Datasaab Experiences and Reflections

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At the final meeting of the Friends of Datasaab (Datasaabs Vänner) on 23 January, 2018, I talked about the history leading to the development of the Datasaab FCPU (Flexible Central Processing Unit) used as the CPU in the D23. Kjell Johansson asked me to prepare a notice about these developments for the final Newsletter that I am pleased to provide.

My Datasaab experiences are also mentioned in a chapter I did for an IFIP book on Computer History in 2012 and I have keep this updated. Latest version is available for download at:

https://www.thesystemslandscape.com/author

In this notice, I provide a more detailed description of the events leading up to the FCPU development, describe the development and provide some important reflections.

After several years at Univac (1959-61) and IBM (1961-67) working on compilers and programming languages, I became interested in computer architecture and microprogramming. I led a small research group at IBM in NYC from 1965-67. There we developed ideas for enhancing performance and reducing software complexity via so-called T-Machines (designed for compiler development) and E-Machines (designed for execution environments for higher-level programming languages). These ideas, while interesting, would not change IBMs direction that had already marched into what I call “the black hole of complexity” with the IBM 360.

I left IBM to become a professor at Brooklyn Polytechnic in June, 1967. While there, with a few students (including Len Shustek – now Chairman of the Board at the Computer History Museum in Palo Alto) we implemented the T and E Machine ideas as interpreters for a subset implementation of the PL/I language (running on an IBM 360 model 50). We called it PLAGO (Polytechnic Load and Go) that was quite successful and provided for quick translation and execution (a few seconds per student job). Around this time the ACM started a special interest group on microprogramming (SIGMICRO). There I met Professor Sir Maurice Wilkes (inventor of microprogramming) and several other colleagues with common interests in exploiting microprogramming.

One company, the Standard Computer Corporation of Santa Ana, California had already developed and marketed microprogramable computers (IC 4000 and 7000)

that emulated both the IBM 7090 and the 1401 computers. I joined them in June 1969 and together with Dave Keefer and Burton Smith was co-architect of a next generation machine called the MLP-900 (Multi-Lingual Processor). This attracted significant international attention and one day in the spring of 1970 Gunnar Lindström visited us at our facility in Newport Beach. As a result, after a visit of Bengt Asker, discussions about a licensing of the design transpired. Kurt Widin, Lennart Ridell and Bengt Malm came to Santa Ana and we began to plan for the emulation of D22. Fred Howden at that time CEO of Standard Computer visited Linköping as well to start discussions about the license agreement.

Later in 1970 unfortunately a major shareholder in Standard Computer, Jim Hines became CEO and Fred Howden and even Dave Keefer (a founder) were dismissed. Hines had only "next quarter thinking" about profitability and cancelled the MLP-900 project. Despite the fact that we had a working prototype and concrete orders from the Stanford Linear Accelerator Group (SLAC) and the Rand Corporation as well as expressed interest from the US Air Force to buy several machines.

Note: The prototype MLP-900 was delivered to the Rand as a settlement of breech of contract. Some people at Rand left and moved the machine to the University of Southern California Information Science Institute. There some minor hardware changes were made and a set of software support tools developed. An emulator for the PDP-10 computer was made and it was put in a dual configuration with a real PDP-10. It was then placed as a node in the original ARPA network and provided a unique research facility for developing and testing emulators remotely. This was used by, amongst others, the US military to emulate several computers like Anyuk.

So, access to the MLP-900 was not available for Datasaab and personally, I returned to Brooklyn Polytechnic. In the fall of 1970, Bengt Asker contacted me and inquired if I would be willing to come for 3 months to explore a path for developing a microprogramable machine. I agreed and the same time agreed with ICL in England to come for 3 months as well (6 months leave from my professorship). ICL was also very interested in licensing the MLP-900.

On 1 February 1971 I came to Linköping (A very cold day). Together with several of Bengt Asker's people, especially Gunnar Hallin as well as Bengt Malm, we started to explore what could be done. I then developed the fundamental concepts of the FCPU and presented them to Gunnar Lindström, Viggo Wentzel, Bengt Asker, and others. The idea to build a machine that could emulate the D22 but (as was planned also for the MLP-900) as well as to implement T and E Machines for a future generation (we called ND – Ny Dator) with significantly improved performance.

Since Datasaab liked my ideas, I did not go to ICL and stayed on the entire 6 months in Linköping. So, working closely with several colleagues and especially Bengt Malm, we structured up my concepts to a proposed architecture for the machine and gave it the name FCPU (Fleixble Central Processing Unit). I returned in September to Brooklyn but continued to work on the architecture. Bengt Malm came over to

Brooklyn as well and we continued our cooperation. I also came to Linköping for a week around the Thanksgiving holiday. I think shortly after that Datasaab decided to go with this design. An implementation group was set up under Bengt Magnhagen and detailed design and implementation plans were developed. I then decided to return to Linköping in January of 1972 and assist in the implementation.

Well, I must say, working with Bengt and his team including Bror Petterson, Bengt Malm, Valter Sundström, Ingemar Andersson, Per Falk, Rolf Flisberg, Karl-Erik Johansson, Håkan Danielsson, Bengt Eriksson, Rolf Loh, Johnny Ahl, Sture Lahrin, Jan Ställborn and Sven Torneus was a real pleasure. Also Gunnar Hesse supported the effort by hunting down appropriate components in the USA. We moved quickly from concept to reality. The microprograms for the D23 emulation were developed by Håkan Niska and Torbjörn Granberg. However, I did the microcode implementation of the floating point arithmetic instructions.

