Part III

1980's -- The IBM/Macintosh Era.

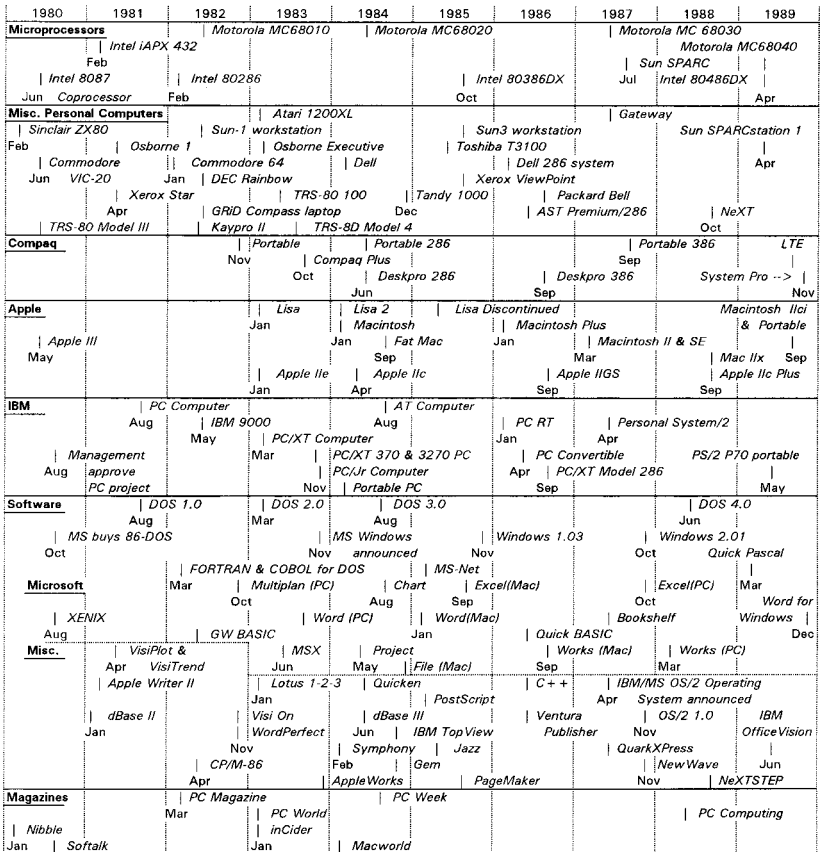

Figure 8.1: A graphical history of personal computers (1980's) - The IBM/Macintosh era.

Chapter 8 Microprocessors in the 1980's

8.1 ... Intel

Microprocessors

The iAPX 432 (Intel Advanced Processor Architecture) which was now a 32-bit microprocessor, was introduced in February 1981. Principals in the development were William Lattin and Justin Rattner. The chip was an advanced design with an innovative architecture. It supported data store using multiple pointer levels, fault tolerance, memory error correction, multiprocessing and object-oriented software. The microprocessor was described as a micromainframe computer in the May 3, 1982 issue of *Fortune* magazine. However, due to performance deficiencies the product was discontinued.

Intel announced the 80186 and 80188 high integration 16-bit internal data path microprocessors in 1982. Both processors were designed for embedded applications in computer peripherals and other electronic products.

The 80286 microprocessor was introduced in February 1982 and was four times more powerful than the 8088. The chip has 134,000 transistors, a 16-bit internal data path and at a clock speed of 8 MHz it has a rating of 1.2 MIPS (million instructions per second). The microprocessor featured on-chip memory management to support multitasking. It also had an on-chip security system for data protection. The memory addressability is 16 megabytes and the microprocessor is available at clock frequencies of 8, 10 and 12.5 MHz. The price at introduction was $360. This microprocessor was selected by IBM for the PC AT computer released in August 1984.

A group of engineers led by John Crawford developed Intel’s 80386DX microprocessor. It had full 32-bit capability and preserved software compatibility with the previous 8086 and 80286 architectures. The 80386DX was introduced in October 1985 and was approximately fifteen times more powerful than the 8088.

The chip has 275,000 transistors, a 32-bit internal data path and at a clock speed of 16 MHz a rating of 6 MIPS. The memory addressability is 4 gigabytes and the microprocessor became available at clock frequencies of 16, 20, 25 and 33 MHz. The price at introduction was $299.

