# Titbit from the History of Computing – 8

## ETA 10 Supercomputer – Genesis and Demise

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*"History, despite its wrenching pain, cannot be unlived, but faced with courage need not be lived again"*

*- Maya Angelou*

The Cambridge dictionary meaning of titbit is "A small and particularly interesting item of gossip or information".

### Genesis of ETA Systems

Control Data Corporation (CDC) was a mainframe computer manufacturer that was established in 1957 in Minneapolis in Minnesota, USA. It started manufacturing computers intended for intensive scientific computation as a competitor of IBM which was dominant at that time. The main team of designers in CDC included the legendary Seymour Cray and William Norris. The first large computer it designed and marketed was CDC 1604 followed by CDC 3600 which was installed by many universities in the USA and also at TIFR in Mumbai. CDC went on to manufacture faster computers including CDC 6600 in 1964 and CDC STAR-100 in 1974 which was the first supercomputer that used vector processing and its speed was 100 Megaflops (Million floating point operations per second). Seymour Cray who was one of the main designers of CDC computers decided to leave CDC in 1972 to form his own company devoted exclusively to design, develop, and market supercomputers. The first supercomputer he designed was Cray-1 that used a pipelined vector processor achieving a speed of 160 Megaflops that was the fastest supercomputer in 1975. It cost $8 Million and around 80 systems were sold. CDC in competition designed CDC Cyber 203,205 series of supercomputers. They were also vector processing computers but were slower as the vectors were stored in the main memory rather than in vector registers in the CPU. In some problems that required long vectors CDC supercomputers outperformed Cray. However, Cray dominated the supercomputer market.

In 1983 CDC decided to design the next generation of supercomputers to succeed the CDC Cyber 20x series. A group consisting of Lloyd Thorndyke, head of the CDC advanced design laboratory, Neil Lincoln, the chief engineer of the CDC 205 project, and several other engineers convinced the CDC top management headed by William Norris that a separate corporation should be spun off from CDC to design it. The reasons given were:

1. A new company devoted primarily to manufacture supercomputers can generate capital by selling shares to both public and private investors.
2. A small specialised new company can be nimbler and take quick decisions to meet the challenging deadline of designing and marketing a new architecture supercomputer in three years.
3. A specialist company set up for designing state-of-the-art supercomputers can get government funding as a R&D project.

A new company named ETA Systems was established in 1983, a few kilometres from CDC headquarters, with the aim to design, build, and market a 10 Gigaflop supercomputer ETA 10 in three years.

### Hardware design of ETA 10

One of the first decisions to be taken by the designers of ETA 10 was to select the integrated circuit chip technology to be used in the Central Processing Unit (CPU). Most supercomputers in 1980s used Emitter Coupled Logic (ECL) as it was the fastest technology. However, ECL circuits consumed more power and the packing density of transistors in ECL was lower compared to Complementary Metal Oxide Semiconductor (CMOS) logic. CMOS was the emerging technology with a lot of effort put in by the semiconductor industry to increase the number of transistors that could be packed in a chip. Switching speed of CMOS was slower than that of ECL. The ETA design team decided to use CMOS technology in its CPU. To increase the switching speed of CMOS the team came up with an innovative idea of immersing the CPU in a liquid nitrogen bath at -196.5° C. (Nitrogen is an electrical insulator). Studies showed that cooling CMOS circuits increased their switching speed by a factor of two, speed similar to ECL circuits. The packing density of transistors in a chip increased dramatically by choosing CMOS. The CPU consisting of 250 integrated circuit chips could be packaged in a single printed circuit board eliminating error prone back panel interconnection circuits. The printed circuit board that was designed had space to place 260, 1 sq. cm IC chips, each chip with 20,000 gates. Each IC had 284 pins including 40 power and ground connections. The printed circuit board was a marvel of technology in the 1980s. It was a 41.9 cm × 57.2 cm × 0.64 cm, 44 layers board on which the logic chips were mounted and interconnected using 75000 plated through holes. Each IC chip had innovative self-checking logic circuits for ensuring reliability. At the end of the board there was a 3864-pin connector to connect the CPU to the memory system and I/O. An enclosure was designed to store liquid nitrogen and up to 2 CPU boards could be immersed in it [1]. The system was a shared memory parallel computer with up to 8 CPUs. The memory

**ETA 10 CPU Board being shown to me (third from left) and my team at the ETA factory**

system was mounted on the CPU enclosures and connected to the CPUs. Each CPU had 32 MB SRAM. The system was a shared memory parallel computer with 2GB DRAM that was shared by all CPUs. Besides these there was a fast communication system buffer memory to speed up communication between CPUs in the parallel configuration.

