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MINICOMPUTER ARCHITECTURE, DESCRIPTION AND DESIGN

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ANCESTRY

Minicomputer ancestry began with the first operating, stored program computer, the Cambridge University, EDSAC.[1] EDSAC was in contrast to the larger word, multiple address computers built in the early 50's. Aerospace control computers of the early 1960's have also been claimed to be antecedants. Minicomputers (for minimal computers) are a state of mind; the current logic technology, the characteristics found in larger computers, are combined into a package which has the smallest cost.[2] Almost the sole design goal is to make the cost low; usually the performance/cost ratio derivative must be positive (and large) for the incremental additions beyond the minimal structure. Alternatively stated: the hardware-software tradeoffs for minicomputer design have, in the past, favored software. (A recent trend, with computer families would allow the user to make the tradeoff.)

Recently users (or their equipment) want dedicated, direct access to computers with a small cost relative to equipment and people.

HARDWARE CHARACTERISTICS

Minicomputer may be classified at least two ways:

1. It is the minimum computer (or very near it) that can be built with the state of the art technology.

2. It is that computer that can be purchased for a given, relatively minimal, fixed cost (e.g., $10K in 1970).

The first definition would probably preclude hard-wired floating point arithmetic from being part of a minicomputer, while the second definition would convey the attitude of the larger general purpose computer.

Several dimensions of a computer space (Figure 1) characterize today's minicomputers. The dimension values are: a cost of four to eight 1971 kilodollars; a 12 to 16 bit word length (as measured between the processor and primary memory); a 4 minimum Kword memory with addressing capability to 32 or 65 Kwords; and a processor state of about four words (program counter, accumulator, accumulator extension, and possibly an index register).

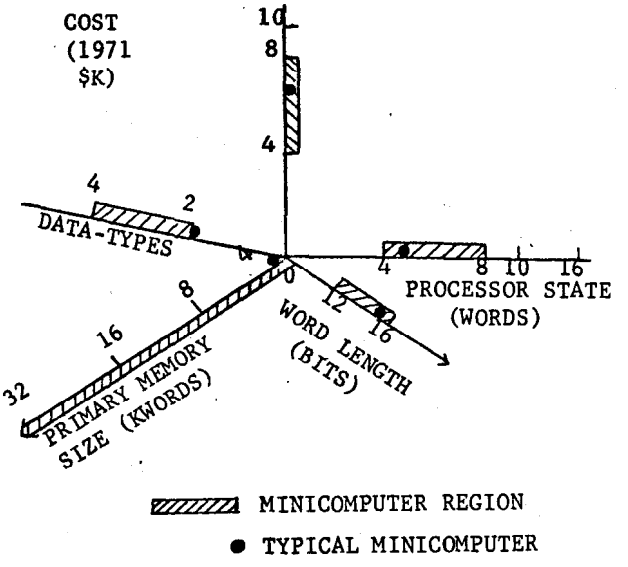

FIGURE 1. SOME COMPUTER SPACE DIMENSIONS

The common characteristics for nearly all 1971 technology computers are: small to medium scale integrated circuitry; core primary memory - with MOS memories likely to be delivered during the year; memory cycle times of .7 to 2 microseconds with correspondingly fast processor times; internal clock rates of 5 to 10 mhz; and uni-processor structures.

Characteristics less easily defined are the processor's data types. Initially, one word integers and one word boolean vectors (usually called logical words) were available. Vectors and character strings are accessible indirectly via index registers. Data types for byte and double word integers are now common; and floating point will undoubtedly be added.

Many attributes have been acquired from larger computers (see Table 1). These are adopted either of necessity (e.g., interrupts and some form of base addressing) or of utility (e.g., index registers, general registers and specialized processors). If a feature on a large machine enables it to perform well, the minicomputer will adapt it.

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[1] 17 bit; two's complement arithmetic; 1024 word primary memory; (eventually one index register after they were invented); one accumulator with extension and 32 instructions.

[2] As opposed to larger general purpose computers that are: given a cost, then fill cabinets to meet the cost; given the technology, maximize performance with no cost constraints.

Table 1. Characteristics derived from larger computers

Internal central processor
indirect addressing; interrupts; index registers; multiple, general purpose registers; base and/or page addressing; floating point data-types*; paging, segmentation, and interprocess communication*

Structural
specialized processors; multiprocessors*

Implementation
microprogramming*; lookahead*; cache*;

Software
compilers: Fortran; time-sharing monitors*

*not extensively used, but use likely to increase

EFFECT ON OTHER COMPUTERS

The above parasitic view is hardly fair. The principle minicomputer effect has been to provide more people with access to computers.

A computer myth that peripheral equipment costs are constant at about 25 to 50 kilodollars for any kind of peripheral (e.g., card reader, card punch, line printer, magnetic tape, or disk drive) is now being destroyed. The minicomputer industry has at last challenged this, and costs are decreasing by an order of magnitude (two factors: a large number of computers hence a large market, and emphasis due to the relatively high cost of the peripheral).

FUTURE

The most likely extrapolation is to look at large computers, take their features (see Table 1) and predict they will be incorporated into minicomputers. More data-types, schemes for memory paging and segmentation will exist in tomorrow's minicomputer to provide better performance and allow larger programs to be run.

The technique of microprogramming favors high production (hence minicomputers) because the setup costs of the memory are high. Thus, minicomputers can build in extra features at a low production cost.

The LSI technology is well suited to the minicomputers. For the first time, the cost of primary (and some secondary memory) is constant, independent of the size. In fact, as large primary memories are built, the cost increases because more switching is necessary, and because increased delays require more processor logic to overcome the larger memory delays. The first computer deliveries, with MOS read-write memories, are in minicomputers.

[1] Assumes: several languages, e.g., an assembler, Algol, BASIC, Fortran, LISP; editors; and file management.

APPLICATIONS

Table 2 gives the common uses of minicomputers. These are associated with the word minicomputer because they imply dedicatedness to specific tasks. Other applications are interesting because they cause us to question whether the relatively large general purpose computer may take on the role of the dinosaur - just large enough to support its own operating system.

Table 2. Characteristics generic to minicomputers

Internal central processor
base addressing; adequate interrupt response time; power on-off interrupt

Structural
very little hard copy i/o, secondary memory; obvious structure (allowing easy interfacing); direct memory access

Uses (dedicated)
control (e.g., plant, instrument); communications (e.g., message switch); larger computer (e.g., terminals, files, hard copy)

Software
small general purpose monitor; languages: primitive assembler, BASIC, Fortran; specialized dedicated use packages (e.g., typesetting, instrument, testing, process)

Through their use in communications for message switching more processing can take place within the message switching network and need never be referred to a large computer. For example, up to 64 minicomputers are used as the terminal, file, and monitor control computers in the very large, array processing CDC STAR. Here, the operating system is distributed throughout the minicomputers as opposed to being built as a large monolith in the central computer.

Timesharing has provided an order of magnitude decrease in the per terminal cost of computing. A $50K minicomputer system will serve about 16 on line users[1], whereas about $500K is the cheapest, large, general purpose system. A large, timeshared computer has a per console capital equipment cost of $50K; a well configured $50K minicomputer could provide more power, better reliability, flexibility and modularity.

A program written for a minicomputer came in second in the ACM computer chess tournament. We normally think of artificial intelligence applications as requiring high speed and large primary memories. A fast computer with effective management of secondary-primary memory may do just as well.

Minicomputers have been already offered, with tongue-in-cheek, for Christmas. A few minicomputers are used in homes, and with software, a very large number will be soon used in small businesses. Home use will come later.