Lars Blomberg programed a simulator of the FCPU in Algol-Genius and a ML (Microprogramming Language) translator in Cobol. These were operable on the D22 and provided a means of developing and testing microcode before the prototype hardware was available. This proved to be an important facility.

Due to the structure of the FCPU as asynchronously controlled units that communicated via hardware semaphores, the unit testing and integration went quite smoothly and I was extremely surprised that the entire development cycle was so short. This notion of locally synchronous – globally asynchronous served us well and became the hallmark of lower power processor designs in the microprocessor era. The approach eliminated the need a single global clock signal. During the implementation we did have some component problems, particularly with a new generation of Intel memory chips.

During the spring of 1972 Bengt Asker and I visited universities at Linköping, Lund, Chalmers, KTH and Uppsala and I lectured about the FCPU resulting in significant interest. Also NUTEK became interested and there was a meeting in Rimforsa to discuss how universities could contribute to the further development of this new machine. Some great ideas evolved. Despite efforts of some researchers, this did not evolve into any type of concrete product result.

Well, several D23 machines were delivered to customers. One customer that was planning for D23 was SMHI. I met with Lennart Bengtsson of SMHI who was really interested in our FCPU-D23 approach. So, I together with Lars Blomberg developed a plan to have a facility in the Fortran compiler to invoke a special set of vector arithmetic functions and I wrote and tested the microcode for these extensions. We called this the Datasaab Array Manipulation Package (DAMP). This would have speeded up weather calculations enormously as the machine had a novel memory addressing mechanism that supported multi-streaming from memory.

Reflections

We all know the disruptive microprocessor hardware technology that arose during the mid 1970,s that radically changed hardware economics. Had this not happened, or was delayed for say 5 years, and we could have implemented T and E Machines, I am sure we would have become an important international actor in the computer industry. Given FCPU performance, I estimated the performance improvements for implementation of the T Machine and E Machines (for Fortran, Cobol and Algol-Genius). I am convinced we could have had about 20 times compiler performance for all languages and somewhere between 6 and 8 times for the programming language E Machines compared to D23 performance.

For me personally, this was a very exciting period of my life. I was involved in discussions with two other manufacturers about cooperation. One was Regnecentralen in Denmark. They were quite interested in cooperating around a new generation of machines based on the FCPU that would exploit their operating system from the RC4000 and RC6000 projects. Rune Nyman and I also met with the VP of the Burroughs Corporation and discussed cooperation. It is quite well known that the Burroughs machines B5000, 5500 and 6500 also provided for direct execution of programs expressed in a higher-level language. These machines were architected by Robert "Bob" Barton. Neither of these became a reality and as we know Saab-Univac was created to take over D20 series customers. We can also note that Univac and Burroughs eventually merged to build Unisys.

The design of the FCPU resulted in significant interest in the USA and several academic colleagues took up the design in their computer architecture courses. The paper "Advantages of Structured Hardware" authored by Bengt Magnhagen and myself received the Best Paper Award and the 2nd annual International Symposium on Computer Architecture in 1975. Further, I was involved in two patent cases where the FCPU was cited. Fortunately, I found some documents that I needed at the Datasaab archive in Vadstena. (A great bit of history that must be preserved.)

As a final reflection I must say that working with a small group of qualified and motivated colleagues that I found at Datasaab has left a permanent impression. We worked hard but we had a lot of fun as well. THANKS to all for this fantastic experience.

Publications

Several publications were produced about the FCPU and it has been my pleasure to co-author many of these with colleagues.

A Flexible Asynchronous Microprocessor, The Scandinavian Computer Journal BIT, Volume 13, Number 2, June 1973. Co-author Bengt Malm.

The Datasaab FCPU Microprogramming Language, Proceedings of the SIGPLAN/SIGMICRO Interface Meeting, May 1973. Also published as Saab Scania Report GM-72:296, November

1972. Co-author: Lars Blomberg.

SILL Specification (A System Implementation Language Proposal), Internal Saab Scania Document, May 1974. Co-author: Lars Blomberg. (Note: Planning for the T and E Machine implementations).

Advantages of Structured Hardware, Proceedings of the Second Annual Symposium on Computer Architecture, Houston, Texas, January 1975. Co-author: Dr. Bengt Magnhagen. (Note: selected as the best paper at the Symposium).

An Asynchronous Approach to Microprogramming, A chapter appearing in Microprogramming and Firmware Engineering Methods (editor: Prof. Stanley Habib), Van Nostrand-Reinhold, 1988. Also published as report LiTH-IDA-R-86-09, Department of Information and Computer Science, Linköping University.

In addition there are several Datasaab internal memorandum about the Standard Computer plans as well as the development of the FCPU and its usage that I have retained.

IMPORTANT TO NOTE

I am in the process of donating much of my historical information to the Computer History Museum and will be donating information about the FCPU. The Museum is also interested in receiving other information about the history of computing. If some of you have something that you would like to donate, it would be quite welcome. This even includes sales brochures about products. For example, I have a Swedish version of the brochure about the D23 but I know there was an English version. Let us make sure that Swedish computer history gains a place in this international recognized museum in Silicon Valley. You are most welcome to contact me if you would like to discuss any aspect of donating physical objects as well as documents.

Please check out the website concerning donations at:

http://www.computerhistory.org/artifactdonation/