A "BETTER LATE THAN NEVER" SPECIAL REPORT

WORKSHOP ON MODULAR COMPUTER SYSTEMS

The Computer Architecture and Mid-West Area Committees of the IEEE Computer Society co-sponsored a workshop on Modular Computer Systems. The workshop was held at the Clayton Inn in St. Louis, Mo. on December 2 and 3, 1971. There were twenty-three participants registered for the workshop.

Discussion during session 1 revealed that there are presently a rather large number of systems which could be described as modular, particularly at the processor, memory, switch (PMS) level. These systems, including several aerospace computers, are characterized by providing the ability to configure a system with several separate but interconnected processors and memories as the application dictates.

Some attempt was made to predict the organization of the future commercially available systems built around modularity concepts. It was postulated that such systems would contain several small processors, as described above, which would themselves be modular at level dictated by the availability of LSI functional modules. It appears to be impossible to predict at this time just what these modules might be but they would be replicated all through the system to lower system cost. This architecture, featuring many inexpensive processors, would permit individual processors to be idle at times resulting in operating systems of less complexity than those of today. It would also be possible to use modules from several different manufacturers. Finally, such systems will cost much less than today's complex, commercially available systems.

There is another level of modularity available today and is probably best described as the Register Transfer (RT) level as used in a number of computer description languages. In session 2, two such systems were presented. Register Transfer Modules were later characterized as being product oriented and of somewhat limited scope. Mactromodules were described the next day as being an existence proof of the ability to design and construct a complete and useful set of such modules and of having essentially unlimited flexibility. Philosophical discussion seemed to be limited; participants were primarily interested in learning details and questioning the designers with regard to design philosophy and decisions.

An evening session was held at Washington University's Computer Systems Laboratory. Several systems constructed using macromodules and register transfer modules were demonstrated and workshop participants were able to study electrical and mechanical construction details.

Session 3 saw the presentation of theoretical models of asynchronous systems. Participants were particularly interested in how well the models fit existing systems and elucidated possible system difficulties. Some concern was generated over the fact that more than one element sometimes resulted in Petri net constructions of identical form.

The session ended with a lively discussion of the problem of resolving conflicts resulting from the interconnection of unsynchronized systems. The problem was characterized as being of a probabilistic nature with solutions which reduce the probability of such conflicts to one small enough to accept. Several participants described specific instances of troubles they had encountered in actual practice. It appears that the difficulties stem from the arbitrarily long time which may be required for a flip flop to reach its final state if the input signal is a runt pulse. As signal repetition rates increase, the problem occurs more often. A consensus was reached that the problem could become critical as modular systems become more common and attention should be drawn to it.

A brief discussion of the use of the currently available RT level modules in education resulted in some feeling that such modules might not be a good model in a logic design course of the way things actually are today. However, for other courses the situation would be different and these modules would be extremely useful. Also, it was pointed out that the availability of such modules would increase student motivation in design of computer systems.

In session 4, the participants attempted to define modularity in computer systems. No solid definition was possible but it was concluded that such "modules" should be general and be replicated in many places throughout the system. Also, because modules would be described by the input-output parameters, instead of internal implementation, a system might be modular at points where the number of descriptive parameters reach local minima.

It was pointed out that there is a gap between the PMS and RT levels of modularity. There seems to be a prevalent attitude that, at least implicitly, there is such an as yet undefined level. There was considerable confusion on this matter; one camp maintained that there really wasn't such a level, another thought that such a level did exist, and yet another felt that such a level might exist but the module characteristics would depend on the application.

The workshop closed with a discussion of a number of computer system parameters and what effects modularity would have on each. At first it appeared that "programming" would be more difficult for modular hardware but it also seemed possible that it might be made easier if the hardware could be tailored to the application. Performance can be improved by a modular system by having the system organization optimized for the application. However, the modularization might result in decreased performance of the individual modules. Improvement in reliability is often cited as a reason for modularity. However, reliability might suffer, particularly due to increased connections that must be made to connect the modules together.

It was pointed out that modular systems would enable changes in technology to be assimilated into the system without drastic revision. The modularizing process seemed to be a way to look at system modelling and theoretical studies. It was agreed that modular systems would dramatically ease the design process in terms of time and therefore contribute to a lower total system cost. System growth could be evolutionary and controlled because of modularization. Modular computer systems can promote experimentation with a system design and free the designer from committing resources until he is satisfied with the system. This was compared to the concept of delaying variable binding for as long as possible. Finally, it was noted that modular computer systems are ecologically sound because the modules may be re-cycled for use in other systems!

Robert A. Ellis of Washington University, St. Louis, was the workshop chairman.