

## 1990s

### **Shift of mainframe CPUs to CMOS**

#### **~ Integrated Circuit ~**

Competition of performance improvement of mainframe computers became increasingly fierce since the 1980s, and the US companies (such as Burroughs, Honeywell, CDC, etc.) not having advanced semiconductor technology development organizations and production lines within the companies dropped out of competition one after another, and three companies which won this competition (IBM in the US, Fujitsu and Hitachi in Japan) continued dead heat over the high-performance mainframe market. The models released by the three companies in 1990 were all water-cooled computers by ECL. With a 0.8 $\mu$ m technology, the chips with high integration density of 10k to 20k gates, speed higher than 100 ps/gate, power consumption of 20 to 30 W were mounted in high density on multiple modules and water-cooled. These three companies' water-cooled bipolar machines could respond to the increasing demand from the major banks and others who required high-speed batch processing of large-scale data, and even after the burst of Japanese economic bubble, the mainframe businesses of Fujitsu and Hitachi were able to maintain reasonable performances.

However, in the technology trend of downsizing and open architecture of computers, with respect to the semiconductor technology to be used in the model to be released five years later (1995), it became a big discussion item in each company whether to select bipolar or CMOS, taking the progress of microfabrication technology and the trend of high speed/high integration of CMOS into consideration.

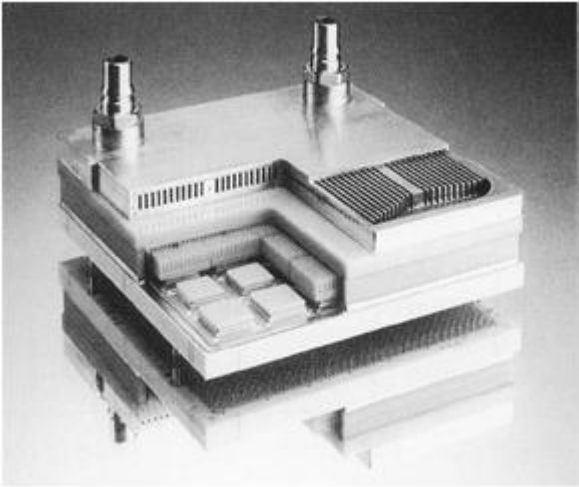
(1) Whether to realize a one-chip processor by applying 0.3 $\mu$ m CMOS and to achieve substantial cost reduction.

(2) Whether to realize one-module processor by the adoption of improved bipolar technology incorporating new idea (in case of Hitachi, on-chip mixed technology of bipolar and CMOS) to achieve higher performance and lower cost.

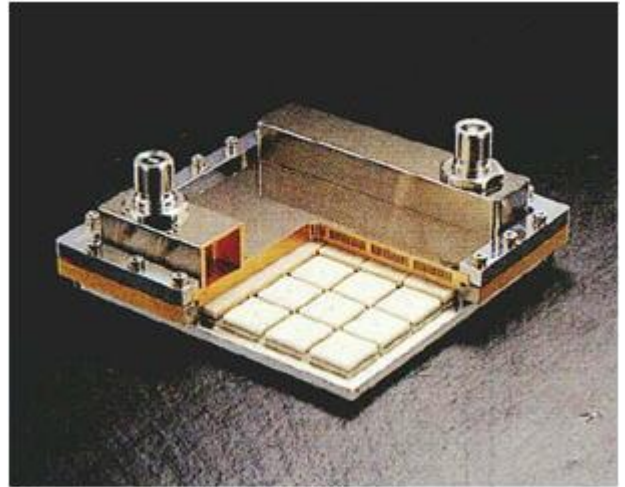
IBM and Fujitsu chose the former (CMOS one chip) and Hitachi chose the latter (one module technology by improved bipolar). The result was that the latter achieved 3 to 4 times the higher-speed performance compared to CMOS one chip technology with superior cost/performance ratio, and it was supported by customers overwhelmingly in the high-end machine market. Hitachi could successfully expand its business for 3 -- 4 years after that.

But IBM pursued the enhancement of mainframe computers by improving CMOS chip design (logic circuit/architecture and chip shrink) every year, and finally achieved similar performance as bipolar machine in 1999. This is the result of CMOS performance enhancement by Moore's Law, in other word, the scaling rule, and then only CMOS technology has been adopted for the mainframe computers after that.

During this period, hardware prices continued to decline in the mainframe market and the hardware alone business (so-called PCM business (Plug Compatible Machine business)) itself became difficult. Hitachi took a strategy of technology partnership with IBM, introducing the CMOS chips from IBM, and concentrating to system business after 2000. Fujitsu has continued the main frame system business by its own CMOS technology until today.



Module in 1990



Module in 1995  
(One-module processor)