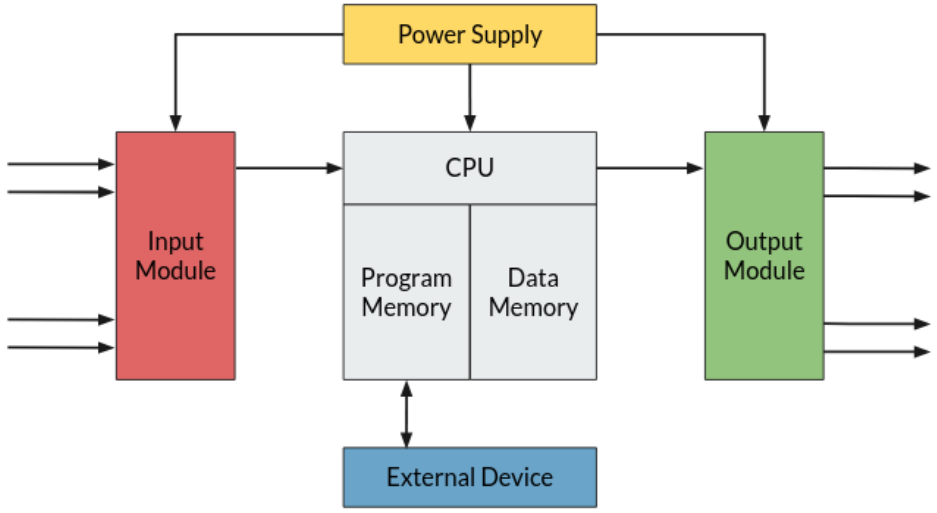
PLC Theory – PLC Architecture

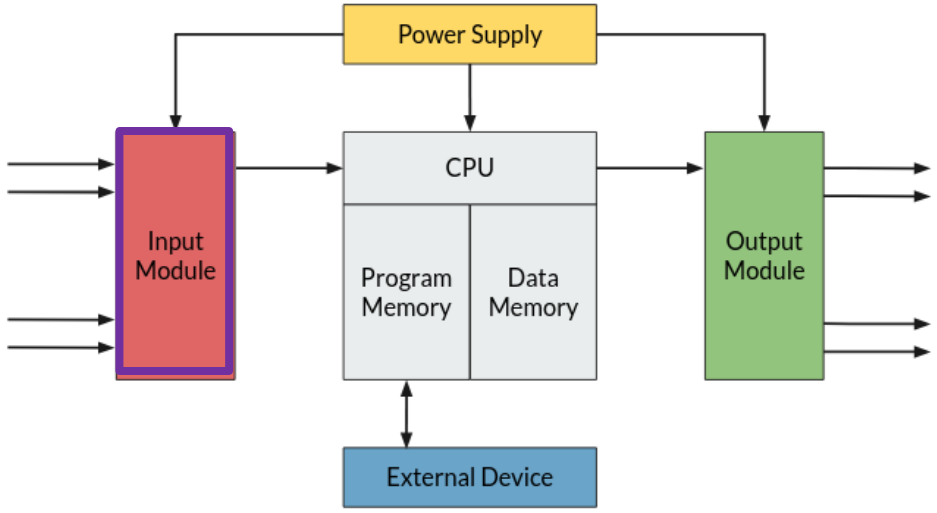
Parts of a PLC

- The architecture of a PLC is split into several parts
  - Input module
  - Output module
  - CPU
  - Memory
  - Power supply



