

## Assignment 1

Due: September 22<sup>nd</sup>, 11:59 pm  
Weight: 10% of total class grade

### Overview

In this assignment, students will code a model of a system clock, memory, and the fetch instruction cycle of a CPU. These models will be driven by a command parser reading data file containing commands. The parser will read each line, parse the command, and apply it to the appropriate device. The device will execute the command by emulating the appropriate behavior.

### Program Execution

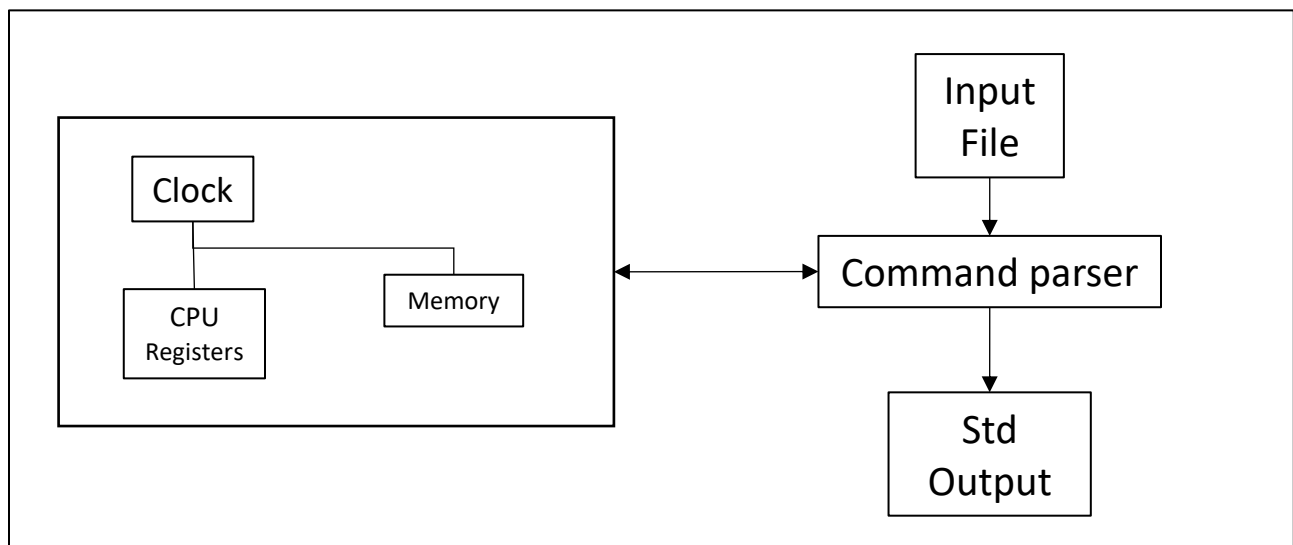
```
cs3421_emul <data_file>
```

### Input Details

The cs3421\_emul program reads an arbitrary number of lines, one line at a time from the data file. Each line will begin with a device identifier. The format of the rest of the line will be device dependent. For this assignment, possible devices are “clock”, “cpu”, and “memory”. For example:

```
clock reset
memory create 0x10000
memory reset
memory set 0x0 0x8 0x08 0x07 0x06 0x05 0x04 0x03 0x02 0x01
cpu reset
clock tick 8
cpu dump
```

### Devices



### Clock

The clock device is the heart of the system, providing synchronization between all other devices. On command, it provides a “tick pulse” to all other devices that need a clock. For diagnostic purposes, the clock will maintain a monotonically increasing unsigned 16 bit count that can be displayed.

#### *Clock commands:*

reset

The reset command sets the internal counter to zero. Example: “clock reset”.

tick <decimal integer>

The tick command accepts a positive decimal integer indicating how many clock ticks should be issued to attached devices. The internal counter is incremented by the specified number of ticks.

dump

The dump command shows “Clock: “ followed by the value of the internal clock in decimal.

