The IEEE Computer Society's Technical Committee on Minis and Micros presented its first workshop on microcomputer I/O, peripherals, and software October 11 and 12, 1977. Co-sponsored by and held at the Johns Hopkins University Applied Physics Laboratory, the workshop drew approximately 125 members of industry and government. General Chairman was Paul L. Hazan, with Program Chairmen Robert B. McDowell and W. J. Sanda handling the sessions on I/O and peripherals, and software, respectively.

The goals for the workshop were two-fold: (1) to provide a forum for interaction among users, manufacturers, and standards setters, and (2) to provide up-to-the-minute information on products, applications, technical problems, and standards.

To achieve these goals, the workshop was divided into four sessions of papers; each session was followed by a panel with each day concluding with a period of demonstrations of applications and hardware illustrative of the topics presented earlier. Each of the five demonstrations allowed hands-on operation by attendees. The demonstrations were:

1. Interactive personal computer (provided by National Semiconductor).
2. Intellec microcomputer development system (provided by Intel).
3. Universal multi-chip development system (provided by Tektronix).
4. Intellec microcomputer (provided by National Semiconductor).
5. Intellec microcomputer development system (provided by Intel).

A brief welcoming address was given by Dr. Robert P. Rich, Director of the APL Data Processing Center. He emphasized the hope that, with the coming of micros, hardware designers would come closer to understanding the needs of the programmer.

Workshop chairman Hazan, who is also the Computer Society's recently named director for micro and minicomputers, gave the keynote talk. His main thrust was that we are at the beginnings of a new technological revolution, which instead of multiplying man's hands and strength, is multiplying man's minds. This workshop, he said, is an opportunity to have a decisive input to the direction of this new revolution.

McDowell followed up on Hazan's keynote by pointing out that micros are about to become as ubiquitous as electric motors are now. They will, therefore, be built into and interfaced to countless devices in the future. This will make microprocessor I/O a key area in this new technology.

**Summary of technical talks on I/O and peripherals**

Leadoff speaker in the I/O and peripherals portion of the workshop was Kent Simcoe, peripherals market-management manager for Intel. His survey of applications for microprocessor I/O made several key points:

1. I/O devices and peripherals for micros constitute an extremely high growth area, with expectations of $800 million of business in this area by 1981. This is likely to be the biggest segment of the business with CPU's and memory trailing behind.
2. Smart controllers with device densities above 22K per chip will be common and will take over much of the burden now assigned to operating systems and similar software in the CPU.

Following Simcoe was Taylor Scanlon, manager of Microprocessor Support Products Engineering for Motorola. He described the Motorola 3870 single-chip microcomputer which emphasizes I/O capability. Of the 40-pin package 32 pins contain I/O related functions. The device is perhaps a prototype of a trend toward microprocessors that can be used in constructing very smart controllers. Scanlon's talk proved to be a good engineering level example of one of the key points discussed by Simcoe.

The final talk of the morning was given by Gordon Force, engineering manager in the Microprocessor Group at National Semiconductor. Force is also the IEEE subgroup chairman for bus standardization at the card level. The main thrust of his talk was a description of the Microbus, a bus-oriented I/O standard believed by...
National to have widespread application. The standard defines basic programmed I/O exchanges, addressing techniques, interrupt conventions, DMA conventions, and electrical and timing specifications.

In addition to the Microbus, a very good overview of the types of interface devices now available in the industry was presented. Such devices as timers and clocks, analog switches, sample and hold devices, A/D converters, interrupt controllers, DMA controllers, disk formaters/controllers, and CRT controllers were discussed.

The first speaker for the afternoon session was George Clark of NBS, who has been a member of many ANSI and international standards committees over a great many years. This paper was given jointly with Yogi Bakshi of NBS. Clark gave a good overview of the standards that pertain to computer interfaces. Key features of a minimum standard are electrical, mechanical, and functional. However, this complete sort of standard has been difficult to attain, particularly for peripherals because of competitive pressures to deliberately make peripherals different. Nevertheless, in the long run, appropriate standards can promote expansion of the industry if a wide variety of devices can be easily strung together and replaced with updated versions without major interface costs.

