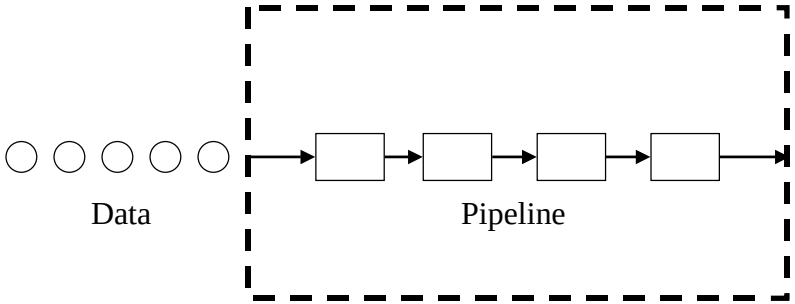
Pipelining

- Allows multi-stage operations to proceed on multiple data.
- Each stage can be applied to a different piece of data simultaneously.
- When the pipeline is full the level of parallelism is equal to the number of stages in the pipeline.

Lecture 7

Intro to parallel computer architectures, vector supercomputers, data-parallel/massive parallel systems.

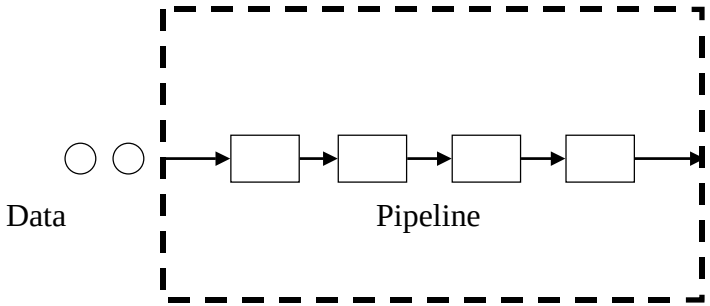
Pipelined operations.



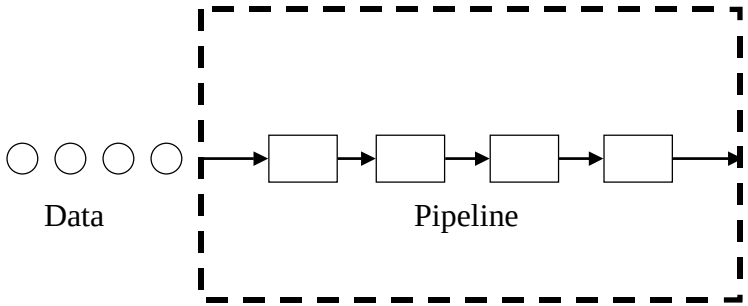
Parallel Architectures

- Allow several computations to proceed simultaneously.
- There are many ways to achieve this, so many types of parallel computer exist.
- To understand the major trends in design we will look at examples of the major classes of parallel computer.
- The fundamental issue is how to apply multiple operands to a given data set simultaneously.

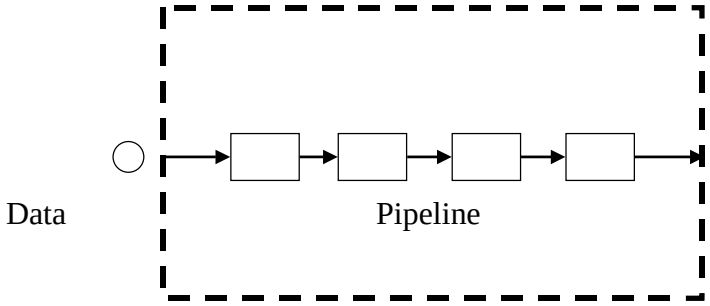
Pipelined operations.



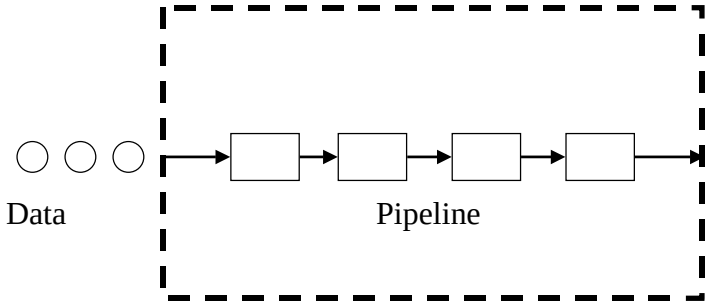
Pipelined operations.