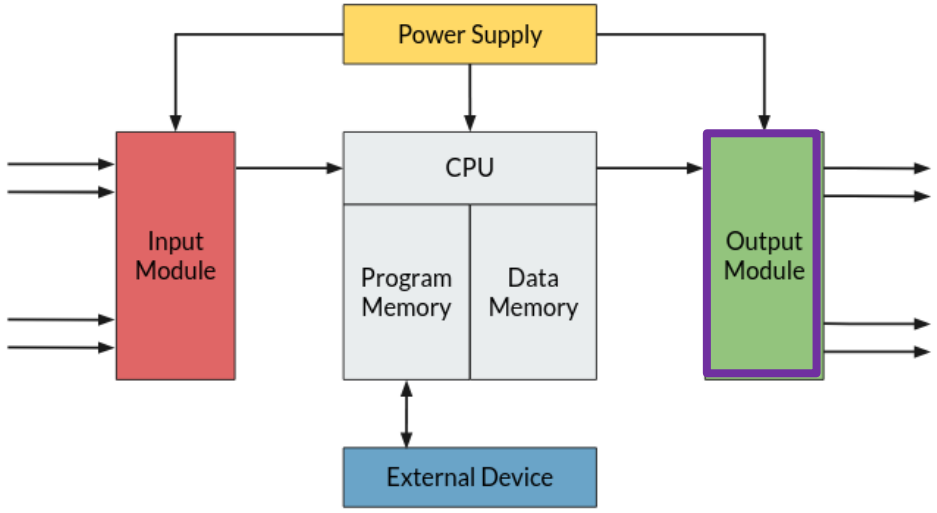
Input module

- The input module takes readings from external sensors and allows the PLC to interpret them
- They have two main input types in them analogue and digital
- For analogue input they require an ADC (Analogue Digital Converter)
- Often contains built in isolation to protect the PLC from surges and interference from external devices.



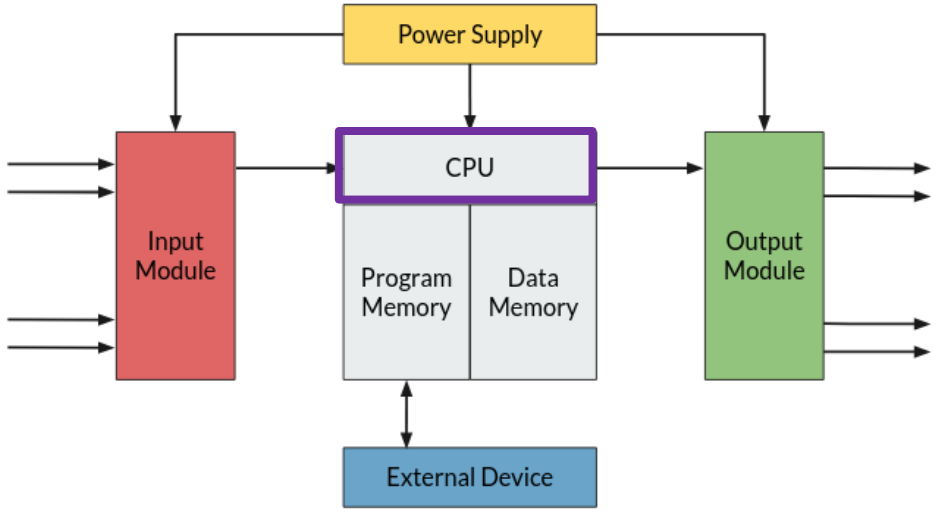
Output module

- The output module sends commands out to the connected actuators
- The output will usually be a digital signal however with specialist units it can be analogue
- For analogue output they require a DAC (Digital Analogue Converter)
- Often contains built in isolation to protect the PLC from surges and interference from external devices.



