Part IV

1990's -- Current Technology.

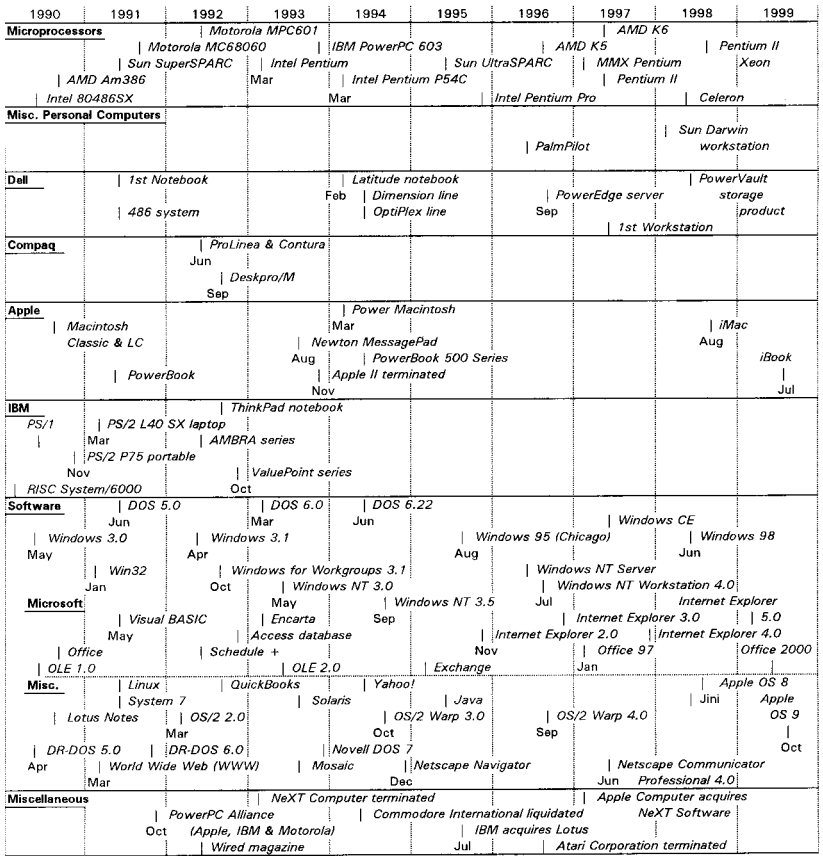

Figure 14.1: A graphical history of personal computers (1990's).

Chapter 14 Hardware in the 1990's

14.1 ... Microprocessors

IBM

IBM introduced a new RISC central processing unit (CPU) for the RISC System/6000 workstation in February 1990. The 32-bit superscalar CPU contained seven to nine VLSI CMOS chips using 1-micron technology with operating speeds of 20, 25 or 30 MHz. The architecture was called a "second generation RISC" by IBM. The CPU contained an instruction/branch unit, fixed point unit, floating point unit, data cache and storage input/output control unit. The instruction set had 184 instructions. Depending on the speed and configuration, the CPU could execute between 28 to over 40 million instructions per second (MIPS).

In October 1991, IBM participated in the formation of the PowerPC Alliance with Apple Computer and Motorola (See Section 19.6). IBM wanted to extend its workstation RISC microprocessor technology to a broader base of personal computers and reduce its dependence on Intel. Production of the PowerPC 601 by IBM began in late 1993. The PowerPC 603 for portable applications was announced in October 1993.

Intel

The 80386SL microprocessor was designed for low power, small size portable PC systems and was introduced in 1990. The chip has a 32-bit internal data path and a memory addressability of 16 megabytes. The microprocessor is available at clock frequencies of 20 and 25 MHz.

The 80486SX microprocessor is similar to the 80486DX except it does not have an integrated floating-point unit. It was introduced in April 1991. The chip has a 32-bit internal data path and a memory addressability of 4 gigabytes. The microprocessor is available at clock frequencies of 16, 20, 25 and 33 MHz.

The 80486DX2 uses a speed doubling technology and was introduced in March 1992. With this technology the microprocessor runs at 66 MHz while interfacing to a low cost 33 MHz system. This boosted computer performance by up to 70 percent without a system redesign. The chip has a 32-bit internal data path and a memory addressability of 4 gigabytes. The microprocessor is available at clock frequencies of 50/66 MHz.

The OverDrive processors were introduced in 1992, as an upgrade strategy for Intel 486 systems. The OverDrive processor is based on the "speed doubling" technology of the 80486DX2. It doubles the internal speed of the CPU while still "talking" to the rest of the system at the same frequency. This boosts overall performance by 70 percent.