The 80386DX was selected by Compaq for the Deskpro computer released in September 1986. This was the first product application of the microprocessor. Intel had tried to get IBM to incorporate the new microprocessor in their product line. However, IBM had concerns regarding the processors power affecting their microcomputer sales and were therefore slow in adopting the 80386. Initially the 80386 microprocessor was not second sourced by Intel to other competitors, other than IBM for a portion of its internal use. The 80386 became a very successful product and started to contribute significantly to the company profits.

The 80386SX microprocessor was introduced in June 1988. The chip has 275,000 transistors, a 32-bit internal bus with a 16-bit external bus and at a clock speed of 16 MHz a rating of 2.5 MIPS. The memory addressability is 16 megabytes and the microprocessor is available at clock frequencies of 16, 20, 25 and 33 MHz.

The 80486DX microprocessor was introduced in April 1989. The chip has 1.2 million transistors, 1.0 micron minimum feature size and a 32-bit bus. This was the first Intel processor to incorporate a Level 1 (L1) cache of 8 KB for faster data access. At a clock speed of 25 MHz it has a rating of 20 MIPS. The microprocessor included an integrated floating-point unit. The memory addressability is 4 gigabytes and the microprocessor became available at clock frequencies of 25, 33, 50, 60, 75, and 100 MHz. The price at introduction was $950.

Coprocessors

The concept for a coprocessor evolved at Intel from the 8086 microprocessor in 1976. This resulted in a floating-point extension to the 8086 instruction set and a systems interface architecture. In 1987 the development of the coprocessor was assigned to the Intel design center in Haifa, Israel.

The 8087 math coprocessor added a set of floating-point instructions to the 8086/88. It was the first implementation of the IEEE standard for floating-point mathematics. Use of the coprocessor resulted in a significant increase in the speed of mathematical computations. The 8087 coprocessor was released in June 1980. Intel announced the 82786 graphics coprocessor in May 1986.

Corporate & Other Activities

Competitive pressures in the microprocessor market from companies such as Motorola and Zilog, resulted in the implementation of a sales campaign called "Operation Crush" in early 1980. Intel had been loosing market share, mainly to Motorola whose microprocessor products were perceived as being superior. Numerous activities were initiated to communicate the overall advantages offered by the company, and the sales personnel were assigned goals to increase the number of design wins for the use of Intel chips in customer products. By the end of 1980, the campaign became very successful. One major design win with far reaching consequences for Intel, was in Boca Raton, Florida for the IBM Personal Computer.

Intel and Advanced Micro Devices (AMD) negotiated a ten year technological exchange agreement, and AMD became a second source for the 8088 microprocessor in February 1982. This was largely the effect of a desire by IBM to have an alternate source for the microprocessor in its new personal computer.

IBM purchased 12 percent of Intel Corporation for $250 million in December 1982. Intel was having financial problems due to intense competition from Japanese manufacturers of memory chips. Then in 1983-84, IBM increased its investment in Intel to 20 percent.

In 1984 Intel approved a project for a line of parallel processing supercomputers. The company also licensed AMD as a second source for the 80286 in 1984.

The semiconductor industry had been enjoying a boom market until mid-1984, when demand slowed dramatically. This resulted in excess capacity across the industry and prices collapsed between 1985 and 1986. At Intel, a reduced demand for microprocessors and

termination of the company's DRAM chip business resulted in significant losses in 1986. This resulted in plant closings and the termination of over 8,000 employees. However, in 1987 conditions improved. Intel started to report profitable income and Andrew Grove became the chief executive officer.

During 1986, Intel concluded a technological exchange agreement with IBM. IBM received rights to manufacture up to half of its own requirements for the Intel 80386 microprocessor and to develop an enhanced design for its own use and external sales. Intel received a number of IBM technologies, such as advance chip packaging. IBM started reducing its investment in Intel Corporation in 1986, and completed its divestiture of Intel shares due to its own financial problems in December 1987.

Robert Noyce, who had been moving towards semi-retirement, accepted a position as chief executive officer of SEMATECH, Inc., in mid-1988. SEMATECH is an acronym for SEmiconductor MAnufacturing TECHnology. The company was founded by the U.S. Government and a group of leading U.S. semiconductor manufacturers to conduct research that would help combat competition from Japan.

