or

expand → c

shrink (c) → d

has its exact equivalent in a segment

negation of the first instruction → c

negation of expand (c) → d

and this equivalent is executable as well in two instructions. Thus we can delete the shrink group without a significant loss of program runtime since shrink rarely appears as the first statement in a program. The only disadvantage of this processor is the absence of shrink in any language since the rearrangement shown can hardly be done by a compiler due to its strong side effect.

14. Conclusions

The theory presented here has shown that any instruction of a parallel processor with a given architecture can be expressed as a combination of several elementary operations. If we preserve basic architecture features, various parallel processor designs may differ only in implemented combinations. We cannot discover any essentially new instruction having unexpected effects. Parallel processors designed in agreement with the presented theory differ from CLIP3 only in that they offer a larger set of clear instructions with a comparable hardware complexity.

Of course, one could design processors which provide very large sets of much more complicated combinations than the CLIP3 has. But in the author's experience

1. it is undesirable to create complicated combinations since they lead to obscure, i.e. practically meaningless instructions
2. there is no need to create such instructions since none of them is used so often as to improve the processor performance.

The combinations expand (shrink)—non-interactive operation are easy to implement in any parallel processor in the way shown in the previous section. In the author's opinion such a design represents a balanced compromise between the processor performance and its complexity which must lie within present LSI technology limits.

The next step in development is an extension of a cell processor by a carry bit register and a change of a cell to enable it to operate like a full adder. This would speed up the execution of arithmetic operations by at least a factor of two. This step is necessary since fast arithmetic is needed in many important algorithms.

The questions discussed so far are now practically closed. But there are several quite open problems in increasing parallel processor performance. Not all operations which appear in algorithms can be effectively executed in parallel over a whole image. Many operations are rather serio-parallel in their nature. When they are performed on a CLIP-like machine, 'unemployed' cells idle. This rapidly decreases processor performance. How to remedy that is a goal for further research.

15. Acknowledgments

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Book review

Communication Satellite Systems, by James Martin, 1978; 398 pages. (*Prentice-Hall*, £25·55)

James Martin has an excellent ability to produce readable and informative books on telecommunications and related subjects. There was a time, a few years ago, when I became irritated at each new book having a large overlap with others of his; lately he has overcome this failing.

In this book he addresses in some detail the principles, technology and potential developments of communication satellites. His first part, on the space segment, gives a good grounding on the characteristics of beams and their frequencies, satellite, orbits, the characteristic components, the factors causing satellite failure, transmission losses, noise, characteristic uses of the frequency spectrum and tradeoffs in satellite design. In the second, on the ground segment, similar information is provided on multiplexing, modulation, demand access, transmission errors and problems caused by transit times on interactive computing. He then branches off into the newer fields of burst reservation and contention systems. Finally, he touches briefly on availability, privacy and tradeoffs in systems design.

While not perhaps as easy to read as a novel, the technically minded reader can skim easily straight through the book without pause. At the same time there is a wealth of information included. James Martin has supplied as much detail as most people not specifically concerned with satellite systems design would require. He has provided his book at a particularly appropriate time. The world conference to define frequency allocations is meeting this summer. Both France and West Germany are proposing significant new communications satellite activities—the former like those of SBS in the US. The SBS initiative with small earth terminals is under review in the US. The North Sea oil rig communication requirements are kindling interest in the use of small earth stations there. Several developing countries are also proposing National or Regional satellite systems. In each case, the requirements for data transmission as part of electronic mail, telemetry, business and even home entertainment use is becoming more significant.

I am delighted the book has appeared. I have no hesitation in recommending it as required reading in any third year undergraduate course on data communication and networks—and feel it should have a wide audience.

PETER T. KIRSTEIN (London)