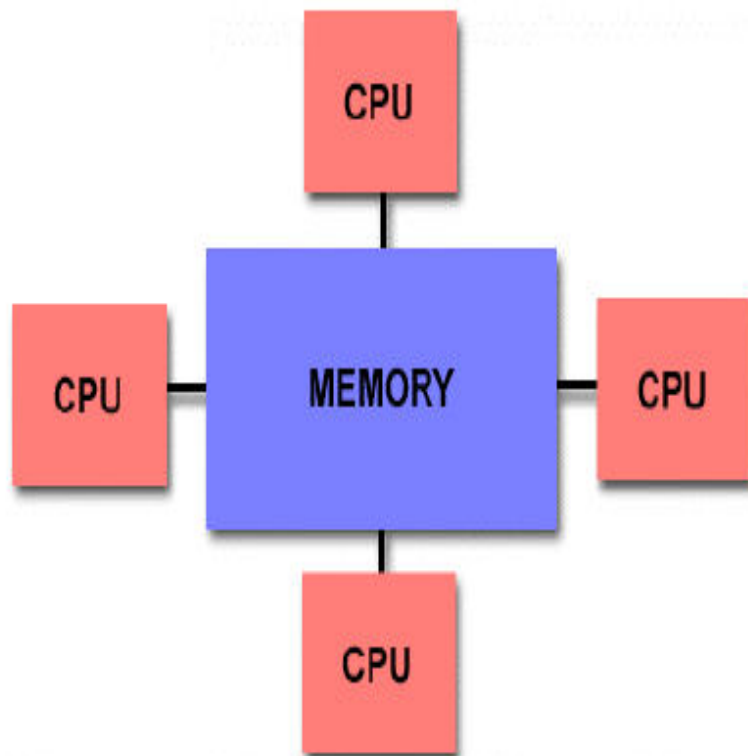


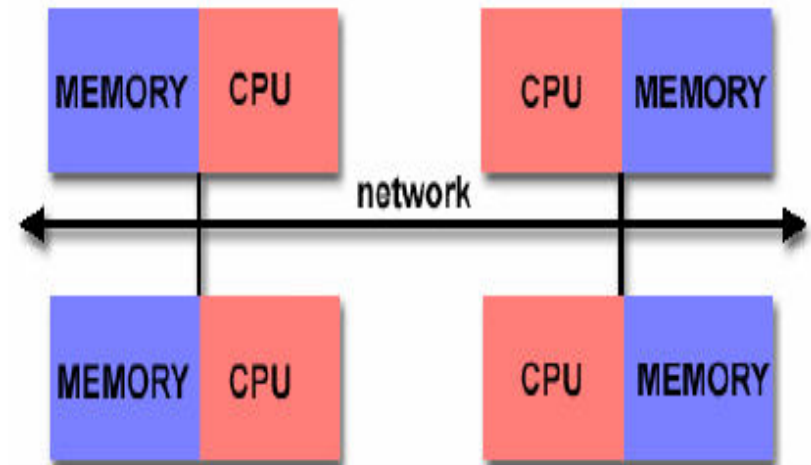
PARALLEL PROCESSING

- Parallel computers are those that emphasize the parallel processing between the operations in some way.
- Various Varieties
 - Shared Memory
 - Distributed Memory
 - Hybrid Memory

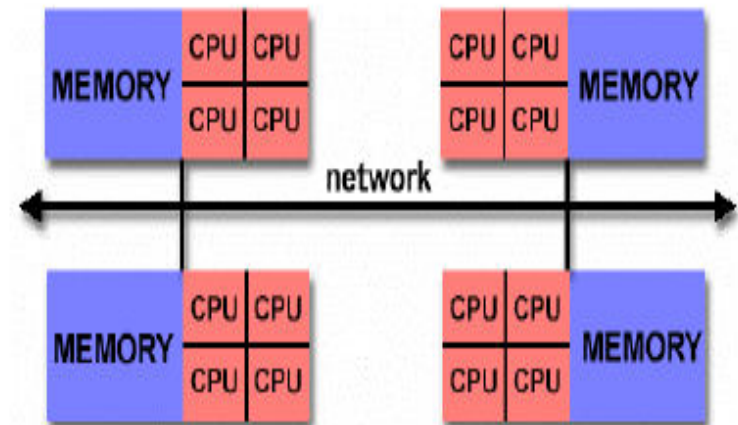
Shared Memory



Distributed Memory



Hybrid Memory



Flynn's Taxonomy

- This classification was first studied and proposed by Michael Flynn in 1972.
- Flynn did not consider the machine architecture for classification of parallel computers
- He introduced the concept of instruction and data streams for categorizing of computers.
- Instruction stream - a flow of instructions from main memory to the CPU
- Data stream - a flow of operands between processor and memory
- All the computers classified by Flynn are not parallel computers
- Let I_s and D_s are minimum number of streams flowing at any point in the execution