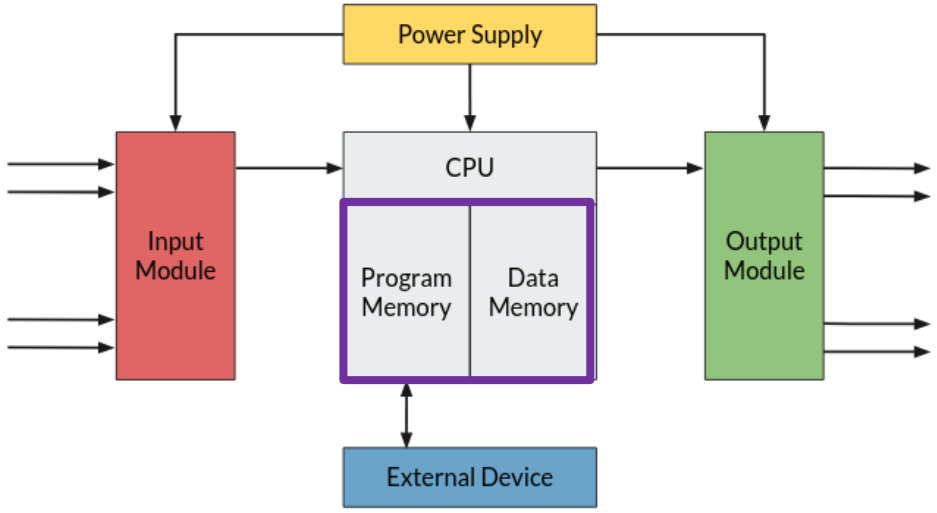
Central Processing Unit

- The CPU processes the user inputted programme
- Consists of:
  - Arithmetic Logic Unit (ALU) which does calculations
  - Control Unit (CU) which directs the execution of a program
  - Clock which controls the speed at which actions happen



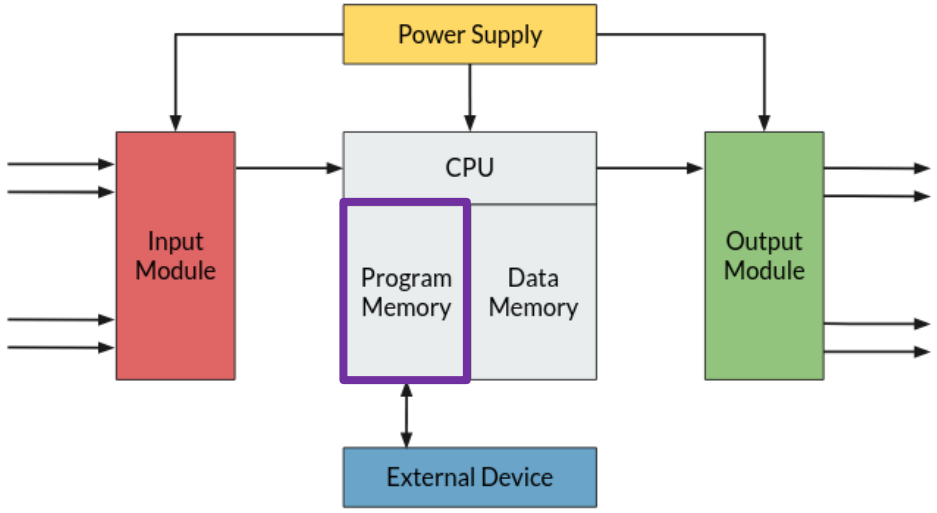
Memory

- The memory holds information for the CPU to use
- It has two main forms:
  - ROM/EEPROM (Program)
  - Ram (Data)



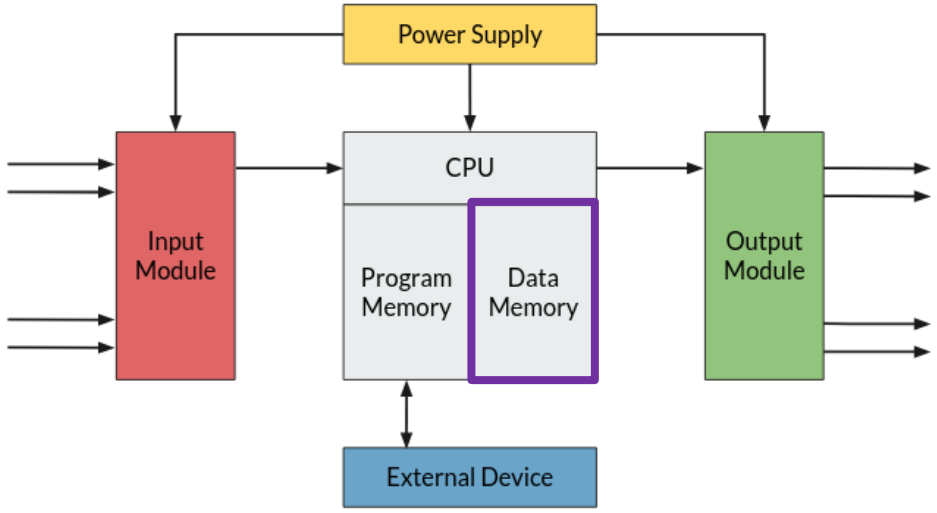
ROM

- Holds the programme which the CPU will run
- Also holds any other data which needs to be permanently saved for example config files
- The ROM is non-volatile, this means that when it's turned off it keeps its data



