1-1966

The Memory Unit of a Digital Computer

Bobby Ridgell

Ouachita Baptist University

THE MEMORY UNIT OF A DIGITAL COMPUTER

by

Bobby Ridgell

H71, Honors Seminar

January 10, 1966

#12

THE MEMORY UNIT OF A DIGITAL COMPUTER

Since the development of the first modern digital computer in August 1944, the digital computer has become one of the most essential machines of the modern day. According to Edmund Berkeley and Lawrence Wainwright it is one of two events by which the twentieth century will be remembered. This development has also led to what has been called the Second Industrial Revolution.[1] That so much importance should be placed on one development is extraordinary, but the far reaching effects of the digital computer are also extraordinary.

Computers are defined as "devices which accept information, perform mathematical or logical operations with the information, and then supply the results of these operation as new information."[2] In a digital computer information required for problem solving as well as the instructions for carrying out the required operations are stored in the memory unit. The memory unit is also made up of an address selector which chooses the location for data to be written in or read out and read and write circuits which perform

---

[1]Edmund Berkeley and Lawrence Wainwright, Computers- Their Operation and Application, (New York, 1956), p. 3.

[2]Vinscent S. Darnowski, Computers- Theory and Uses, (Washington, 1964), p. 3.

the actual reading and writing of information.[3] Their is no one system of storage best for all types of computers and the choice depends on the space available and the desired speed.

Since the development of the Harvard IBM Automatic Sequence Controlled Calculator which was the first digital computer, one of the two main development has been, "the recording of information in new physical mediums, of which perhaps the most far-reaching consists of polarized spots on a magnetic surface."[4] The principal of polarized spots is utilized in both the magnetic drum and the magnetic tape storage systems. Both systems have the characteristics of a large storage capacity for reasonably compact size and the ability to allow information to be read out without losing that information. The magnetic tape has an advantage over the drum in that interchangeable tape may be used in a computer and thus make available an unlimited source of information. The magnetic drum's main advantage is in the speed of the read out operation. This access time is never longer than the time required for one revolution of the drum whereas the magnetic tape may have to go to the end of the tape for the desired information.

The principal of the magnetic tape and drum storage is the same as that of the regular tape recorder and is simpler in that distortion of the input signal is of no significance since

---

[3]Paul Seigel, Understanding Digital Computers, (New York, 1961), p. 21.

[4]Berkeley and Wainwright, p.25.

only a on or off signal is recorded. The magnetic tape computer storage is more complex because of the high speeds , rapid starts, rapid stops, and reverses. Recording is accomplished by sending a pulse current through the energizing coil of a recording head which has a very narrow gap in the pole-pieces across which is drawn the magnetically coated tape. A multi-track tape is feasible because the pole-pieces of the recording head may be arranged so that the flux of the magnetic dipole induced in the coating runs the length of the tape and not the width. Only a off or on may be recorded or a "0" and "1" as it is more commonly referred to since a binary number system is used in digital computers. The difference in the o and 1 being in the direction the current is sent through the energizing coil, the flux of the recorded dipole will be opposite of the o for the 1. Reading out is carried out by drawing the magnetized tape across the pole-pieces of the recording head. The direction of the induced voltage is noted to determine whether a o or 1 was recorded.[5]

The only difference between the magnetic tape and the magnetic drum is in the physical setup of the system since both use the polarized spot. The magnetic drum system consists of a nonmagnetic metal drum which is coated with a magnetic material. The recording heads are arranged to give several hundred parallel tracks each of a small width but the entire

---

[5] T. E. Ivall, Electronic Computers, (New York, 1956), p. 141-143.

circumference of the drum and the drum is rotated at an average speed of from 3,000 to 6,000 revolutions per minutes. One track of the drum is usually utilized as an indicator. Address symbols are recorded on the indicator track at regular angular intervals corresponding to the division of the track into registers. To read out a particular bit of information, the coded signal indicates which track or read out head the information is in and then the proper register.[6]

A storage system which is newer than either the magnetic tape or drum but which is very widely used is the coincident current magnetic core matrix. The system consists of a number of small magnetic cores arranged in a definite pattern. The cores are arranged in rows and columns with a wire passing through each core in a row and a wire passing through each core in a column. The result is a networkof squares with a magnetic core at every intersection of two wires. There is also a wire interlaced through the pattern so that it passes through each core but the order is of no importance. A bit of information is stored in a particular core by passing a current through the two wires that intersect at that particular core. The current of course goes through each core in the row and column of that particular core where information is to be stored so only half enough current to magnetize a core is sent through each wire. The result of this procedure is that only where the wires cross is there enough current to magnetize the

---

[6] Ivall, p. 144-147.

core. A "1" is usually recorded by sending a current through the wires from the left and top while the "0" is recorded from the right and bottom if the matrix is standing upright.[7]

The cores are constructed of a materal which exhibits a nearly square hysteresis loop on a graph of magnetic flux against magnetic field strength. The material used is usually ferrite. If the core is magnetized to saturation in one direction by sending a pulse of current through a winding, the magnetization will remain at least at 90% of the maximum flux density when the current is stopped, therefore the information has been recorded.

If a current pulse is now passed through the core from the opposite direction the magnetic flux will decrease slowly at first then will drop suddenly go to saturation in the opposite direction. This is used to change the stored information and this in turn is the way information is read out of the core. "If a particular core is in the "1" state the application of coincident read-out pulses of, say, "0" direction to its two intersecting wires causes the core to be switched over. The resultant large change of flux induces a voltage pulse in the output wire which threads all the cores. The presence of this output pulse indicates that a "1" was stored. If, on the other hand, the core had been in the "0" state, the application of the "0" read-out pulse would have made no real difference to it. There would have been no large change of flux and no voltage pulse induced in the output wire-thereby indicating that a

---

[7]Ivall, p.137-141.

"0" was stored."[8]

A storage system of lesser importance since the development of the magnetic core is the electrostatic memory where electrostatic charges of two different kinds may be maintained on a surface. A cathode-ray tube may be used for this purpose. Information is stored by the present or absence of an electrostatic charge on a particular small spot. [9]

A final storage system which was used in the Univac I but which was replaced by magnetic cores in Univac II is the delay line storage. The Univac I computer had a memory consisting of seven tanks of mercury. Each tank had eighteen paths along which a pattern of pulses could be remembered as a circulating train of waves. The system operates much like an echo in the air only using waves in mercury. A wave issued from the far end of the line is detected, amplied, reshaped, and reinserted into the beginning of the line so that the whole train of waves with its pattern of presence and absence of pulses will circulate indefinitely until either the power ceases or a new pattern of pulses is inserted.[10]

Each of the discussed storage systems has advantages and disadvantages in the computer they are used in, the success and versatility of the digital computer however may depend largely on how advanced the memory unit becomes and how well these systems may be used together.

---

[8] Ivall, p. 138.

[9] Berkeley and Wainwright, p.34.

[10] Berkeley and Wainwright, p.35 and p.215.

BIBLIOGRAPHY

Berkeley, Edmund Callis and Lawrence Wainwright. Computers- Their Operation and A pplications. New York: Reinhold Publishing Corporation, 1956.

Darnowski, Vincent S. Computers- Theory and Uses. Edited by Hugh Allen, Jr. Washington: National Education Association, 1964.

Ivall, T. E. Electronic Computers. New York: Philosophical Library, 1956.

Seigel, Paul. Understanding Digital Computers. New York: John Wiley and Sons, Inc., 1961.