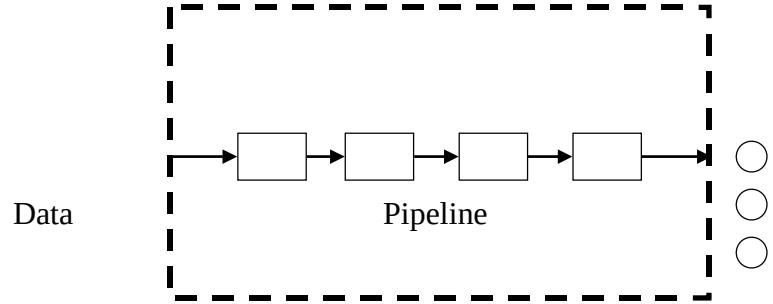
Pipelined operations.



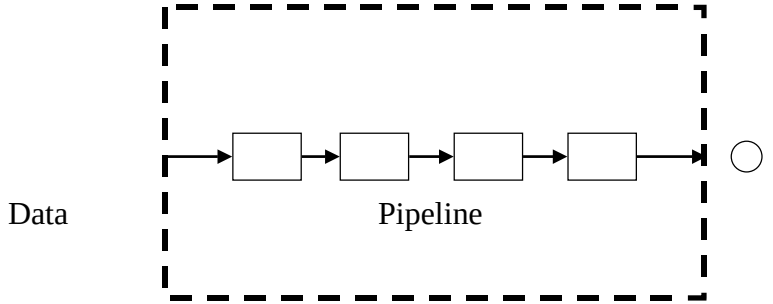
Pipelined operations.



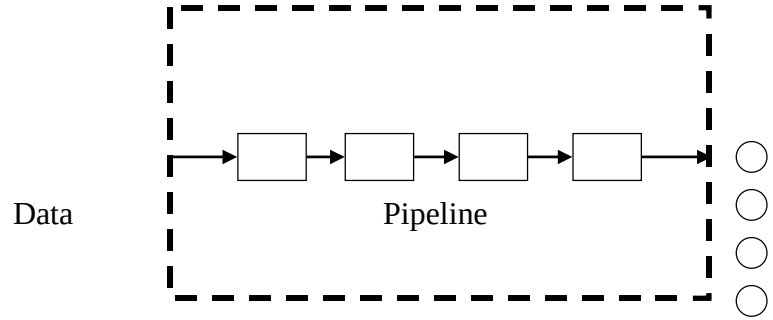
Pipelined operations.



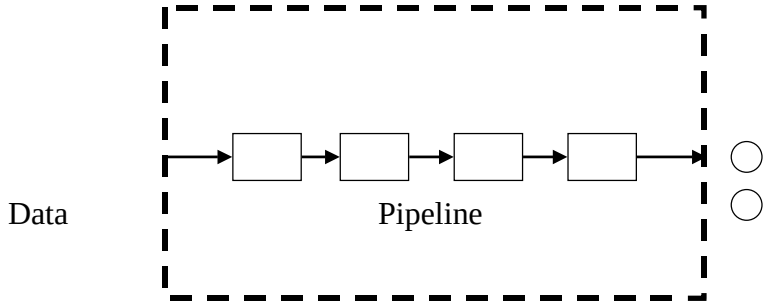
Pipelined operations.



Pipelined operations.



Pipelined operations.



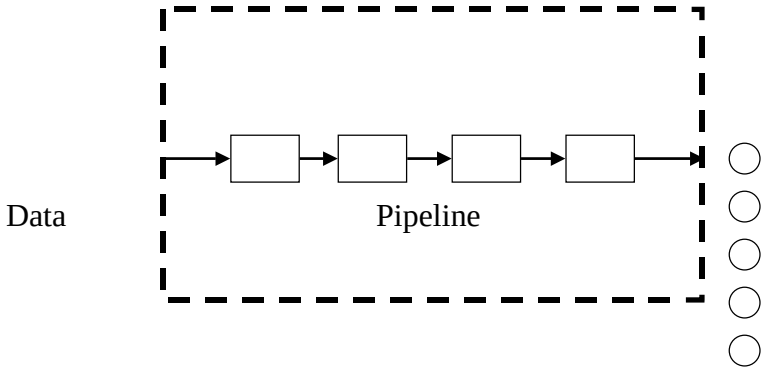
Speedup in a D-stage Pipe

- Assuming N data items.