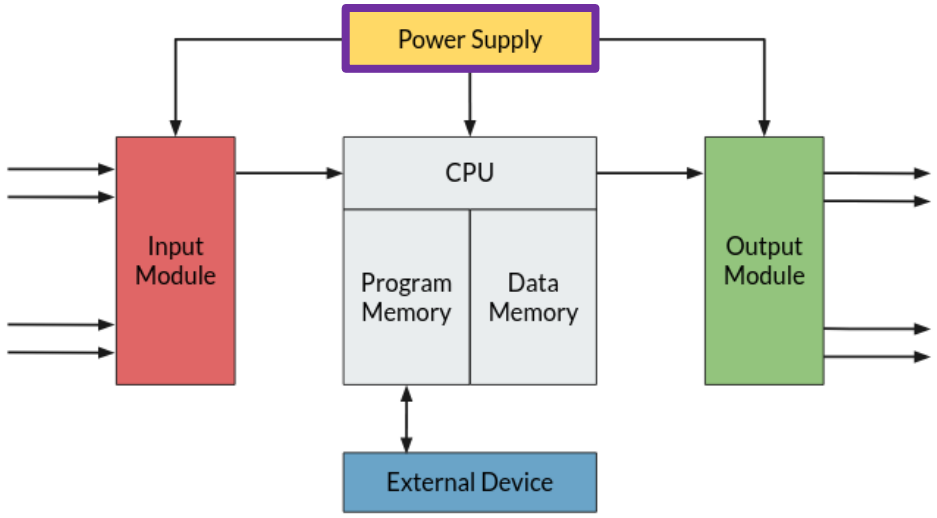
RAM

- Holds any temporary data which the CPU needs
- Most often used for real-time data
- One example of this is the RAM holding input and output values



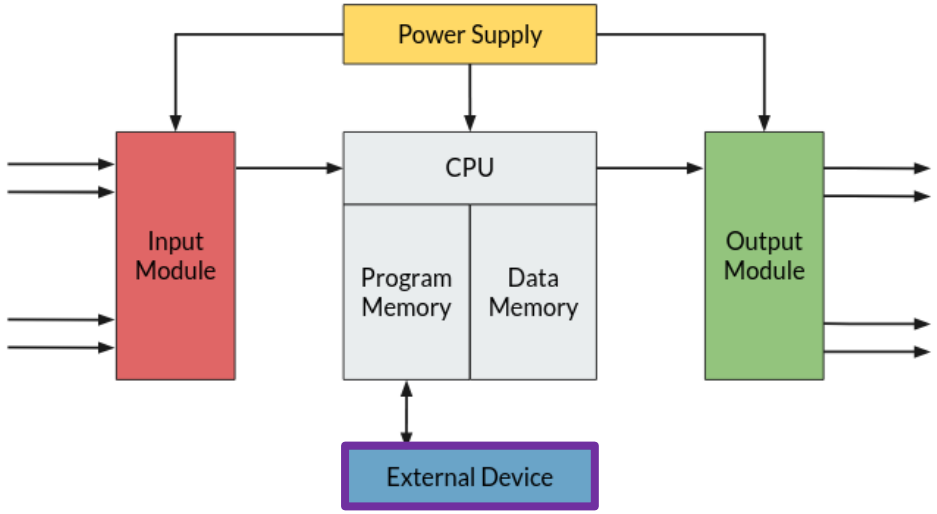
Power supply

- Provides power for all the components inside the PLC
- Most commonly converts mains AC voltage (120/240v) into DC (24v)
- Can also commonly accept a DC 24v input directly
- Often stabilises and isolates inputted power to ensure no damage to the PLC when power spikes