Instruction Cycle

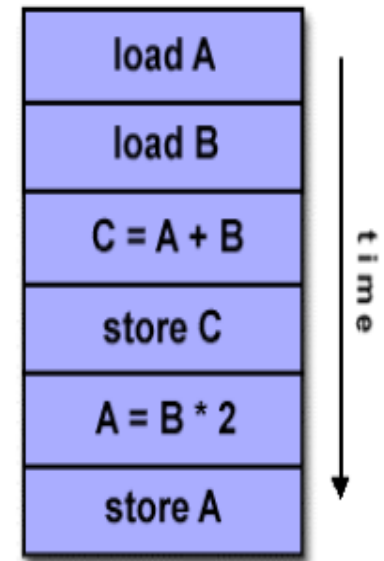
- Start
- Calculate the address of the instruction to be executed
- Fetch the instruction
- Decode the instruction
- Calculate the operand address
- Fetch the operands
- Execute the instructions
- Store the results
- If more instructions to be executed, go to step 2 else stop.

Flynn's Classification

- SISD: Single Instruction Single Data
 - Classical Von-Neumann architecture
- SIMD: Single Instruction Multiple data
- MISD: Multiple Instructions Single Data
- MIMD: Multiple Instructions Multiple Data
 - Most common and general parallel machine

Single Instruction Single Data stream

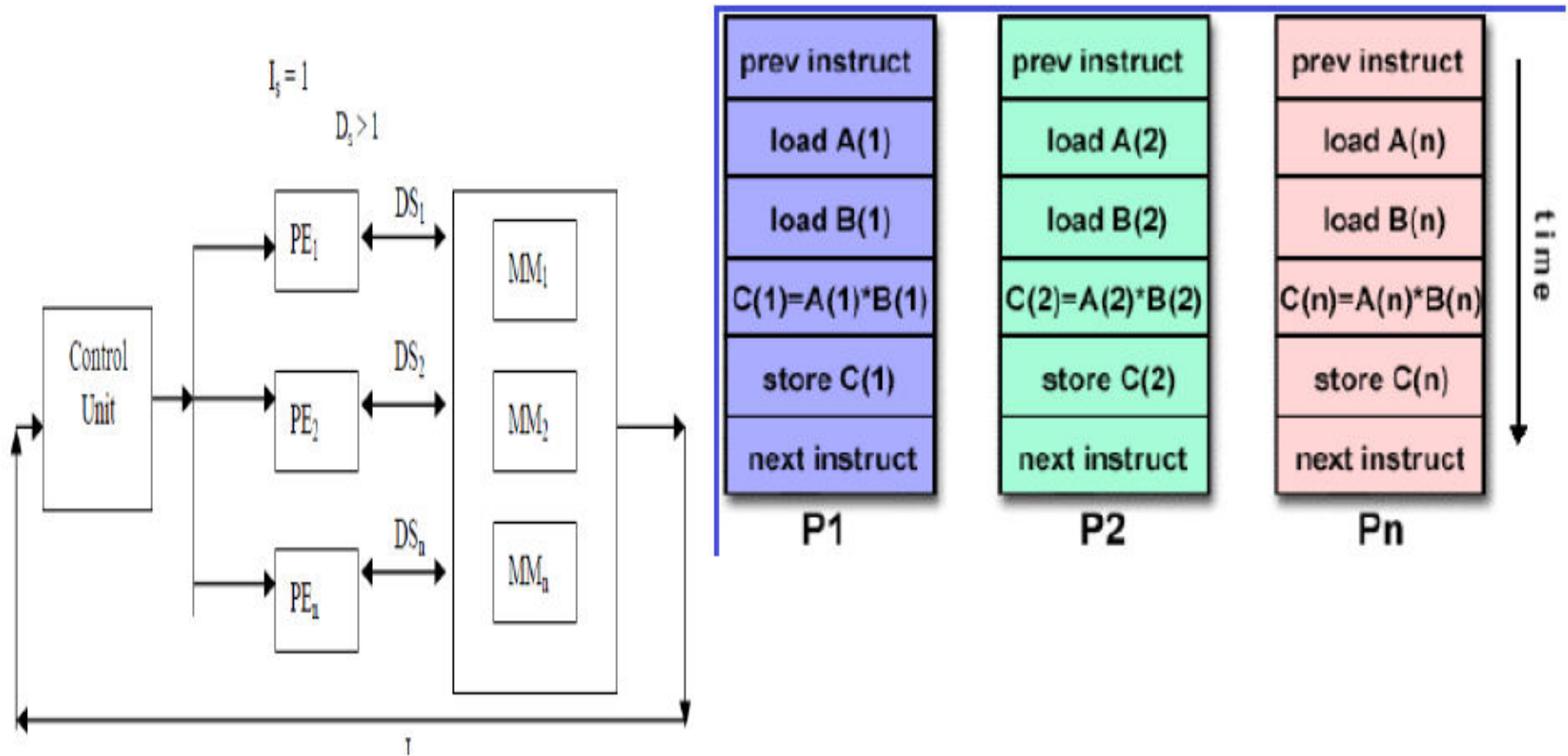
- A serial computer
- SISD machines are conventional serial computers that process only one stream of instructions and one stream of data.
- $I_s = D_s = 1$
- Examples
 - CDC 6600 which is unpipelined but has multiple functional units.
 - CDC 7600 which has a pipelined arithmetic unit.
 - Amdhal 470/6 which has pipelined instruction processing.
 - Cray-1 which supports vector processing.