The Pentium microprocessor was introduced in March 1993. The name was selected in an employee competition and was registered to prevent similar product designations by competitors. The word Pentium contains the syllable pent, which is the Latin root for five and is also Intel's fifth-generation microprocessor. It has 3.1 million transistors, nearly three times as many as the Intel 486 microprocessor. It uses 0.8 micron BiCMOS technology that combines bipolar (speed) and CMOS (low power consumption) characteristics. It is capable of running many applications five to ten times faster than a 33-MHz 486 unit. It has a 64-bit data bus and at 66-MHz it has a performance of 112 MIPS (Million Instructions Per Second). It utilizes superscalar RISC architecture and has two execution units which can process up to two instructions in a single clock cycle. It also features two Level 1 (L1) 8 KB on-chip caches, one for data and the other for instructions which improves performance. The original Pentium was available at speeds of 60 and 66 MHz. The price at launch was $878. This microprocessor is now available at speeds from 75 to 200 MHz.

Intel introduced the Pentium "P54C" that operated at 3.3 volts in 1994. Then Intel introduced the clock-tripled 80486DX4 with a larger cache in March. A joint venture with Hewlett-Packard to develop a new 64-bit

microprocessor was announced in June. This would become the IA-64 microprocessor.

In the fall of 1994, the public became aware of a minor design error in the Pentium microprocessor. The design flaw which was in the floating point unit, caused a mathematical rounding error in a division once every nine billion times. Intel had encountered the problem several months earlier and had established a policy of replacing the chip for those users who were doing a lot of mathematical calculations. Then in December it was reported that IBM was stopping shipment of all computers using the Pentium. The adverse publicity resulting from this and other reports caused Intel to change its replacement policy in late December to include all customers, who wanted the Pentium changed. Intel scrapped all Pentiums that had not been sold. This and the replacement program resulted in a financial loss to Intel of $475 million.

Intel announced the Pentium Pro (initially known as the P6) microprocessor in November 1995. The Pentium Pro contains two chips, a CPU and two sizes of cache in a single package. The CPU has 5.5 million transistors. The chip incorporated a 16 KB Level 1 (L1) cache. The Level 2 (L2) 256K cache has 15.5 million transistors and the 512K version has 31 million transistors. The CPU and cache are in a single package connected by a ultra-high-speed bus. The register size is 32 bits, the data bus 64 bits and the address bus is 32 bits. The microprocessor can process a maximum of three instruction per clock cycle and 300 million instructions per second. Clock speeds were 150, 166, 180 and 200 MHz.

Intel introduced the Pentium processor with MMX technology in January 1997. The MMX processor provided 57 new instructions to improve multimedia program performance. It also included a 32 KB Level 1 (L1) cache. The Pentium II processor was introduced in May 1997. It extended the power of the Pentium Pro by adding MMX technology, dual independent bus architecture and was introduced at processing speeds of 233, 266 and 300 MHz. The chip has 7.5 million transistors. It also featured a new single edge contact cartridge physical configuration.

In October 1997, Intel announced the new IA-64 64-bit microprocessor, code named Merced with introduction planned for 1999 (subsequently changed to 2000). Principals in the joint development with Hewlett-Packard were John Crawford of Intel ad Jerry Huck of HP. It was also announced that the design would use the concept of Explicitly Parallel Instruction Computing (EPIC). It would also be able to run Windows software and HP's version of UNIX.

The Celeron processor with a clock speed of 266 MHz was introduced in April 1998. The Celeron is the same as the Pentium II, but is mounted in a lower-cost module and has no L2 cache. The processor is targeted at the low-cost personal computer market. In August Intel announced two new versions of the Celeron, the 300A and the 333. Both chips had 128 KB of integrated L2 cache and the 333 operated at 333 MHz.

The Pentium II Xeon microprocessor was introduced in August 1998. It was designed for mid- and high-range servers and workstations.

Intel introduced the Pentium III microprocessor, operating at 550 MHz in early 1999. A 600 MHz version was introduced in August. In October, Intel announced it had selected Itanium as the new brand name for the first product in its IA-64 family of processors, formerly code-named Merced.

Motorola

The MC68060 is a 32-bit superscalar microprocessor introduced in 1991. It executes instructions at 100 MIPS, has a 8K byte instruction cache, 8K byte data cache and a floating-point unit. Clock speeds are 50-66 MHz.

Motorola announced the PowerPC 601 microprocessor in 1992. The new microprocessor was developed through the PowerPC Alliance with Apple Computer and IBM (See Section 19.6). This is the first implementation of the PowerPC family of reduced instruction set computing (RISC) microprocessors and is designated MPC601 by Motorola.