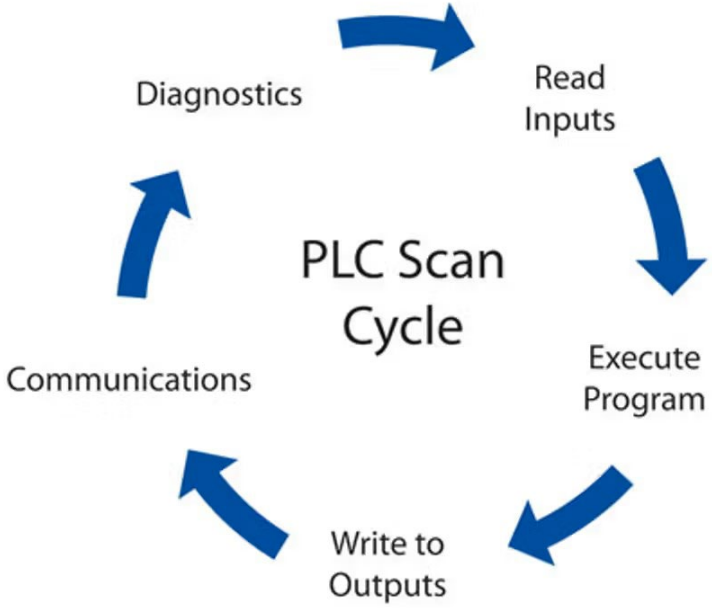
External Device

- The external device or programmer is whatever we are using to program the PLC
- The programmer will have a software on it that allows it to communicate with the PLC
- At this college we use the desktops with Siemens TIA installed on them.



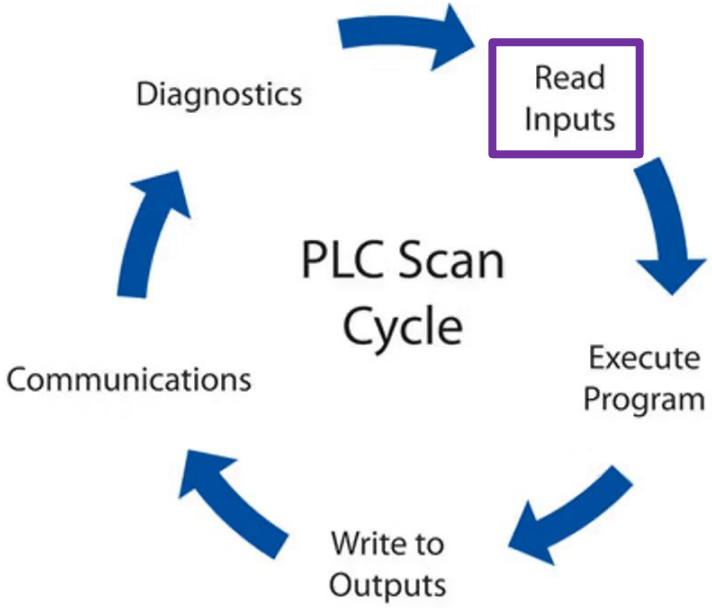
Scan Cycle

- The scan cycle dictates the order in which things happen inside a PLC
- It repeats continuously whilst the PLC is on
- It consists of 5 major parts:
  - Read Inputs
  - Execute Program
  - Write to Outputs
  - Communication
  - Diagnostics



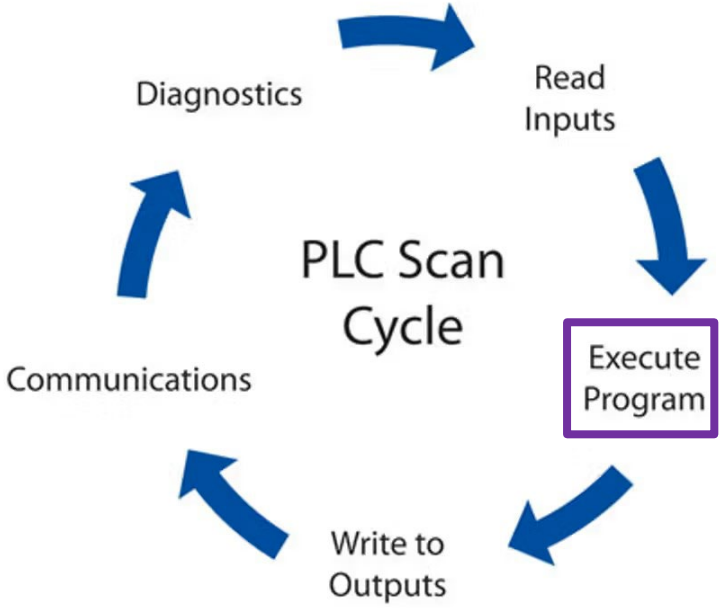
Read Inputs

- PLC reads any inputs from sensors using the input module
- It then stores the values in the RAM in an image table
- This allows the PLC to keep track of the input values
- As this happens once its equivalent to a “snapshot” meaning the input values wont change mid scan



