**ADD HACK EXPLANATION:**

**0000000000000010**

As the opcode (the first bit) is 0, this is an A instruction. The symbolic syntax is @value. So the given instruction can be expressed as @2. The A-register is set to 2. This is done by setting the load bit (the control bit) in the A register to 1. The A-register puts 2 to the address bus. This is used to access RAM[2]. The value of RAM[2] is put in to the data bus and is output as the M register (M input).

**1110110000010000**

As the first opcode (the first bit) is 1, this is a C instruction. The symbolic syntax is D=A, so the given instruction can be expressed as D=2. The C-register is set to D=2. This is done by setting the binary, 2 X components, C1, C2 and dest2 components to 1. The register replaces D as 2 to the address bus.

**0000000000000011**

As the opcode (the first bit) is 0, this is an A instruction. The symbolic syntax is @value. So the given instruction can be expressed as @3. The A-register is set to 3. This is done by setting the load bit, j2 and j3 to one. The A-register puts 3 to the address bus. This is used to access RAM[3]. The value of RAM[3] is put in to the data bus and is output as the M register (M input).

**1110000010010000**

As the first opcode (the first bit) is 1, this is a C instruction. The symbolic syntax is D, so the given instruction can be expressed as D=D+A. The C-register is set to D=D+A. This is done by setting the isC, 2 X components, c5 and d1 dest to 1. The C register puts D+A to the address bus.

**0000000000000000**

As the opcode (the first bit) is 0, this is an A instruction. The symbolic syntax is @value. So the given instruction can be expressed as @0. The A-register is set to 0. This is done by setting all components to 0. The A-register puts 0 to the address bus. This is used to access RAM[0]. The value of RAM[0] is put in to the data bus and is output as the M register (M input).

**1110001100001000**

As the first opcode (the first bit) is 1, this is a C instruction. The symbolic syntax is M, so the given instruction can be expressed as M=D. The C-register is set to M=D. This is done by setting the isC, 2 X components, c3, c4 and d3 to value of 1. The C-register puts M=D to the address bus.

**Computer Add, Computer Rect and Computer Max:**

**The abstraction of CPU memory consist of 3 logical segments**

1. Address 0 to 16383: data memory
2. Address 16384 to 24575: screen memory map
3. Address 24576: keyboard memory map

The computer add register only consist of data memory addresses, which are values between 0-16383. Whereas the computer max consist of values ranging from data memory to keyboard memory map. While the Computer Rect had values ranging from data memory to screen memory map. The 3 abstractions are functions of the 3 CPU memories which are data, screen map and keyboard map memory.

Computer Add: Data Memory

We start from data memory and then we work on instructions by instructions. The Computer Add is the basis of the CPU system, where the data are shared. It consist of 3 chips: The RAM16K, Screen and keyboard. Basically, we made it run 6 times as there are 6 variables to run to prove its success. The time is 0-15, with 1 reset

Computer Rect: Screen Memory Map

We move on to the screen memory map, which consist of the program and data of the CPU, which will then be used to combine and create the computer system

Computer Max: Keyboard Memory Map

Finally it will be the keyboard memory map, which consist of the main building blacks, like the input/output, memory, program + data, CPU and ALU + registers.

The memory is designed based on the stored program. Designed to store instructions which will be executed by the CPU one by one. There are 3 types of information that we are interested in, which are data, addresses and controlled information. The information is implemented by set of wires named “bus”. The ALU should know what operation to perform. It requires control information as inputs. ALU informs other building block what to do based on the result of the operation. Provide control information as output. Should be connected to the data bus.