

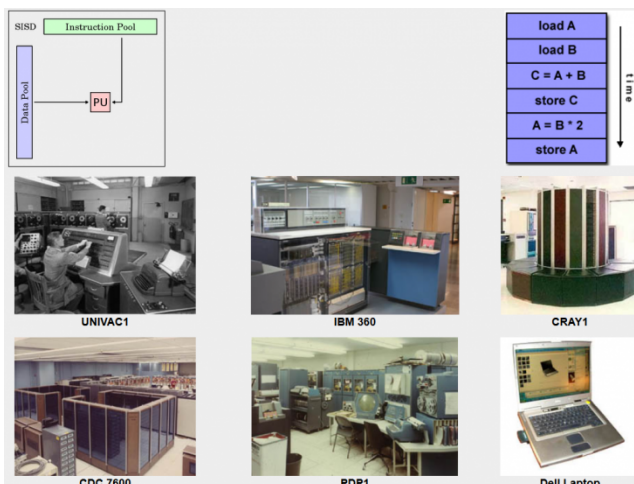
Flynn's Classical Taxonomy

- There are different ways to classify parallel computers. Examples available [HERE](#) (<https://hpc.llnl.gov/sites/default/files/parallelClassifications.pdf>).
- One of the more widely used classifications, in use since 1966, is called Flynn's Taxonomy.
- Flynn's taxonomy distinguishes multi-processor computer architectures according to how they can be classified along the two independent dimensions of Instruction Stream and Data Stream. Each of these dimensions can have only one of two possible states: Single or Multiple.
- The matrix below defines the 4 possible classifications according to Flynn:

S I S D Single Instruction stream Single Data stream	S I M D Single Instruction stream Multiple Data stream
M I S D Multiple Instruction stream Single Data stream	M I M D Multiple Instruction stream Multiple Data stream

Single Instruction, Single Data (SISD):

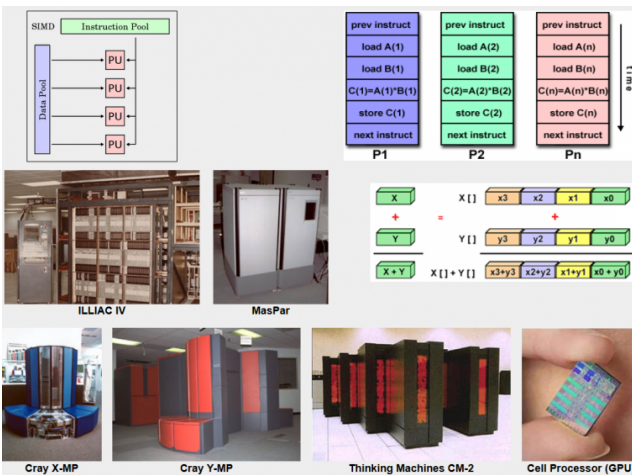
- A serial (non-parallel) computer
- Single Instruction: Only one instruction stream is being acted on by the CPU during any one clock cycle
- Single Data: Only one data stream is being used as input during any one clock cycle
- Deterministic execution
- This is the oldest type of computer
- Examples: older generation mainframes, minicomputers, workstations and single processor/core PCs.



(<https://hpc.llnl.gov/sites/default/files/210.PNG>)

Single Instruction, Multiple Data (SIMD):

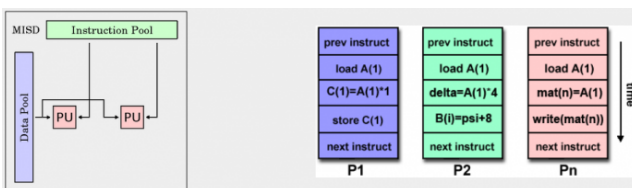
- A type of parallel computer
- Single Instruction: All processing units execute the same instruction at any given clock cycle
- Multiple Data: Each processing unit can operate on a different data element
- Best suited for specialized problems characterized by a high degree of regularity, such as graphics/image processing.
- Synchronous (lockstep) and deterministic execution
- Two varieties: Processor Arrays and Vector Pipelines
- Examples:
 - Processor Arrays: Thinking Machines CM-2, MasPar MP-1 & MP-2, ILLIAC IV
 - Vector Pipelines: IBM 9000, Cray X-MP, Y-MP & C90, Fujitsu VP, NEC SX-2, Hitachi S820, ETA10
- Most modern computers, particularly those with graphics processor units (GPUs) employ SIMD instructions and execution units.



(<https://hpc.llnl.gov/sites/default/files/211.PNG>)

Multiple Instruction, Single Data (MISD):

- A type of parallel computer
- Multiple Instruction: Each processing unit operates on the data independently via separate instruction streams.
- Single Data: A single data stream is fed into multiple processing units.
- Few (if any) actual examples of this class of parallel computer have ever existed.
- Some conceivable uses might be:
 - multiple frequency filters operating on a single signal stream
 - multiple cryptography algorithms attempting to crack a single coded message.

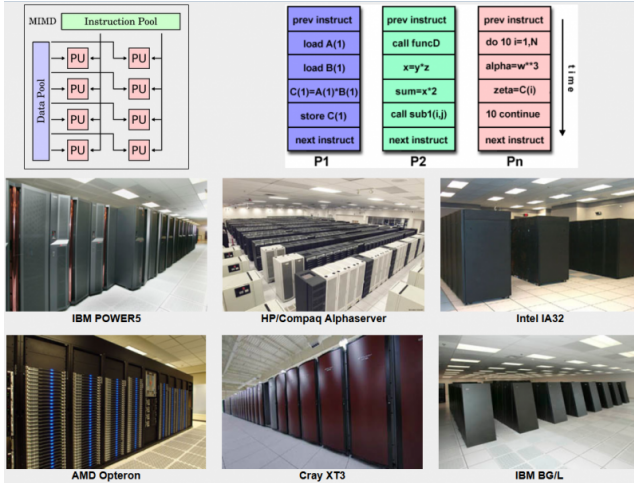


(<https://hpc.llnl.gov/sites/default/files/212.PNG>)

Multiple Instruction, Multiple Data (MIMD):

- A type of parallel computer
- Multiple Instruction: Every processor may be executing a different instruction stream
- Multiple Data: Every processor may be working with a different data stream

- Execution can be synchronous or asynchronous, deterministic or non-deterministic
- Currently, the most common type of parallel computer - most modern supercomputers fall into this category.
- Examples: most current supercomputers, networked parallel computer clusters and "grids", multi-processor SMP computers, multi-core PCs.
- Note: many MIMD architectures also include SIMD execution sub-components



(<https://hpc.llnl.gov/sites/default/files/213.PNG>)

Lawrence Livermore National Laboratory is operated by Lawrence Livermore National Security, LLC, for the U.S. Department of Energy, National Nuclear Security Administration under Contract DE-AC52-07NA27344.