Reprinted from the *Journal of the Institution of Electronics & Telecom. Engrs.*, 1977 Vol. 24, No. 3 & 4, pp 113-115

Minicomputers and Microprocessors†

(Key-note Address)

S. SRIKANTAN*

The rapid development in the semiconductor components technology in the last decade has great impact on the design, development and production of several types of electronic systems, perhaps with the greatest influence in the field of computers. As a sequel to this phenomenon, the concepts in the design and applications of these components and computer systems built employing them have vastly been changing, mostly so in USA, Europe and Japan. It may be worth-while to consider to what extent Indian environment as of now presents a situation suitable for similar exploitation of the products of the new technology—the minicomputers, microprocessors, other LSI chips etc for applications in our country.

IN the field of minicomputers and microcomputers, several spectacular advances have taken in the seventies. The largest single factor contributing to this has been the dramatic developments in the semiconductor technology leading to the 'processor-on-a-chip'—the so called microprocessors—incorporating large-scale integration techniques.

Since the development of the first microprocessor in 1969 by Intel, these have continued to grow in complexity and performance with the prices continuously declining. Currently, 16-bit microprocessors have become commercially available which are almost as powerful as the minicomputers of just five years back and cost only a fraction.

At the same time, minicomputers have also benefitted from the LSI technology such as bit-slice microprocessors, microprogramming, fast semiconductor storage, etc. resulting in present-day 'superminis' that can outwit midicomputers of yesterday in terms of cost and performance. Thus one sees that while yesterday's minis are chasing the midi- and large computers, today's microcomputers are chasing the minis in turn.

Just like minicomputers in the sixties, the microcomputers too have been instrumental in opening up vast new areas of applications previously not considered viable from economic considerations. Only that in this case, the impact has been far greater with prices as low as $5 that makes it feasible to incorporate the microprocessors even in domestic appliances and other consumer products that are mass produced.

A look at the growth of mini- and microcomputer industry abroad and of the factors responsbile for the same can be helpful in recognizing the problems of achieving growth on similar lines in the Indian context.

HISTORICAL PERSPECTIVE

The first minicomputers had small instruction sets, few internal registers and short word lengths that severely limited the addressable memory capacity. But the introduction of Medium and Large scale Integration techniques permitted continuing design improvements involving large rinstruction sets, more registers, longer word lengths and greater memory capacity.

At the same time, there were several architectural innovations in the design of minicomputers such as microprogramming, hardware memory management techniques, multiport memories, cache buffer storage, multibus and multiprocessor configurations etc.

Simultaneously, there has been a tremendous change in the application concepts of computers in data processing, telecommunications, business management and in utility- and service-oriented industries.

Throughout its history, the minicomputer industry abroad has been marked by the almost continuous introduction of new and improved products at constantly decreasing prices. A prime factor in the price decline is the fact that the minicomputer was a system component and the minicomputer manufacturers had to continuously cut down the prices by adopting improved design and production techniques to prevent the system makers (OEMs) from making minis themselves instead of buying.

Another contributing factor to the all around growth in the popularity of minis has been the tremendous amount of efforts and resources put in by all sections of the scientific and engineering community in the developed countries—the R&D, industry, system houses end-users, etc—to exploit the power of the minis by enhancing the scope of application.

MICROCOMPUTERS

Unlike minicomputer, a microcomputer is designed around a single microprocessor chip that contains all the logic needed for the central processor unit of a general-purpose computer. However, these too require external circuits like read-only and read/write-memory interfaces, and input-output control.

Only recently microprocessor chips have been introduced that incorporate small amount of memory and simple serial Input/Output interfaces in addi-

† Presented at the IETE Mid-Term Symposium on Design and Applications of Computers, held at Hyderabad in Aug. 1977.

* Head, Computer Group, Electronics Corporation of India Ltd., Cherlapalli, Hyderabad 500 762.

8560
780508

tion to the processor logic, in what can be called a rather primitive version of "computer-on-a-chip".

The microcomputers apart from their small size and cost are characterized by limited software and memory capacity and low cost mini-peripherals like cassette, floppy disk, slow-speed printers, etc. The word length that was earlier restricted to 4 or 8 bits has ceased to be a limitation any more with the improvements in technology.

Many minicomputer manufacturers and independent semiconductor houses are presently marketing 12-bit and 16-bit single-chip microprocessors that implement in toto the instruction sets of several earlier popular minis. The initial speed limitations of microcomputers have been largely overcome with the introduction of silicon-on-sapphire and integrated injection logic technologies.

Another distinguishing characteristic of microcomputers is the use of read-only memory for application programming and relatively small amount of read/write memory for variable data storage. This is so because microcomputers find their most prominent usage in a dedicated environment as a component part of instruments, display terminals, numerical control machines, point-of-sale terminals, etc. with programmes fixed once for all.

