BIG BREAKTHROUGH

Corporate executive envisions the era of the $500 PC

By Dean Takahashi
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SANTA CLARA, CALIF. — Brian Halla holds a black box about the size of a thick magazine in one hand and waves it around. It is the next big thing in personal computing he says — the $500 PC.

"We know we can build it for $220 in components," says Mr. Halla, the chief executive officer of National Semiconductor Corp. "This is the beginning of the information appliance."

The machine is more prop than prototype at this point because National Semiconductor hasn't yet perfected the chipmaking technology that will make $500 PCs possible. The process places circuits as thin as .25 micron — 1/400th the width of a human hair — on silicon, which would allow so many transistors that most of the functions of a computer could be included in a single chip.

So-called systems-on-a-chip are already a reality for digital cameras and are close to reality for products such as video-game players, cellular phones and other non-PC devices.

As for PCs, Mr. Halla figures his factories will be able to cram 20 million transistors on a chip by the middle of this year, enough to create a PC-on-a-chip that is about as powerful as the sub-$1,000 machines that are taking the market by storm. The chip design would include a clone of Intel Corp.'s best-selling microprocessor and run Microsoft Corp.'s software.

Part of the Landscape

Mr. Halla talks of a day when such PCs will be so cheap that they are built into watches and dashboards, increasing annual PC shipments to 700 million units from 70 million.

"This is how the computer fades away and becomes just a part of the landscape, just like the electric motor," Mr. Halla says.

Such super-cheap PCs could threaten plans by companies such as Oracle Corp. and Sun Microsystems Inc. to offer so-called network computers that run off host machines and don't need Microsoft software. They could also threaten the profit margins of Intel.

But some people think of Mr. Halla as a bit of a crazed visionary.

Andrew Grove, Intel's chief executive officer, talks of "Brian Halla's fantasies." Intel's president, Craig Barrett, notes sarcastically that to get to 700 million PCs, one out of every two people in the world would have to buy a computer every four years.

Mr. Halla's former boss at LSI Logic Corp., Wilfred Corrigan, thinks that it might be suicidal to take on Intel at any price point.

As head of marketing and later executive vice president, Mr. Halla helped pioneer the concept of mixing and matching functions on a chip at LSI, but that company is concentrating on non-Intel businesses such as cellular phones and video-game players. "We're not quite bold enough to take on Intel head-on," Mr. Corrigan says.

Bold Moves

But Mr. Halla has always shown a flair for bold moves. After marketing microprocessors for 14 years at Intel, he jumped to LSI in 1989 to start its microprocessor business.

He invented the term "coreware" to help explain LSI's strategy of mixing and matching libraries of designs so they could be reused in different kinds of chips. To make sure customers got the idea, he erected a huge Mr. Potato Head in LSI's lobby.

(Please turn to Page 16)

How to Read These Charts

The charts on the right track the power of Intel Corp.'s microprocessor chips from 1971 to 1997. The chart along the bottom and up the right side shows a 27-year perspective.

Each dot represents one Intel microprocessor chip. Each chip is identified by its name and clock speed (the speed at which the system clock coordinates the components in a computer, measured in megahertz). In some cases, the dots overlap because Intel introduced more than one chip at the same time.

Because of the increasing growth in chip power in recent years, the early period appears flat. For a more in-depth view, this chart has been divided into three smaller ones, each covering 10 years. The dots on the small charts correspond to the dots on the bigger chart.

The scale for all the charts is in MIPS (millions of instructions per second), which has been used historically to measure computing power.

The blue-shaded areas are U.S. economic recessions. The flags on the charts represent computer-related events and technological advances. U.S. presidents are shown at the top of the three smaller charts.

The Need for Speed

The desire for faster and more-powerful computer technology isn't new.

One early example of this demand was the computer known as Whirlwind, which was developed at the Massachusetts Institute of Technology between 1945 and 1953. It was built as part of a U.S. military aircraft-simulation project and initially performed 20,000 operations a second.

To improve the computer's speed, Jay Forrester and his research team developed a way to replace the vacuum tubes that stored data in Whirlwind with magnetic core memory. This enhanced its performance and reliability.

