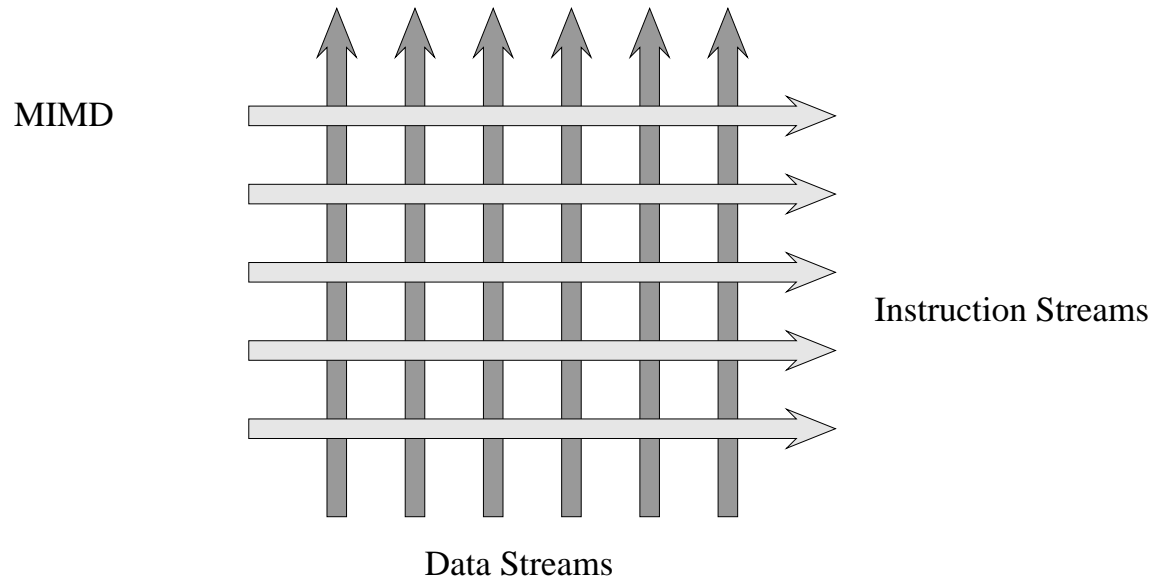


- This machine retains the single instruction stream of SISD machine, but supports instructions which initiate many operations on conceptually different streams of data.

(Examples: CRAY 1 Pipelined Vector Computer, AMT DAP Array Processor)

Flynn's Taxonomy

MIMD - Multiple Instruction Stream / Multiple Data Stream

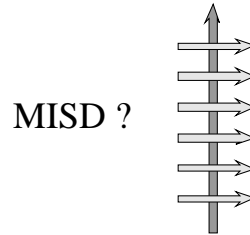


- The multiple instruction streams lead to a number of instruction processing units each with one or more data streams.

(Examples: Intel Hypercube, Transputer Array)

Flynn's Taxonomy

MISD - Multiple Instruction Stream / Single Data Stream



- There are no examples of machines which apply multiple instruction streams to the same stream of data, although Flynn tells us that they might exist.

The main distinction that will concern us is that between SIMD and MIMD.¹ This is the *Control Unit Architecture Classification* that was mentioned earlier.

- SIMD machines have a single instruction processing unit.
- MIMD machines have a number of different instruction processing units.

¹Note that a Pipelined Vector Computer is SIMD, but a Replicated Parallel Computer or a Replicated Parallel Pipelined Vector Computer may be SIMD or MIMD.