As of now, application programming is relatively difficult with microcomputers because of the limited software tools and the hardware debugging aids available. End-user must develop their application programme specifically tailored to their requirement using any of the two possible alternatives. They can use special development systems that provide all the features of the *target* microcomputer along with a variety of other supporting features to facilitate the application programme development. Alternatively, the programme can be developed and tested on an existing larger computer system with the help of simulators, cross-assemblers, etc. Once the programmes are thoroughly tested and finalized, these can be converted into a bit pattern mask for using into ROMs by the circuit maker or in some cases by the user himself using PROMs.

Architecturally, the microcomputers provide minicomputer type of instructions but the addressing structure is less flexible. The pin limitations on microprocessor chips enforce predominantly bus-oriented discipline for the external interfaces with a single bus data path shared between memory andInput/ Output. Time-multiplexing of address and data information on a single set of lines is quite common for the same reason, though a notable exception is Intel 8080A. Bus control signals are usually designed to directly connect to the other memory and interfacing support chips from the same manufacturer. The architecture is such as to permit the splitting of programme and data between separate read-only and read/write-memory areas.

Though main impact of microcomputers is in the low-end applications for which minicomputers represent an overkill in either speed or cost, it is possible to divide the constituent tasks of an application among many separate low-cost microcomputers for less than the cost of a single high-performance system. Such configurations of a network of microcomputers are likely to become more and more common in the future.

A significant development in the field of microprocessors has been that of microprogrammable microprocessor bit-slices. These permit a user to define his own instruction set and a microcomputer word-length suitable for his task. However, because of the sophistication and skills required in their usage, their use has been mostly limited as LSI building blocks, by the minicomputer manufacturers for their computer products.

APPLICATIONS

Microcomputer applications will be greatest in intelligent computer terminals and in dedicated data systems. Dedicated applications, of greatest potential being process and numerical control, instrumentation, displays, navigation, terminals, data entry, point-of-sale systems and traffic control. Other applications include computer peripheral device controllers, communications equipment and medical instruments. Microcomputers have been used for controlling the services in buildings, such as, programming elevators, controlling heating and airconditioning, triggering fire-alarm systems etc.

The customers for microcomputers, other than end-users in R&D who are capable of developing their own systems complete with software are manufacturers of mini and large computers, and system manufacturers, systems houses, who were using minicomputers and terminal manufacturers.

CERTAIN OBSERVATIONS

(*i*) The spectacular growth in the computer technology and the extent of its applications witnessed abroad is quite natural. It has been possible because of the similar and parallel developments in the technologies of all other engineering disciplines and the support by way of tremendous investments of resources in R & D on a continuing basis.

(*ii*) The overall outlook, aspirations and values which the societies in the developed world consider as most important are to an extent responsible for the ever-increasing demand for new, sophisticated and quality products and services in the market place, in the scientific, industrial, public utilities, government and in the consumer sectors of the society.

(*iii*) The overall economies in these countries are such that they can safely absorb and support all these high-technology products in large volumes. In fact, this absorption capacity is partly responsible for the

high rates of obsolescence of all type of products in these countries.

(*iv*) Simply stated, spectacular growth in technology and applications is not possible unless the community meant to use the products can absorb the costs and can fully recognize the benefits that can flow in bettering the living standards of the community as a result of improvements in technology and its applications. This recognition will not come without adequate efforts of all communities and unless the values and aspirations of the community in general change.

(*v*) In India, one has to face the fact that there is no integrated and balanced (overall) development in technologies of various disciplines. Technologies in a few disciplines, however much they advance, do not find enough scope for growing over a broad spectrum of applications and so have to put up with a low volume of consumption of their products.

(*vi*) For a high technology product with immense application potential, which the computer is, much needs to be done by agencies other than the manufacturers themselves, to promote translation of its power and flexibility through application studies, and system engineering, as useful user-oriented products and systems, more so because of the great role being played by the 'software' part in computer applications. This activity on the part of equipment manufacturers, the systems houses, software consultancy firms and the educational institutions—unlike in developed countries is very limited in India in scope and extent. This is very true in computer field, owing to the unbalanced mode in which our technological disciplines and industries have grown to date.

Under the circumstances, the understanding of the promises offered by new and advanced technologies in computer field by a small segment of our scientific and industrial communities in our country will become more or less an academic exercise. The means to prove their applicability and utility on a vast scale rest with several other sections of our people to a large extent. However, it may be worthwhile to consider as to what is to be our approach to make large-scale utilization of computer products to benefit our community, in a lasting sense. To me, it appears, that in the given conditions in our country, expanding the scope of applications is required to be done more urgently than chasing technological advances taking place abroad. Our environment, our economies, and our values as of today do not permit the high rates of premature obsolescence in products of this or any field to take place, before their actual usability and utility naturally spreads and expires. This is a reality which we have to face, if we aspire to nurture and grow our technology and industry at a pace which all round developments in the country would permit from time to time.