Successful Project

The success of this project led to the SAGE (semi-automatic ground environment) system in 1956. SAGE was a network of very large computers housed in large bunkers across Canada and the U.S.

Based on Whirlwind, this system was designed to detect enemy aircraft and was linked to radar stations, ships at sea, antiaircraft missiles and command centers in Washington.

The full system was completed by 1963, when the race to outer space and the cold war with the then-Soviet Union created the desire for even faster computer technology.

In 1968, the late Robert Noyce and Dr. Gordon Moore founded Intel Corp., which is now the world's largest maker of microprocessor chips.

On Nov. 15, 1971, Intel came out with the first microprocessor, the Intel 4004, which contained 2,300 transistors. Its clock speed was 0.108 megahertz (MHz) and it performed about 60,000 instructions a second, or .06 million instructions per second (MIPS).

Next came the Intel 8008 microprocessor in 1972, with a clock speed of 0.2 MHz and 2,500 transistors.

This was followed by the 8080 in 1974, which contained 5,000 transistors and had a clock speed of 2 MHz.

The 8080 became the brains for one of the first popular personal computers, the Altair, in 1975. And in 1981, the first PC by International Business Machines also used the 8080 microprocessor.

In 1978, Intel introduced the 8086. It contained 29,000 transistors and ran at a maximum clock speed of 10 MHz.

In 1989, the company unveiled the Intel486 DX CPU microprocessor. This chip had 1.2 million transistors and ran at a clock speed of 25 MHz.

Faster Chips

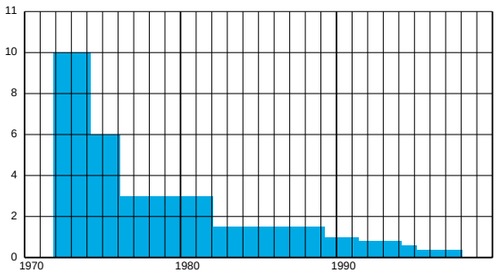
The 1990s brought even faster chips as Intel introduced the Pentium processor in 1993. It had 3.1 million transistors and a maximum clock speed of 66 MHz.

Intel followed this with the Pentium Pro in 1995, which had 5.5 million transistors and ran at a maximum clock speed of 200 MHz.

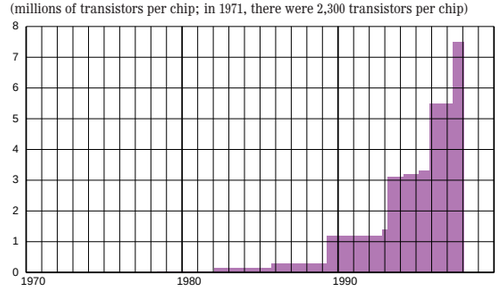
The Pentium II processor, which came out in 1997, contains 7.5 million transistors, can perform at more than 600 MIPS and has a clock speed of 300 MHz.

The Pentium II incorporates Intel MMX technology, which is designed specifically to process video, audio and graphics efficiently.

As the width of connectors in transistors decreases ...
(in microns. 1971, 10 microns; 1997, 0.35 micron)



... the capacity of each chip increases.
(millions of transistors per chip; in 1971, there were 2,300 transistors per chip)



THE TRANSISTOR was launched commercially in 1951 to replace vacuum tubes, which were deemed too slow. Transistors were more-efficient because they used less power, generated less heat and were smaller.