Example: “clock dump” would show:

Clock: 148

## Memory

The memory device provides storage for the system. Prior to use, it must be created with the “create” command, which specifies the size in bytes. At that point, memory is in an undefined condition. The “reset” command is used to initialize all of memory to zeros. The contents of memory can be displayed via the “dump” command, and assigned with the “set” command.

### Memory commands:

create <size in hex bytes>

The “create” command accepts a single integer parameter which indicates the size of the memory in bytes. Example: “memory create 0x10000”.

reset

The “reset” command causes all of the allocated memory to be set to zero. Example: “memory reset”.

dump <hex address> <hex count>

The dump command shows the contents of memory starting at address <address>, and continuing for <count> bytes. The output should begin with a header showing “Addr”, 3 spaces, and then 00-0F with a single space between each. Subsequent lines are formatted such that each line begins with a 16 bit address (0x and 4 digit upper case hex characters) that is an even multiple of 16, followed by a single space. Following that, up to 16 bytes of data, in 2 digit upper case hex is printed. If the address is not a multiple of 16, blank spaces should be printed until the address is reached. Example: “memory dump 0x1A04 0x20”

```
Addr   00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
0x1A00          11 44 23 93 50 22 AE DE AD BE EF FF
0x1A10 AE DE AD C0 DE FA CE FE ED CA FE BE EF 30 A8 EE
0x1020 55 AA 10 20
```

set <hex address> <hex count> <hex byte 1> <hex byte 2> ... <hex byte N>

The set commands initialized memory locations to a user supplied set of values. The “hex address” specifies where to begin setting memory values, “hex count” is how many bytes will be assigned, and is followed by “hex count” number of hex bytes, separated by a single space. For this assignment, the command will never be used with more than 4096 hex bytes. Example: “memory set 0xABCD 0x05 0x08 0xDE 0xAD 0xBE 0xEF”

set <hex address> file <datafile>

This set command variant is the same as above, except the data is contained in a file. The file must contain a set of hex byte values separated by a single space. The count is determined by the number of entries. Example: “memory set 0x20 file /my/data/file”.

## CPU

The CPU device has 8 one byte data registers labeled RA through RH. The CPU also has a 1 byte program counter (PC) that holds the address in memory of the next CPU instruction to fetch. For this assignment, CPU instructions will simply be 1 byte of data. On each clock cycle, the CPU will shift the contents of each register to the next higher register, such that RH receives the content of RG, RG receives what is in RF, and so on, until finally, RB receives RA. The CPU will then fetch the byte from memory pointed to by the PC, place it into RA, and increment the PC by 1.

### CPU commands:

reset

The “reset” command causes all CPU registers to be zero. Example: “cpu reset”.

set reg <reg> <hex byte>

The “set reg” command sets the value of the specified CPU register. The “reg” parameter can be the value RA-RH, or PC for the program counter. Example: “cpu set reg RE 0xAA”.

dump

The “dump” command shows the value of all of the CPU registers. A sample output would be as follows:

PC: 0xAA  
RA: 0x23  
RB: 0x14  
RC: 0xFF  
RD: 0x44  
RE: 0xAA  
RF: 0x00  
RG: 0x09  
RH: 0x18

## Language

The developer may use either Java or C/C++.

## Submission Details

Submission will be via Canvas. File format details will be made available in class, and this assignment will be updated when they are available.

## Grading

Programs will be primarily graded on the correctness of the output. Given the large number of submissions, the evaluation of the output will be automated. This means it is **CRITICAL** to follow the sample output above. Sample data & output will also be provided to test your programs. The assignment grade may also be based on style, comments, etc. Programs that crash, fail to produce the correct output, or don't compile/run may lose up to 100% of the points, depending upon severity of the

error. Some effort may be made during grading to correct errors, but students should not depend upon this. For grading, programs will be compiled and run on Ubuntu Linux 18.04 LTS.