Without pipelining T= D*N

With pipelining T= D+(N-1)

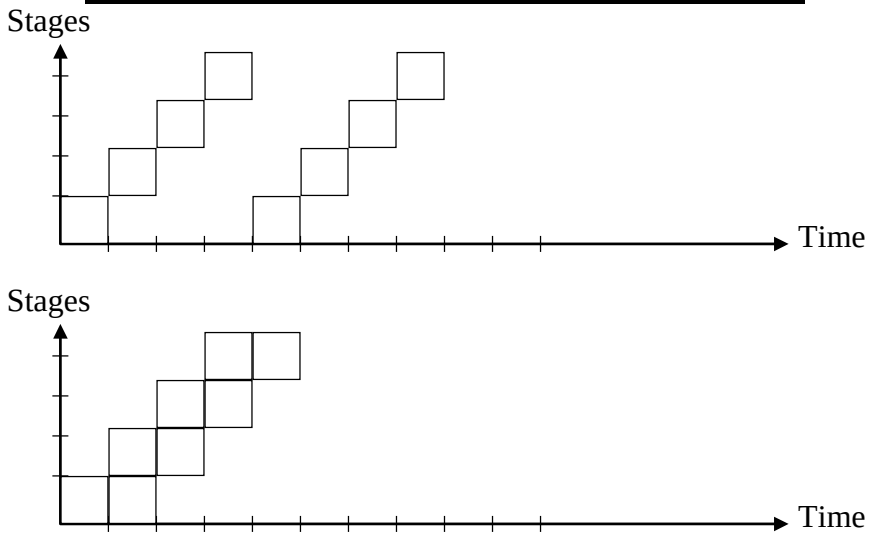
Pipelined operations.



Vectorisation

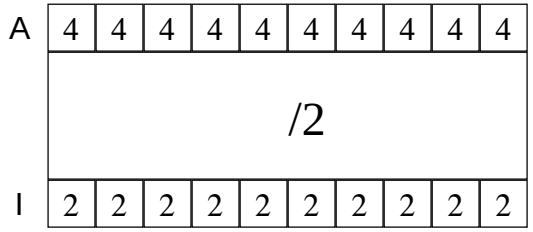
- Implement data operations on arrays, generally in one dimension. Thus "vectorisation".
- Operations like A= 4; I= A/2;
- Where A and I are appropriately declared vectors.
- Eg. int A[Max_Vals], I[Max_Vals]

Operation Timing



Visualisation

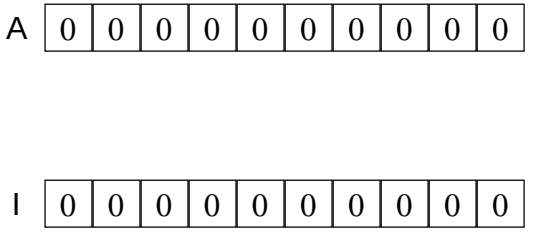
4



Clock 2

Visualisation

4

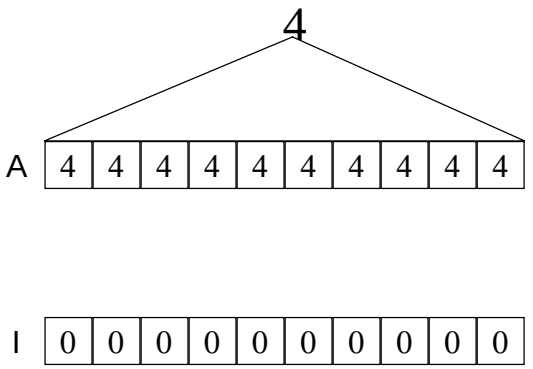


Clock 0

Massively Parallel Computers

- The vectorisation idea can, of course, be extended to more than one dimension and generalised into a hardware design.
- Massively parallel computers are composed of a large number of processing elements which are issued instructions by a central controller.
- Each processor has its own data, to which the instruction is applied.

Visualisation

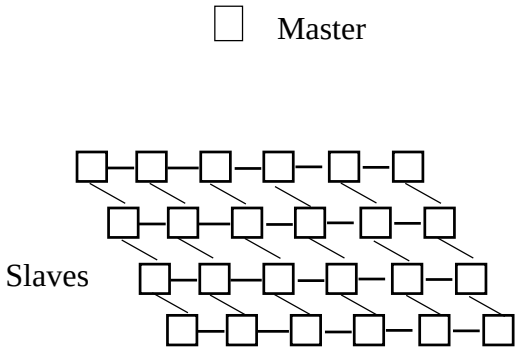


Clock 1

Design and Use

- Normally connected into a mesh.
- Can be used in multiple layers to construct more complex computers.
- The MasPar is an example of a production version of this class of machine.
- The architecture is well suited to image processing tasks, and can perform well on finite element codes for weather modelling and material stress calculations.

Example



Characteristics

- Slaves are very simple.
- Master issues the instructions to the slaves and enables or disables them for the current execution cycle.
- All the slaves execute in lock step.
- Enable/Disable is used to implement conditional execution. Eg. If statements.