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Late 2000s

Shift to multi-core processors

~ Integrated Circuit ~

A multi-core processor has a plurality of CPU cores in a chip and processes information at high speed by parallel computation. From around 2000 when the power consumption of the processor began to exceed the allowable limit, its introduction began as an alternative to the conventional speed-up method by clock frequency increase only, and it was established as a method to achieve high-speed operation while suppressing power consumption.

In the 1990s, when the miniaturization of the MOSFET effectively functioned to speed up the element, the clock frequency of the processor steadily increased with miniaturization, reaching 1 GHz around 2000. However, at the same time, the heat generation of the chip due to the increase in power consumption became a big problem, and power supply voltage of the system had to be reduced in order to suppress it. But various limiting factors for the high speed increased, and the operation speed of the MOSFET did not improve as expected. For example, the mobility of electrons and holes steadily decreased with miniaturization, and thereafter improvement was obtained by introducing distortion technology, etc. However, in general, it remained difficult to increase the speed of the MOSFET under low voltage operations.
Therefore, the circuit/system designers tried to improve the processing speed by arranging a plurality of CPU cores on one chip for parallel processing of information, instead of increasing the clock frequency. In multicore architecture, power supply voltage and clock frequency of each core are controlled independently, so chip design becomes difficult, but the operation of each core is optimized independently, thereby reducing the power consumption of the total chip, while maintaining the operation speed. In today's multimedia age, considering that multiple applications, such as video and music playback, virus checking, document creation, etc. operate in parallel at high speed, multicore processors that perform parallel processing are suitable for today's operating environment.

The start of multi-core processor is POWER 4 released by IBM in 2001. POWER 4 is a 64-bit processor and is a dual-core chip having two cores on one chip. The MOSFET was fabricated on an SOI (Si-on-insulator) substrate, and Cu was used as a wiring material. It operated at clock frequency 1.1 - 1.3 GHz. This move was handed over to POWER 5 (130nm SOI-CMOS, dual core), POWER 6 (65nm SOI-CMOS, dual core), and POWER 7 (45nm SOI-CMOS, 8 cores).
In 2006, Cell, co-developed by IBM, SCE (Sony Computer Entertainment), Sony, and Toshiba, was released. Cell is a parallel processing type processor based on POWER architecture, and it consists of a single general-purpose core called PPE (PowerPC Processor Element) and eight calculation cores called SPE (Synergistic Processor Element). Cell has high-speed image processing function, and it is

installed in SCE's home game machine PlayStation 3 and Toshiba's flat-screen television REGZA, and so on.
Meanwhile, Intel also released the Intel Pentium processor, Extreme Edition 840 in 2005. The chip was the company's first dual-core processor, fabricated using 90 nm technology and operated at a clock frequency of 3.2 GHz. Intel calls a processor with more than 10 cores "many-core", and it is aggressively promoting multicore, including announcing in 2010 the plan of Knights Corner with more than 50 cores.

In addition, as a Japanese manufacturer, Renesas Technology (now Renesas Electronics) developed the dual core SH2A-DUAL, SH4A-MULTI in 2007. The former had two SH2A-FPUs and operated at a maximum frequency of 200 MHz, and the latter was equipped with two SH-4A and operated at the maximum frequency of 533MHz. It realized reduction of the number of parts by memory sharing etc. and reduction of power consumption by parallel processing. Meanwhile, NEC Electronics announced the dual-core V850E2M with two 32-bit CPUs "V850E" in 2009.

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