The MPC601 is a 32-bit implementation of the 64-bit PowerPC architecture. The microprocessor contains

2.8 million transistors. It is a superscalar processor with the ability to execute three instructions per clock cycle. The MPC601 integrates three instruction units: an integer unit (IU), a branch processing unit (BPU) and a floating point unit (FPU). The microprocessor has a 32K byte cache and is available in 50 and 66 MHz clock speeds. The 50 MHz MPC601 is priced at $380 each and the 66 MHz version lists at $374 for production volumes of 20,000 units.

In 1994, production began of the PowerPC 603 for portable applications, the PowerPC 604 for high performance personal computers and the 64-bit PowerPC 620 for servers and high-end workstations.

Miscellaneous

Advanced Micro Devices (AMD) successfully completed the independent cloned design of the Intel 80386 microprocessor in August 1990. The new processor was named Am386 and was followed by the Am486 clone. AMD then started development of its own microprocessor design using RISC technology that resulted in the release of the K5 microprocessor in 1996, to compete with the Intel Pentium. The K6 microprocessor followed in April 1979 using technology it received after acquiring the NexGen company in 1996. AMD announced the K6-2 with additional features in May 1998.

Sun Microsystems released the SuperSPARC microprocessor that had 3.1 million transistors in 1991. However, the performance was below expectations. It was replaced by the successful UltraSPARC microprocessor in late 1995.

Cyrix is a company that got its start by producing the 80486SLC chip for notebook computers. Digital Equipment Corporation (DEC) developed the 64-bit Alpha 21064 microprocessor in 1992, that had 1.68 million transistors and operated at 200 MHz.

MIPS (purchased by Silicon Graphics) introduced the R8000 microprocessor in June 1994. It was reported to be the world's fastest microprocessor, a supercomputer on a chip. This was followed by the R10000 chip in 1995.

In June 1996, the U.S. Patent and Trademark Office overturned a patent awarded to Gilbert Hyatt for the first microprocessor. The first patent for a microprocessor is now attributed to Gary Boone and Michael Cochran of Texas Instruments.

14.2 ... IBM Computers

Andy Heller managed the RIOS project that began in 1986 to develop a new advanced workstation using RISC (Reduced Instruction Set Computing) microprocessor technology. John Cocke who created the RISC concept at IBM was a principal in the new project. The new computer became the RISC System/6000 family of six advanced workstations that IBM introduced in February 1990.

The entry-level systems were called POWERstation and POWERserver, and used a POWER architecture. POWER is an acronym for Performance Optimization With Enhanced RISC. The 32-bit RISC central processing unit (CPU) was mounted on a card that plugged into the system motherboard. The CPU was available with operating speeds between 20 and 30 MHz that enabled 28 to 40 million instructions per second (MIPS). the six models varied depending on the physical construction, CPU speed, memory and storage capacity. Each model used an enhanced version of the IBM Micro Channel (MCA) bus. IBM also released an enhanced version of the AIX operating system and OSF/Motif software for the workstation. An entry-level system with a 20 MHz CPU, 8 MB of RAM, one 1.4 MB 3.5 inch floppy disk, 120 MB hard disk, a 19 inch 1,280 by 1,024 pixel monochrome display and other accessories had a price of $12,995. The workstations were well received and became effective products in competition with other workstation suppliers.

The PS/1 computer was announced in mid 1990.

IBM introduced the PS/2 Model P75 portable computer in November 1990. The portable computer measured 18 by 12 by 6 inches and weighed 22 pounds. A standard unit utilized an Intel 486 microprocessor operating at 33 MHz, 8 MB of RAM (expandable to 16 MB), 3.5 inch high-density floppy disk drive and a 160 MB

hard disk drive. The unit had four MCA expansion slots, a 10 inch diagonal gas-plasma display and a 101 key detachable keyboard. The orange-on-black display supported CGA, EGA, and VGA graphics with up to 16 shades of orange with a resolution of 640 by 480 pixels. The unit also supported XGA graphics with 256 colors with a resolution of 1,024 by 768 pixels on an external monitor. A standard configuration had a base price of $15,990. The portable was not successful due to price and a market change to smaller laptop computers.