Single Instruction Multiple Data stream

- Multiple processing elements work under the control of a single control unit.
- It has one instruction and multiple data stream
- Main memory can also be divided into modules for generating multiple data streams acting as a distributed memory
- Examples of SIMD organisation are ILLIAC-IV, PEPE, BSP, STARAN, MPP, DAP and the Connection Machine (CM-1).
- A type of parallel computer
- Single instruction: All processing units execute the same instruction at any given clock cycle
- Multiple data: Each processing unit can operate on a different data element

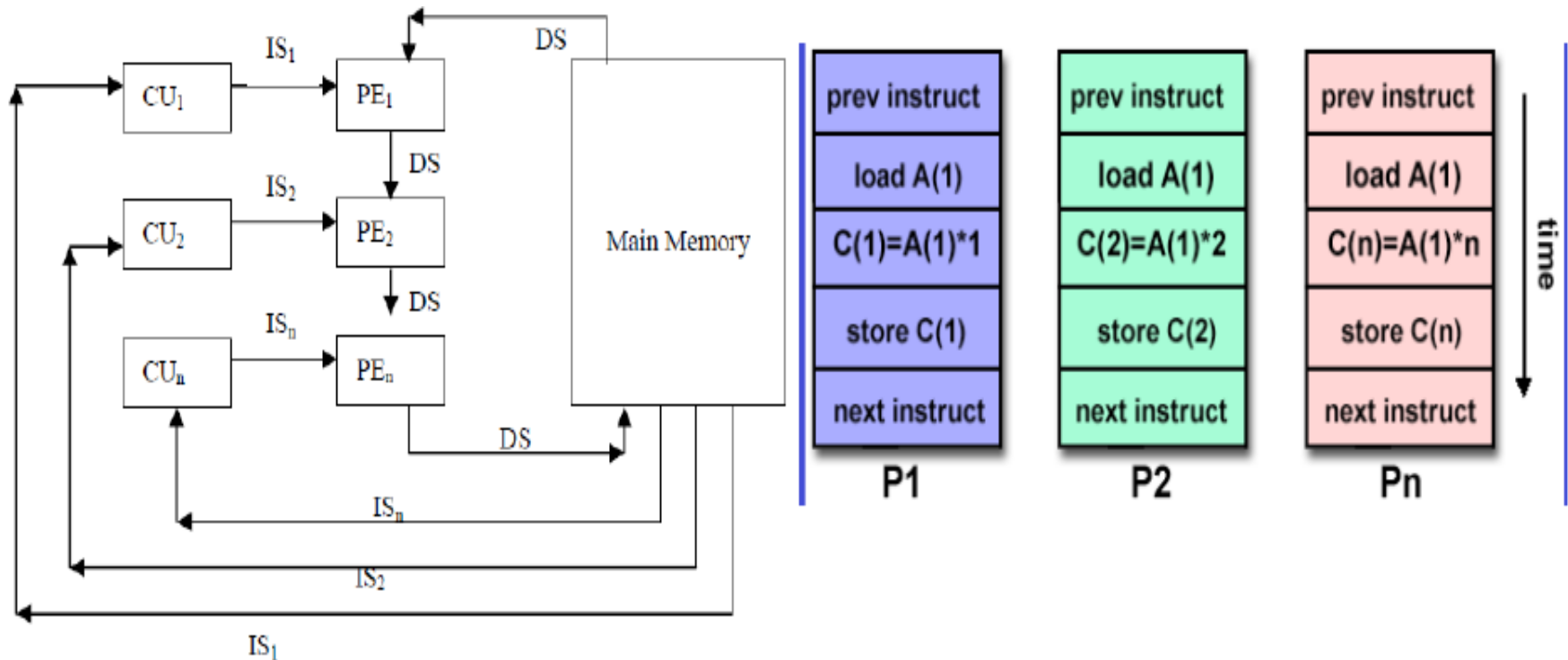
SIMD



Multiple Instruction Single Data stream

- Multiple processing elements are organised under the control of multiple control units.
- Each control unit is handling one instruction stream and processed through its corresponding processing element.
- A single data stream is fed into multiple processing units.
- Each processing unit operates on the data independently via independent instruction streams.
- But each processing element is processing only a single data stream at a time
- All processing elements are interacting with the common shared memory.