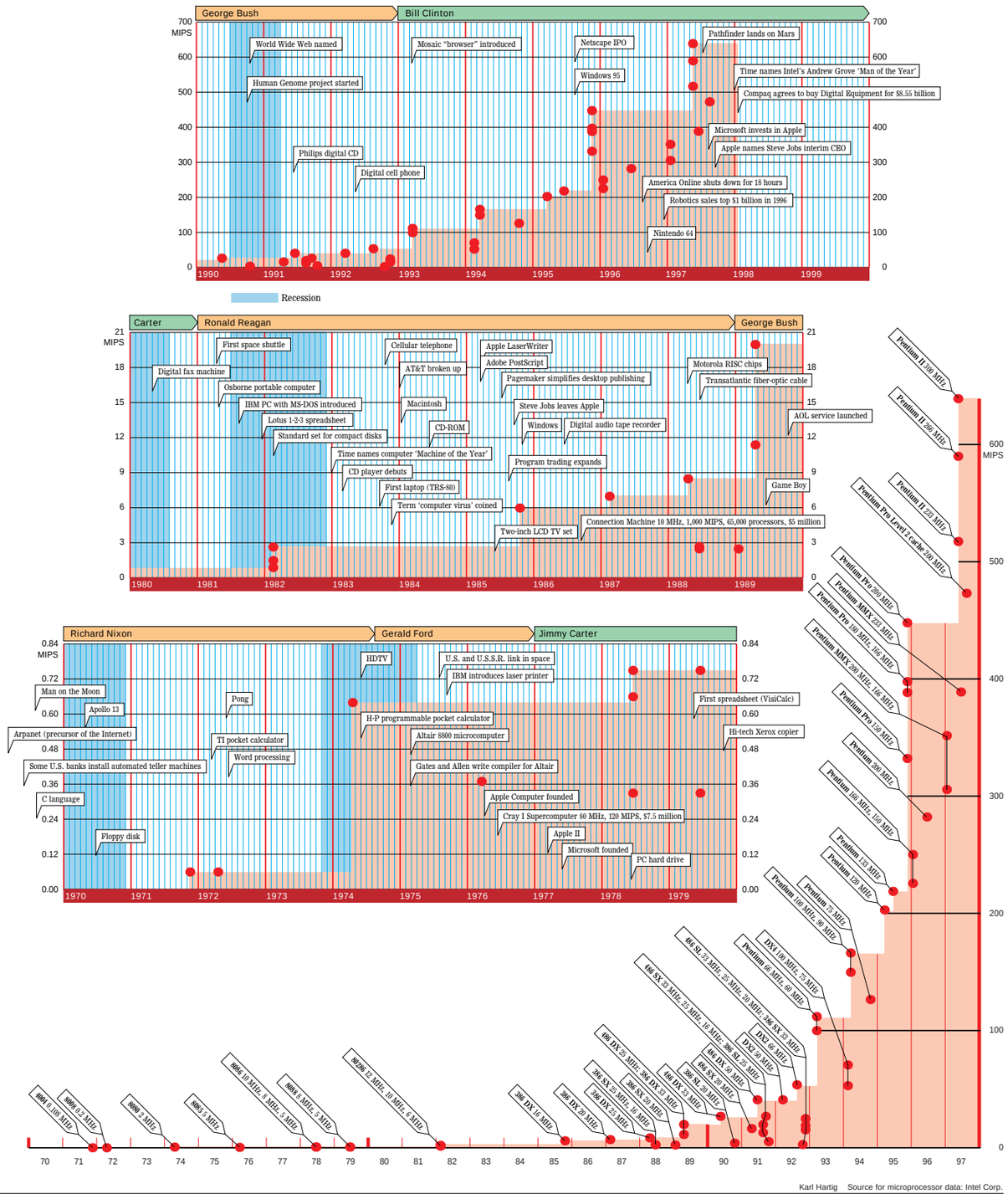
In 1958, Jack Kilby and Robert Noyce independently invented the integrated circuit. It contained several electronic components, including transistors, on one silicon chip. They developed ways of making chips by photolithography, which reduced the size of the chip. Once the initial design had been worked out, chips could be mass-produced cheaply.

An important element in the growth of microprocessing power is the reduced size of components in a transistor. One key unit of measuring these components is the micron, which is the size of 1/100th of a human hair.

The smaller the size of the metal lines that connect transistor components (see top chart on left), the more transistors that can be packed onto a chip (see bottom chart on left).

(In 1965, Dr. Gordon Moore, a co-founder of Intel Corp., predicted that the number of transistors that can be jammed onto a chip would double every 18 months. This became known as "Moore's Law.")

All of these technological advances are helping to fuel the accelerating growth in computing power.



Karl Hartig Source for microprocessor data: Intel Corp.