Bob Lawten headed a project that started developing a laptop computer in January 1990. The computer design was developed at Boca Raton, Florida and at the IBM Yamato laboratory in Japan. IBM announced the battery operated PS/2 Model L40 SX laptop computer in March 1991. The portable unit measured 12.8 by 2.1 by 10.7 inches and weighed 7.7 pounds. The unit used an Intel 80386SX microprocessor operating at 20 MHz and included a socket for a coprocessor. The base system had 2 MB of RAM, expandable to 6 MB. A 3.5 inch 1.44 MB floppy disk drive and a 60 MB hard disk drive were incorporated into the unit. The display was a 10 inch sidelit supertwist VGA LCD that supported 32 gray scales. The laptop had an 84 key keyboard and a 17 key external numeric keypad. The system used a nickel-cadmium battery and an external power supply was provided. The base system cost $5,995.

Ted Selker, who was director of IBM's ergonomics research at the Almaden Research Laboratory in California, created the TrackPoint pointing device around 1991. It was developed as a means of controlling the cursor on the screen without taking the hands off the keyboard. The TrackPoint is a small pole mounted on the keyboard that converts side pressure to a corresponding movement of the cursor. It was one of the innovative features of IBM's ThinkPad notebook computer.

Between 1990 and 1991, IBM started developing a pen computing type of computer. The project was headed by Kathy Vieth. IBM had done research on handwriting recognition and a pen based operating system. However it chose a pen based operating system from Go Corporation

that had been founded by Jerry Kaplan. A pen based computer named ThinkPad was announced in April 1992.

In 1992, IBM introduced two low cost series of computers. The Ambra series was marketed in Britain, Canada and France in June, and the ValuePoint series in the USA in October.

14.3 ... Apple Computers

Disenchanted with the Apple bureaucracy, Steve Sakoman who had headed the Newton project since 1987, resigned from Apple in March 1990. Larry Tesler took over the project in May. In February 1991, Michael Tchao, the product marketing manager, convinced John Sculley to concentrate the project on a less-expensive handheld version of Newton targeted at the consumer market. Sculley envisioned it as a consumer product version of the Knowledge Navigator concept he had described in his 1987 autobiography *Odyssey*. Shortly after, production of the mini Newton with the code name of Junior was approved. Two principals in the product development were Steve Capps and Michael Culbert. It became a new type of consumer oriented handheld computer called a Personal Digital Assistant (PDA). Apple named the new product MessagePad and launched it in August 1993. It had a capability to recognize writing by writing on its 240 by 336 pixel LCD screen with a stylus. It also had an infrared beaming capability for intercommunication between computers. The computer used an ARM 610 microprocessor designed by Advanced RISC Machines (ARM) Ltd. of Cambridge, England. Memory was 4 MB of ROM and 640 K bytes of RAM. The unit measured 7.25 inches long by 4.5 inches wide and 0.75 inches thick, weighed 0.9 pounds and was priced at $699. A number of improved models were released later. However, sales were significantly below expectations. The Newton product line was terminated by Steve Jobs in February 1998.

The Mac LC was released in 1990. Apple discontinued the Apple IIc in November 1990.

In October 1991, Apple participated in the formation of the PowerPC Alliance with IBM and Motorola

(See Section 19.6). Apple wanted a more powerful microprocessor for a new line of Macintosh computers.

Apple discontinued the Apple II product line in November 1993.

In 1994, Apple introduced the Power Macintosh series of computers in March and the PowerBook 500 series of notebook computers in May.

Apple introduced the iMac computer in August 1998. The computer featured a one-piece blue translucent case that incorporated the processor, compact disk drive and 15-inch monitor. The system included a translucent keyboard and a new round translucent mouse. The unit incorporated a 233 MHz PowerPC 750 G3 microprocessor, 32 MB of SDRAM, 4 GB hard disk drive, 24X CD-ROM drive and a 56k modem. A significant omission was that the unit did not include a 3.5 inch floppy disk drive. Apple priced the computer at $1,299. A completely redesigned iMac was introduced in October 1999.

The iBook is a new portable computer introduced in July 1999. It was to be the "iMac to Go' and featured a stylish case, large active-matrix display, long battery life and a PowerPC G3 microprocessor.

14.4 ... Other Computers

Compaq

In response to intense competition from clone manufacturers, Compaq launched a project with the code name of Ruby to develop a low cost personal computer. The project was headed by Richard Swingle. This project resulted in the ProLinea and Contura models being introduced in June 1992 and the ProSignia server computer in October 1992.

The Deskpro/M family of modular computers were introduced in September 1992.

Silicon Graphics (SGI)

SGI introduced the Indigo workstation for the technical market in July 1995. The O2 workstation was introduced to compete with high performance personal computers in October 1996.

U.S. Robotics

U.S. Robotics released a new Personal Digital Assistant (PDA) computer called the PalmPilot in 1996. Principals in the development of the PalmPilot were Jeff Hawkins and Donna Dubinsky. It is a mobile organizer that can interface with a desktop computer. It has become a very successful product.