VLSI AND LARGE SYSTEMS

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Very large scale integration, VLSI, has not invaded the highest performance regime of computation as a component used in large computers. The speed of circuits on VLSI chips has not matched those available at lower levels of integration. The root of the difference is to be found in power; increased in number of components have not been accompanied by a proportionate increase in power per chip. Although the energy dissipated per logic operation has steadily decreased a trade-off between power and speed still exists. Thus the limited ability of technology to remove heat at high density from compact structures implies a lower power dissipation per gate at higher levels of integration and lower speed.

Other requirements of high-performance LSI systems that favor lower levels of integration are:

Long interconnections on VLSI arrays.

Many off-chip connections. The large number of circuits on a chip must have ample communication with the rest of a system.

Good immunity to simultaneous switching disturbance must be insured when using a high I/O count and fast devices.

Means for delivering the high electrical power needed to the chip. This is made difficult by the low-voltage high current characteristics of semiconductor devices and circuits.

The difficulty of meeting all of these requirements is enhanced by the need for dense packaging. Large systems contain many chips. Short delays in transmission of signals from one part of the system to another means that the chips must be packaged closely together.

Recently Tuckerman and Pease at Stanford University have made a major advance in cooling silicon chips. Their method involves etching channels in a chip to transfer heat directly from the chip to flowing water.

This paper explores the implications of the new cooling technique for large systems based on VLSI.