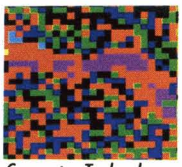
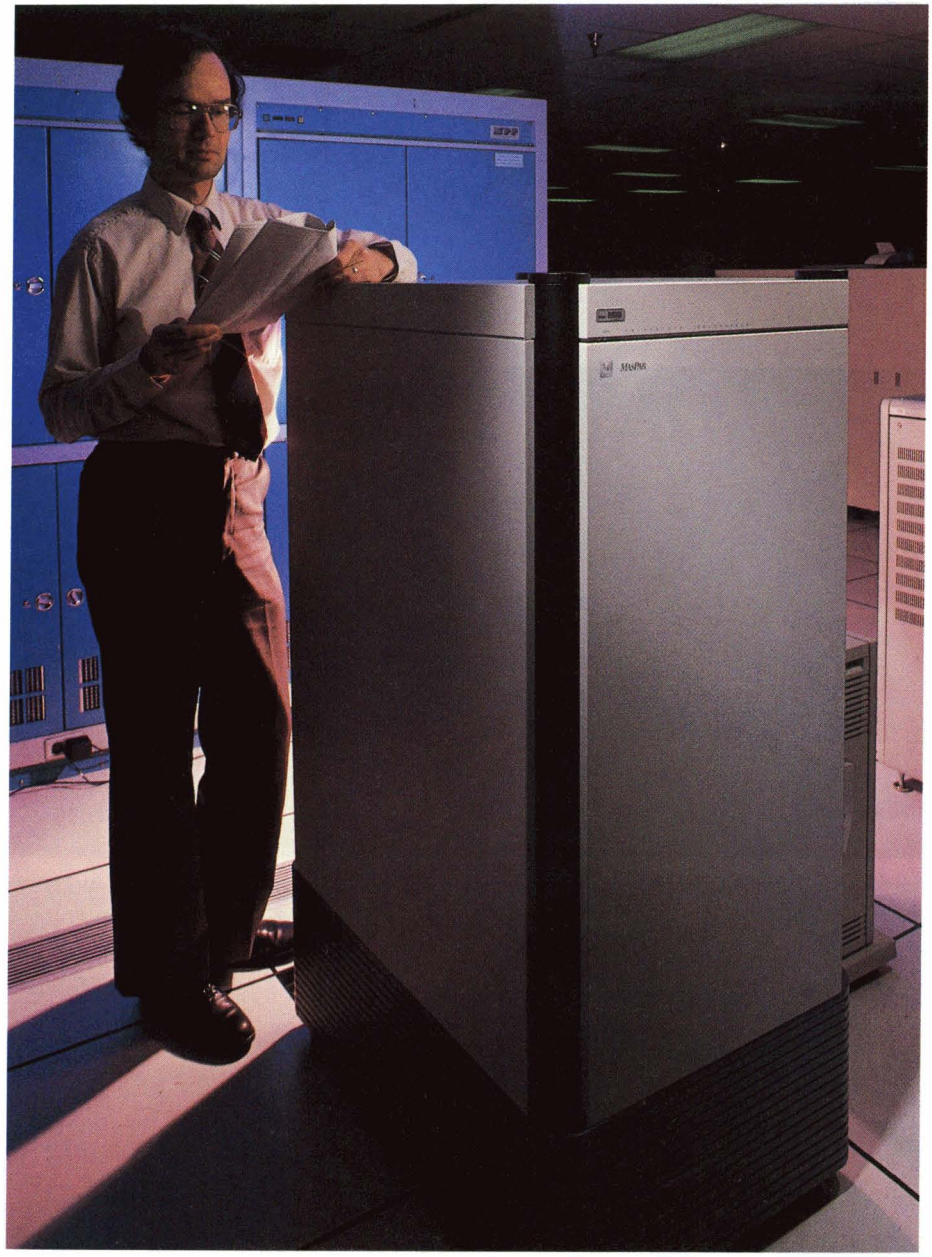


Parallel Processing System



Parallel processing involves simultaneous processing of image picture elements rather than step-by-step serial processing

In the latter 1970s, NASA saw a need for computing power orders of magnitude beyond anything then available for satellite image analysis. Already operating at that time were satellites relaying voluminous information to Earth at high transmission rates, such as NASA's Earth-scanning Landsat resources survey satellite sending digital data to ground stations at the rate of 15 million bits per second. On the developmental horizon were satellites of far greater data gathering and transmission capacities.

To provide a capability for processing very high resolution image data from spacecraft sensors, Goddard Space Flight Center commissioned development of a unique type of computer based on the concept of parallel processing — meaning simultaneous processing of image picture elements (pixels) rather than step-by-step serial processing. Designed and built by Goodyear Aerospace Corporation, the resulting prototype was known as the Massively Parallel Processor (MPP). It was delivered to Goddard in 1983 and it was soon found to have utility in a far broader range of applications than just image processing.

The MPP architecture — known as SIMD for single instruction stream, multiple data stream — offers enormous computational power at lower cost than other architectures. The speed of the prototype derived from a network of 16,384 simple processors, which allowed dividing up a task so that each processor performed the same operation on different pieces of data at the same time.

For example, in tests involving analysis of Landsat data, the MPP would individually study each of the million pixels in a typical image and decide whether each dot represented land or water, forest or farmland, or whatever else. In other words, in massively parallel processing an entire image is processed at once, where in serial processing an image is processed one pixel at a time; the latter takes hours to analyze and classify an image, MPP about 20 seconds.

NASA research led to a new generation massively parallel computing system

In order to measure and document the advantages and disadvantages of parallel processing, and to learn the capabilities and limitations of the MPP, NASA organized a working group of 40 scientists who were provided opportunities to test their computational algorithms on the MPP beginning in the fall of 1985.

A year later, sufficient results had been acquired to warrant convening — at Goddard — the first symposium on massively parallel scientific computation. The MPP investigators described a broad variety of applications, including signal and image processing, Earth science, physical science, computer science and graphics. The performance of many of these applications was found to be in the supercomputer range, and for certain tasks MPP was found to be faster than traditional vector supercomputers. Subsequently, Goddard funded the Microelectronics Center of North Carolina's development of a second generation MPP called the Blitzen Project to demonstrate that the size and weight of the MPP could be reduced enough to allow its use in spacecraft.

Based in part on technology developed in the two NASA MPP projects, MasPar Computer Corporation, Sunnyvale, California, has produced a new generation massively parallel computing system. The MasPar MP-1 product family ranges upward from a unit with 1,024 processors that can deliver 1,600 MIPS (millions of instructions per second) and 82 MFLOPS (millions of floating operations per second). At the upper end of the scale, with 16,384 processors, the MP-1 can deliver 26,000 MIPS and 1,300 MFLOPS. MP-1 users, including NASA, are attacking computationally-intensive problems in such areas as image processing and understanding, signal processing, database management query systems, neural-net algorithms, computational fluid dynamics, content-sensitive text retrieval and seismic data reduction.

At far left, James R. Fischer, head of Goddard's image analysis facility, is shown with the MasPar MP-1 (foreground) and the earlier MPP prototype (blue unit in background); the photo emphasizes the compactness of the new system as compared with its predecessor. Fischer (white shirt) and a colleague are shown **at left** checking out one of the MP-1's circuit boards.