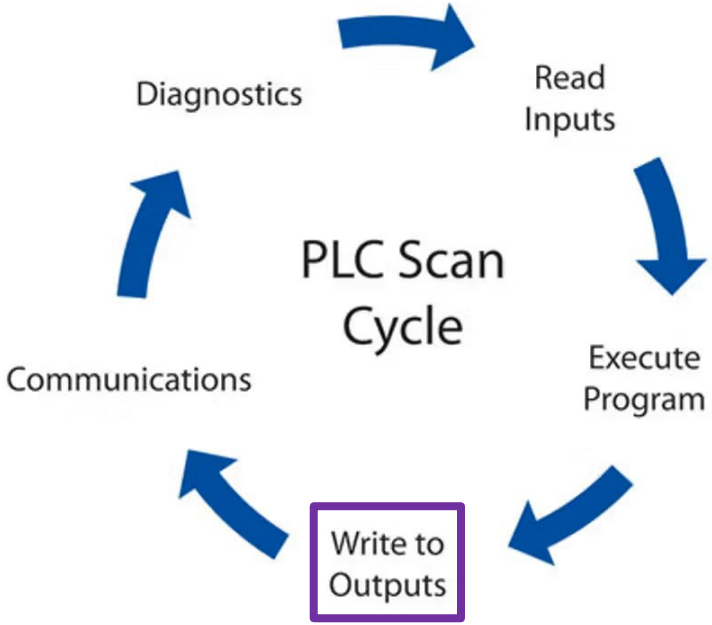
Execute Program

- The CPU runs one full run through of the programmed logic
- It uses the values from the input scan
- It then stores outputs into the RAM image table



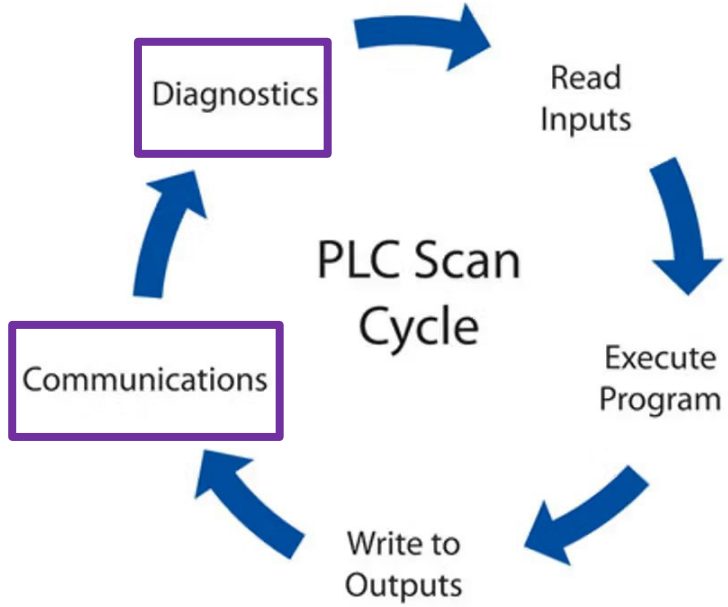
Write to Outputs

- The output module updates the external components based on the values in the output image table
- These outputs stay the same till the next scan cycle