The final speaker, Egil Juliussen of TI’s Corporate Engineering Center, dealt with the field of microperipherals, covering the generic aspects and state-of-the-art features. He emphasized storage peripherals and the radical expansion of storage size that will be available by the 1980’s. A considerable amount of the afternoon panel was devoted to follow-up questions on these topics.

Session chairmen for the above papers were Ronald Imbriale, logic development specialist for Tektronix (morning session), and Alan Belli, communication design engineer at Versitron, Inc. (afternoon session). Panelists, in addition to the speakers and session chairmen, were Yogi Bakshi of NBS, Wil Schneider of the Applied Physics Lab, and Hazan.

Panel summary

The two panels covered a broad spectrum of topics:

1. Chip testing and other reliability questions,
2. Programmable interface devices and high level languages,
3. Logic analyzers/development systems,
4. Multicomputer applications for micros,
5. Storage peripherals,

The first panel started off with questions on what to expect in the way of reliability for interface chips and the kind of testing done. Reliability for interface chips and the kind of testing done. Reliability of these chips clearly is not easy to establish and in general is not known. All manufacturers use standard functional tests, generally of a generic sort, not oriented to a particular application, even for the very large customer. Sensitivity testing of every component within a chip would be extremely complex and costly and is not generally practiced. Some consensus developed that testing was essential for the user to perform in terms of his application in addition to the manufacturer’s testing, which does pretty well at finding design and manufacturing faults but does less well catching random, individual chip faults. There was also considerable feeling in the audience and among the manufacturers that there is a legitimate niche for independent test houses for those users that must have the maximum in reliability. In the meantime, the average chip user does not pay for testing that he does not need in the price of the part.

One suggestion was the possibility of achieving more standardized controllers and other I/O devices by leaving many of the parameters up to software implementation. In general, the component manufacturers were unimpressed with this approach, since it meant slower performance. They also did not want to have to support this sort of programming or software, because of potentially increased cost for the basic chip.

This discussion, however, led to a broader area: namely, the use of high-level languages for the microprocessor itself. This topic was of high interest, so despite the digression from the theme of this day’s sessions, this discussion was very animated. Interestingly, Pascal emerged as a serious contender to replace Basic in the eyes of a substantial number of users and most of the manufacturers. Three out of the four manufacturers represented on the panel either had chosen to go with Pascal or were seriously considering it for the main high-level language they would support in the future.

The main reasons for this were its “elegant” notational form, and its completeness in allowing certain low-level functions such as bit manipulation and efficient I/O control. Basic, however, would probably also be supported, at least for microprocessors that were home computer or directly consumer oriented. Fortran, on the other hand, was definitely out of serious consideration for most micros, now and in the foreseeable future.

Also, connected with the language discussion and a major topic of high interest were logic analyzers/simulators/prototypers. Each manufacturer has his own version for his micros. Tektronix has gone a step further by producing a system that is more or less universal, since it allows development using a variety of different micros. In addition, Tektronix has chosen Pascal as a user language, in which the applications programs may be written regardless of which micro is in the development system.

Significant discussion arose relative to the utility of multiple computer architectures since micros are so cheap and small. Suggested applications were

1. Parallel multiprocessors for increased reliability;
2. Parallel processing for increased speed for general purpose uses;
3. Parallel processing for pattern recognition, particularly speech recognition.

The consensus seemed to be that gaining increased reliability by this method was not yet practical because of the large amount of software and possibly specialized interfaces required. It is just now becoming practical in large multi-million dollar systems after more than a decade of software and hardware development. The manufacturers seemed to feel that the best approach currently to system reliability was good chip testing, easy in-system diagnostics, and easy chip or subsystem replacement.