MISD

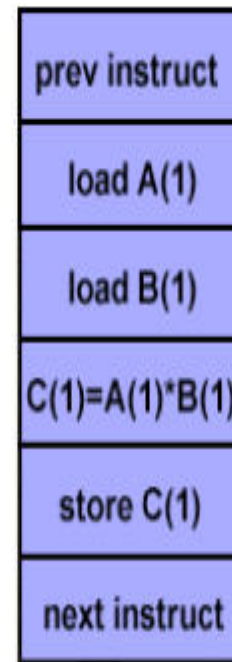
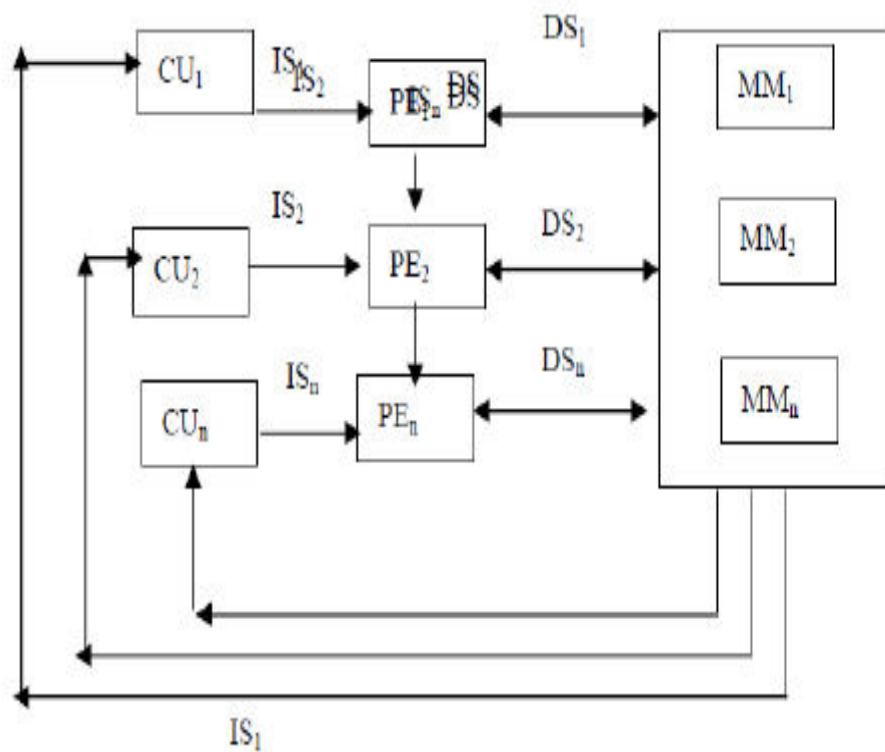


Real time computers need to be **fault tolerant** where several processors execute the same data for producing the redundant data. This is also known as **N-version programming**. All these redundant data are compared as results which should be same; otherwise faulty unit is replaced. Thus MISD machines can be applied to fault tolerant real time computers.

Multiple Instruction Multiple Data stream

- Multiple instruction streams operate on multiple data streams
- The processors work on their own data with their own instructions.
- Tasks executed by different processors can start or finish at different times.
- This classification actually recognizes the parallel computer.
- Examples include; C.mmp, Burroughs D825, Cray-2, S1, Cray X-MP, HEP, Pluribus, IBM 370/168 MP, Univac 1100/80, Tandem/16, IBM 3081/3084, C.m*, BBN Butterfly, Meiko Computing Surface (CS-1), FPS T/40000, iPSC.
- MIMD organization is the most popular for a parallel computer.
- In the real sense, parallel computers execute the instructions in MIMD mode.
- $I_s > 1$, $D_s > 1$

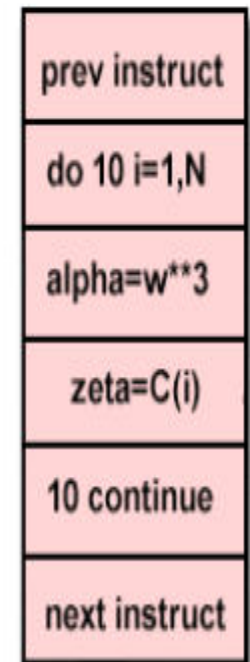
MIMD



P1



P2



Pn

time