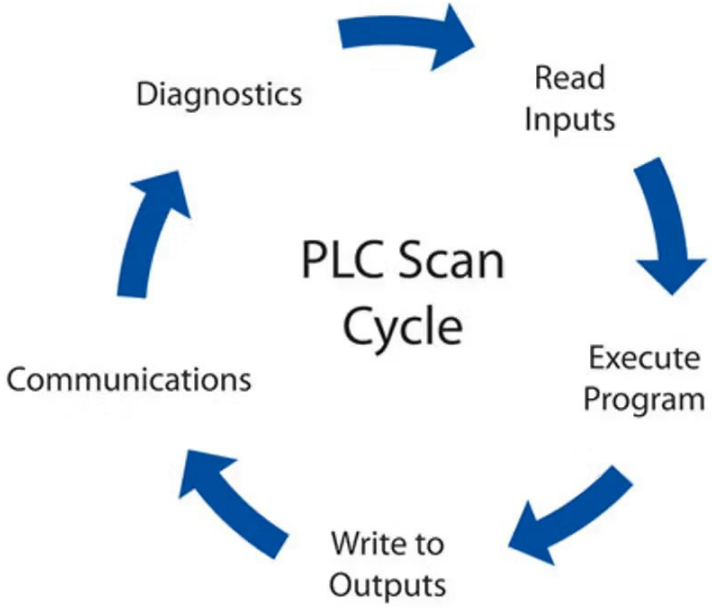
Housekeeping

- Housekeeping is the general term for the steps of Diagnostic and communications
- During this step the PLC communicates any updates to any external sources including HMIs, other PLCs and Programmers
- PLC does self diagnostics to ensure everything is going well and nothing has broken
- The PLC also updates internal counters and timers



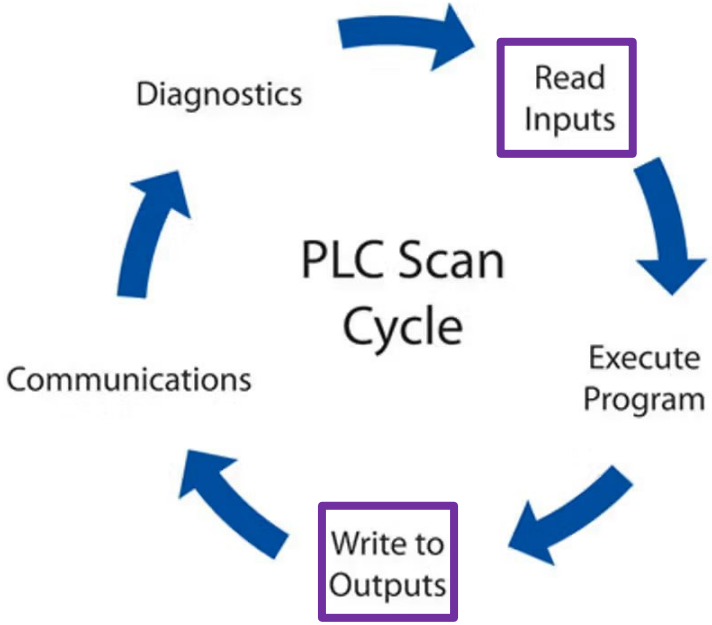
Scan Cycle Time

- Several things effect the time it takes for a Scan Cycle
  - I/O
  - Logic Complexity
  - Processing Power
  - Time dependant components
  - Communication overhead



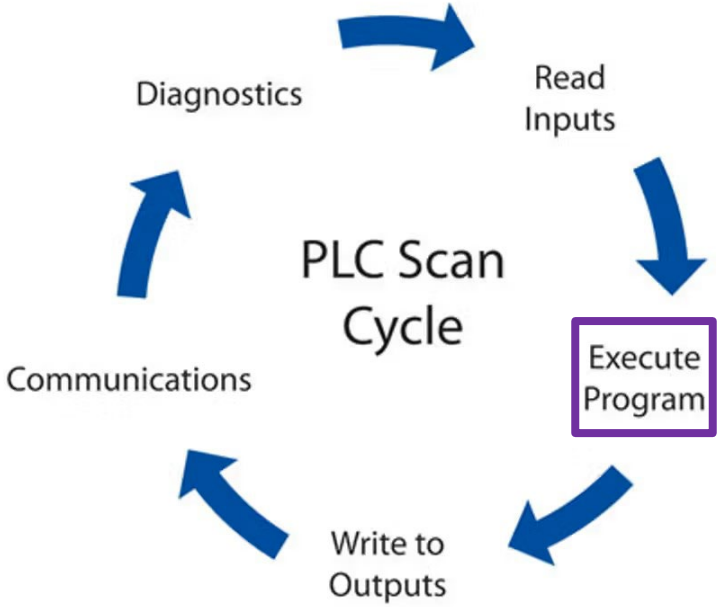
Scan Cycle Time (IO)

