Modifications Made to the ATHENA Computer

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The Univac ATHENA (used for Titan 1 missle guidance) is a small
general purpose digital computer given to the school in 1966.
Due to the computers age (designed in 1959) and intended use as a
secure military control unit, there were many limitations which
prevented its use as an effective and efficient tool for
instruction or research.

As designed there were only 256 24 bit words of magnetic core
storage which store temporary quantities generated by a program.
All instructions were stored on drum (8192 words) and executed
from the drum. There were no instructions which allowed reading
or writing on the drum. The drum was initially loaded by manually
going into Load Program or Manual Load modes. In Load Program
a high speed 7 level paper tape reader is used to dump a program
from the tape onto the drum. In Manual Load instructions can be
loaded by hand one at a time. All program input came from a radar
set and output went to the guidance equipment or to a small adding
machine used as a printer. The only part of the IO setup that came
with the computer was the adding machine.

Some of the limitations:

1. Storage – only 256 words.

2. Not being able to read or write prevents having subroutines, using the drum for additional storage to supplement core , and having programs that can modify themself or other programs.

3. Loading a program is very difficult because there was no punch with the unit and 7 level is not standard (teletype punches are 8 level).

4. There is no way of entering information into a program.

5. The adding machine is very slow and prints only numeric characters.

6. There is no way of saving a program i.e. punching it on paper tape.

In an effort to remedy many of these limitations the following modifications have been made.

1. A. Added an Indirect Unconditional Jump. Jump to the drum location whose address is stored in the core address specified in this instruction.
    B. Added an instruction which allows the Program Address Register(it contains the address of the next instruction to be executed) to be loaded into the Accumulator.

    These two instructions were added mainly because the micro commands were needed for Drum Read-Write and it was easy to make them into separate commands. They can be used for some types of subroutines.

2. A typewriter was installed to expand the output and provide an input device.

3. A form of Indirect Addressing was added. It was discovered to be very difficult to use the newly installed typewriter because there was no easy way of accessing large numbers of core locations without having an instruction per location to be accessed. Indirect Addressing solved this problem.

4. Added the two commands Drum Read and Drum Write. A special
    drum protect feature was also installed to keep one program
    from accidentally destroying another. The drum is divided
    in half with the lower half prevented from writing on the
    upper half. A program in the upper half can write anywhere
    on the drum. The idea is that system programs (fully debugged
    programs like general purpose subroutines,input-output
    routines, etc.) will be kept in the upper half and programs
    being worked on will be in the lower half.

5. A 7 level punch was salvaged from an old Digital Differential
    Analyzer, converted,and installed on the ATHENA as an output
    device. Programs can now be dumped from the drum on to paper
    tape for storage and later read in on the high speed paper
    tape readers. Programs can also be punched off line by hand.

6. A Jump to Subroutine command has been added. This makes it
    very easy to use subroutines.

7. A clear Accumulator and an Exclusive Or were added. Previously
    to clear the Accumulator a zero had to be stored in core and
    then loaded into the Accumulator.

With the modifications made so far and the ones to come the
ATHENA should now be able to move from just taking up space
in the E.E. building to being a useful instructional tool.
It is doubtful that the ATHENA could be used as an effective
research computer with its present dependence on a drum a
relatively low speed storage device (even moving at12,000 rpm).
Until more core is added and the execution of instructions
occurs from core,the main use I see for the ATHENA is for
instructional purposes. (I presently have 8   4096 7bit core
units that will be installed when I have the time and figure
out the wiring.) I feel that a computer that students can program,
run, and modify would be of great assistance in teaching them
the fundamentals of computer design. There are several PDP-8's
on campus that could serve the same purpose but these are tied
up with various projects. Taking a digital design course one may
learn about the PDP-8 and write machine code programs but must
run them on the Univac 1108. This does not really give the student
the contact he needs.with the machine. If one were going to be
a programmer then that is all the contact one needs but if one
intends to design computer systems the machine is the important
part.