ETA 10 system had 10 I/O processors and used fibre optics to connect them to the memory – an innovation at that time. The CPU clock speed was 7nsec. The largest 8 CPU liquid nitrogen-cooled system, ETA 10G had a speed of 10 GFlops, a very high speed in 1986. ETA systems also marketed an air-cooled version, ETA 10P whose clock was 19nsec and speed 370 Mflops. To sum up, the hardware design was highly innovative and met the design goal of 10 Gflops computer.

### Software of ETA 10

While hardware design was a triumph of technology, software design was an enormous failure. ETA software group decided to design an entirely new Operating System (OS) named EOS that was to be upward compatible with VSOS the OS of CDC 20x series of supercomputers. They also made a wrong decision to use Cybil, CDC's proprietary language (derivative of Pascal) instead of C to write the OS programs. The problem was compounded by non-availability of ETA prototype hardware to test the OS. The supercomputer being made by Cray was shifting to Unix based OS away from proprietary OS. The users were also becoming more comfortable using Unix and were demanding it. The development effort of EOS was so slow that when the first ETA 10 was delivered to the Florida State University it was not ready and the University had to run manually one program after the other. Towards late1985, ETA bowed down to market demand and started developing Unix with the assistance of an outside contractor and it was ready by 1987. Most users preferred Unix OS. EOS had many bugs. ETA was unable to run many important application programs as it had not developed the necessary software including an optimizing Fortran compiler. Indian Institute of Science was evaluating ETA along with Cray and other supercomputers in the market in 1987. The institute sent 15 application programs to all the vendors including ETA. ETA was unable to run some of the important applications such as NASTRAN due to the non-availability of appropriate software whereas Cray was able to run all the programs in record time.

### Demise of ETA Systems

ETA Systems sold 7 liquid nitrogen-cooled systems and 27 air-cooled systems and had the best price/performance ratio of any supercomputer in the market in 1989. In spite of this, CDC decided to close down ETA Systems in April 1989. Around 800 employees of ETA Systems were asked to assemble in an auditorium in Minneapolis and the HRD manager announced that all employees would be given one month's salary and terminated.

The three reasons for starting ETA Systems, namely obtaining capital from the market, making it independent of CDC's management, and getting R&D funding from the government were not seriously followed up. CDC treated ETA System as a fully funded and controlled subsidiary, interfering even in its day to day functioning. No R&D funding was given by the government. CDC's mainframe business was becoming unprofitable and it found it difficult to support ETA Systems. CDC tried to sell ETA Systems but found no buyers [2]. The software of ETA was poor. Liquid nitrogen cooling of CPU board put off customers as the board cannot be taken out abruptly from liquid nitrogen to repair as it would crumble. Each repair of the CPU required the CPU board to be slowly heated and brought to room temperature, repaired and immersed again cooling it slowly to liquid nitrogen temperature. This was one of the most intimidating features of the computer as the time to repair each fault would be a few hours. Besides this problem, liquid nitrogen needs replenishment as it would evaporate as the CPU board gets heated during its operation. To replenish liquid nitrogen ETA systems designed a compressor that would take nitrogen vapour, liquify it, and pump it back to the liquid nitrogen tank. Customers wondered, if they bought an ETA system, whether they would be running a computer or a liquid nitrogen plant!

### References

[1] D.M. Carlson ***etal***, The ETA10 Liquid-Nitrogen-Cooled Supercomputer System, IEEE Transactions on Electron Devices, Vol.36, No.8, August 1989, pp. 1404-1413.

[2] Rob Peglar, The ETA Saga, https://yarchive.net/comp/eta_peglar.html

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## About the Author

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A pioneer in Computer Science, education and research in India, Prof. Rajaraman was awarded the Shanti Swarup Bhatnagar Prize in 1976. He is also the recipient of Homi Bhabha Prize by U.G.C., Om Prakash Bhasin award, ISTE award for excellence in teaching computer engineering, Rustam Choksi award, Zaheer Medal by the Indian National Science Academy, Padma Bhushan by the President of India in 1998, and lifetime contribution award by the Indian National Academy of Engineering and Computer Society of India. He was awarded DSc (h.c.) by IIT, Kanpur and by Bengal Engineering and Science University, Sibpur. An author of several well established and highly successful computer books, Prof. Rajaraman has published a large number of research papers in reputed national and international journals. (A detailed biodata may be found in en.wikipedia.org/wiki/Vaidyeswaran_Rajaraman).