- The number of IO devices you have effects the scan time (more devices = longer scan time)
- The type of inputs effects scan times as well (analogue devices often take longer)
- These effect the input and output parts of the scan cycle



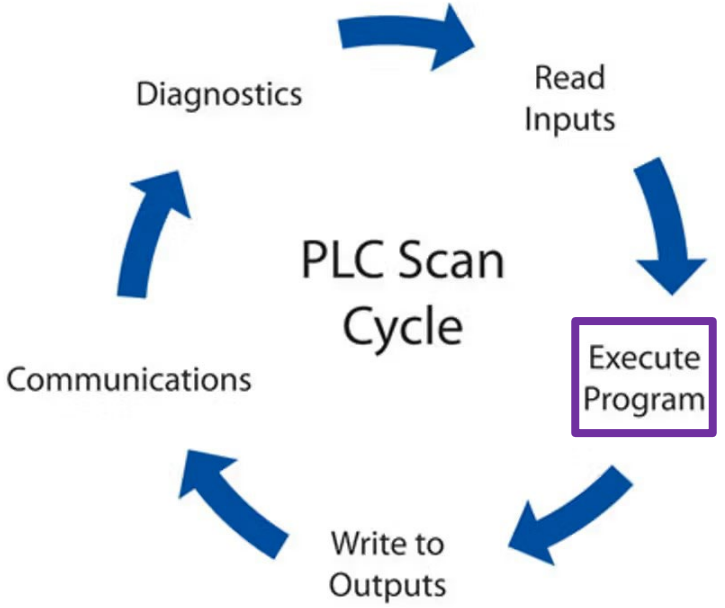
Scan Cycle Time (Complexity)

- The complexity of the user programmed logic will drastically effect scan time
- More instructions = longer scan times
- Heavy use of math operations and loops will increase time as they're harder to run
- They effect the execute part of the scan cycle



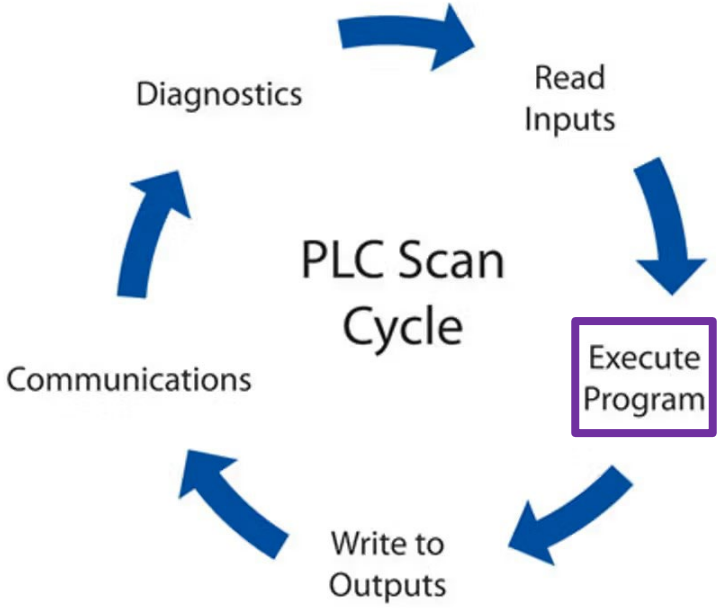
Scan Cycle Time (Processing Power)

- The amount of processing power drastically effects the speed of the scan cycle
- Lower powered CPUs will result in a slower cycle
- In general, the older a CPU the less processing power it will have
- Mostly effects the execute part of the scan cycle however does have a small effect over the whole cycle



Scan Cycle Time (Time dependant)

- Components like Timers, Counters and communication blocks will take more CPU cycles
- This means using these components too much will slow down the scan cycle
- This effects the execute part of the cycle



Scan Cycle Time (Communication)

- Plugging in external devices which the PLC must communicate with will slow the cycle drastically
- This is because it takes time for the PLC to send messages to and from the external device
- This of course effects the House Keeping (communications) part of the cycle