VN Machine

PC → MAR → M → I/O Controller → (keyboard) Input → Output

IR → Decoder → MDR → ALU → A → I/O Controller → (screen) Output

Decoder
Instructions

IN  <DEVICE>
OUT <DEVICE>

Example:
IN  <KEYBOARD>
OUT <SCREEN>
The CPU is idle during I/O. Process P1 is waiting on I/O.
Layout of Drive, Controller and CPU
Disk Layout

When Moving from track to track on the disk we encounter a delay called "seek time".
I/O Optimization

We can minimize the effect of seek time by reordering the I/O requests.
I/O operations from program to hardware

Program
  ...
  ...
  ...
  Read(a)
  ...
  End

Compilation

Object(exe)
  ...
  ...
  ...
  DOIO(#bytes, mem_addr, disk_addr,...)
  ...
  ...

DOIO
build IORB
tell handler there is a new IORB

IO Handler Waiting for IORB

IO complete

Initiate physical IO

Device

IO operation
The I/O handler is used to reorder this queue because it knows more information about the physical characteristics of the I/O device than does to DOIO() OS routine.
I/O Device

Status: Tests to see if device is busy.

Buffer has to be large for DMA (Direct Memory Access).
Memory as Buffer

I/O Device writes to memory.
*Each device has its own characteristics. (Ex. Seek Time)*