General-purpose parallel processing, however, got a much warmer reception among users and manufacturers as a way of increasing effective speed, extending system capability and even improving reliability in some cases. Pattern recognition seemed a glamorous area to be exploited by parallel processing, but large-scale implementation seems to be in the future.
The point was made that the single most important stumbling block to parallel processing was how to handle timing among a variety of more or less asynchronous functions. This technology is still in an evolutionary phase.

The next topic of discussion was storage peripherals. This generated as much interest as the earlier discussion on high-level languages. It seemed obvious that cheap, high-capacity storage peripherals were in high demand and probably were the single most desired type of peripheral for micros. Floppy disks at present came closest to satisfying this need, but a consensus seemed to indicate that due to the electromechanical nature of the device, radical (order of magnitude) price reductions probably could not be achieved in the near or medium term. However, when strictly solid state devices are considered in the time frame of the early 1980's, it appears feasible for megabit and larger bubble and CCD peripherals to be offered at order-of-magnitude price reductions on a per-bit basis compared to present micro-compatible disks. Ultimately, CCD will probably be the choice for both maximum capacity as well as price, except perhaps where nonvolatile memory is essential; then bubbles probably will be chosen. Bubbles, however, are inherently slower because of their serial nature and more complex control. For these same reasons, bubbles do not seem to be suited as logic units, but confined to use only as memory. Finally, for "cheap and dirty" low performance, but where easily removable media are required, the tape cassette may prove as durable as punched cards have been, especially if the simple I/O functions and data formatting are standardized across the industry.

The final, major topic the panels addressed was I/O standards. Such standards define electrical, mechanical, and functional compatibility, most particularly including data, addressing and command formats; control and data timing and sequences; voltage and logic levels; specific control functions; and mechanical structures such as pin assignments and arrangements, types of connectors, line lengths, etc.

The discussion in this topic area was probably the most detailed of any during the two-day workshop. The need for compatibility in this area was generally agreed to be the foundation on which the future of a truly wide spectrum market for all sorts of microcomputer-related devices depends.

Standards specifically related to micros have not been formally developed. However, such defacto standards as the S-100 bus, along with these already available such as RS 232 will probably form the basis for more specifically micro-oriented I/O standards. Several committees are, in fact, already at work on such standards:

1. ANSI X3T9 on Lower Level Interfaces
2. IEEE Subcommittee on Peripheral-to-Processor Interfaces
3. ISO TC97-SC-13, Working Group 3 on Lower Level Interfaces

Direct inputs to at least the ANSI committees can be made via the chairman. A list of chairmen can be obtained from George Clark, National Bureau of Standards, Washington, D.C.

It was hoped that from the discussion some specific ideas, needs or directions might be convincingly presented from the audience. This did not happen, despite the obvious interest in the topic. However, it did become clear that several standards have come—or are coming—into being, such as S-100, Microbus, IEEE 488, RS422, and 1020. They are rapidly filling the need on an ad hoc basis. Specific inputs from the users have been weak, so in general, the manufacturers have taken the lead in developing standards based on somewhat vaguely perceived user needs.

Interestingly, it emerged from the discussions that considerations within DoD on micro standards are moving at such a slow pace that it appears this segment of the market will have little or no impact on the array of standards that will be in place for the 1980's.

Recommendation for IEEE or NBS

One key point seemed to pervade informal discussions but was not directly addressed by any of the talks or panels: the various I/O standards are not correlated in an easily useable way. It is very difficult to know what standards go together and what standards are intended for mutually exclusive purposes. For instance, it was not generally known that while RS422 is supposed to replace RS232 in many instances, it only provides an electrical transmission standard and does not deal with protocol, mechanical, or other requirements. These will be contained in an RS449 which is not yet out. This type of confusion leads to specifications that are incomplete for a wide variety of equipment and thwarts the purpose of having standards. In addition, many specifications for procurement are written which include one standards document, with the writer apparently unaware that for a complete specification sometimes two or more standards documents are required, plus additional user-defined characteristics to take advantage of options or nonaddressed areas in the standards.

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