8.2 ... Motorola

Motorola introduced 10 and 12 MHz versions of the MC68000 microprocessor by the end of 1981. The company then introduced the MC68010 in 1982 and the 32-bit MC68020 in 1984. The MC68020 used 2.5 micron technology, had 200,000 transistors, a 256 byte cache and executed instructions at 2.5 MIPS. Clock speeds are 16-33 MHz.

The MC68030 32-bit unit has all the features of the MC68020 plus a paged memory management unit, separate 256 byte caches for data and instructions and additional enhancements. It executes instructions at 12 MIPS and clock speeds are 16-50 MHz. The MC68030 was introduced in 1987 and was used on the Apple Macintosh IIx computer.

Motorola announced the 88000 family of Reduced Instruction Set Computing (RISC) microprocessors in

1988. They were designed for applications such as multiprocessing and high performance graphics.

The MC68040 is a 32-bit microprocessor that executes instructions at 20 MIPS. It contains 1.2 million transistors, has a 4K byte instruction cache, 4k byte data cache and a floating-point unit. Clock speeds are 25-40 MHz. The MC68040 was announced in April 1989.

8.3 ... Other Microprocessors

The National Semiconductor 16032 was a microprocessor with a 16-bit external data bus and a 32-bit internal bus. It was announced in 1981. The 32032 was the first full 32-bit microprocessor. In 1987, National Semiconductor acquired Fairchild Semiconductor that had been having problems.

The Western Design Center 65802 and 65816 microprocessors were designed by Bill Mensch and announced in 1984. The W65C816 is a 16-bit microprocessor that is used in the Apple IIGS computer.

Gordon Campbell who had previously been with Intel Corporation founded Chips and Technologies, Inc. The company started by producing low cost chip sets for the IBM PC AT computer.

The Zilog Z-80000 is a 32-bit microprocessor and the Z280 is a 16-bit version of the Z-80 that was announced in 1987.

RISC Microprocessors

John Cocke developed the primary concepts for the Reduced Instruction Set Computing (RISC) technology at IBM starting in the 1960's. It evolved from his research on optimizing the interaction between hardware and software. Cocke determined that the overall speed of execution could be increased by reducing the number of complicated instructions to a relatively small set of simple optimized instructions.

The RISC architecture was first implemented on two experimental computers and on the IBM 801 minicomputer in 1978. Then in 1980, IBM's Austin laboratory developed the ROMP (Research Office products MicroProcessor) RISC

microprocessor for the office products division. The original intent was to use the microprocessor in a networked office workstation. The first IBM personal computer to use the ROMP microprocessor was the PC RT workstation introduced in January 1986. IBM's mainframe and personal computer divisions did not support the application of RISC technology on their products. This allowed other companies to exploit the technology during the last half of the 1980's.

David Patterson from the University of California at Berkeley, who after evaluating the complexity of the DEC VAX computer instruction set, developed the RISC-I microprocessor in 1980. John L. Hennessy also did research on RISC microprocessors at Stanford University, and with Skip Stritter, also from Stanford and John Moussouris of IBM, they founded MIPS Computer Systems in 1984. MIPS released the 32-bit R2000 RISC microprocessor, that had 185,000 transistors in 1986.

The SPARC RISC microprocessor was developed at Sun Microsystems by Anant Agrawal with assistance from Robert Garner, William Joy and David Patterson from the University of California at Berkeley. SPARC is an acronym for Scalable Processor Architecture. It was introduced by Sun in July 1987 and used on their SPARCstation 1 in 1989.

8.4 ... Other Corporate Developments

The Exxon corporation acquired Zilog Inc., in 1981 then sold it to Zilog executives in 1989.

Texas Instruments introduced its first single-chip digital signal processor (DSP), the TMS320 in 1982. This subsequently became a major product line for the company.

In April 1985, AT&T purchased the assets of Synertek, Inc., a subsidiary of Honeywell for an estimated $25 million. Then in November a French company, Thomson-CSF purchased Mostek, a subsidiary of United Technologies for $70 million.

AMD started litigation to obtain a license as a second source for the 80386 microprocessor in 1987. Intel wanted to restrict the second sourcing of the microprocessor. However, the technological exchange agreement that Intel had agreed to with AMD in 1982 would become a problem for Intel. During the litigation arbitration in 1989, AMD decided to make an independent clone design of the 80386.

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