Professor Armstrong, the HUB, and I (1977-1981)

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I was Employed by the University of Kansas

After attending the University of Kansas for a couple of years, I had just about exhausted all of the computer science electives which were possible to add to a B.S. in Physics. The spectre of "computer science withdrawal" was looming on my horizon. It was clearly time to do something about this situation. In desperation, I went to the basement of Mallot Hall. I found dusty dewers, dingy labs, cranky professors, strange graduate students, and Room 31.

It seemed that the Physics and Chemistry Departments shared a Local Area Network (LAN) called the Chemical Physics Trilevel Computer network. It was based upon a MODCOMP II minicomputer system. This system was the result of a $250,000 joint Electrical Engineering and Computer Science research project and was among the first of its kind. The MODCOMP in Room 31 was connected in a star-network to three HP 2000 computers from Chemistry, another MODCOMP II (with no local disk storage and only 16K words of memory!) from the Physics department, to KU's Honeywell 635 computer, and to a few other machines including a locally manufactured Kantronics computer belonging to Prof. Friauf.

The main MODCOMP II was quite a machine. It had lots of peripherals (including a Versatec 1100 electrostatic printer), 48K words of memory, 64 peripheral address with 12 main interrupt levels, 5 Mb total disk space, floating point hardware, and direct memory access capability. The memory cycle time was only 800 ns, just 50 ns longer than that of the Honeywell 635 mainframe computer. All of the hardware for the "Hub" fit into only five full sized floor to ceiling cabinets – much smaller than the Honeywell. The computational performance was quite good. This machine was approximately equivalent to a Macintosh Classic with 128 Kb of memory.

The MODCOMP system was jointly funded by Prof. Gilles (chemistry) and Prof. Culvahouse. Hardware and software maintenance, along with system management, was being done by Dwight Baldwin. He was a six or seven year veteran graduate student working for Prof. Culvahouse and was about to complete his thesis. So, there was room for me to take over his computer support activities. But there was little or no money. By now, I was hooked – a computer system that was clay in my hands. Of course, I would have spent incredible numbers of hours playing with the MODCOMP. However, Professors Gilles and Culvahouse wanted me to have responsibilities as well – and this upstart physics professor, Tom Armstrong had money and was beginning to use the computer system. TPA hired me on the spot and immediately went on sabbatical to Germany.

Learning about the MODCOMP

Whenever the liquid nitrogen fights between Dwight and Henry, another solid state graduate student, became just too predictable, the MODCOMP would save the day. The MODCOMP system was old and broke down fairly frequently. Computer crashes were always exciting times. Dwight would open the cabinets, exposing hundreds of TTL ICs and thousands of wire wrap connections. Large 15" x 24" schematics would be scattered throughout the room. Oscilloscopes and other equipment would be moved from the solid state labs to Room 31. Some of the paper tape diagnostics might actually still run on what was left of the hardware. We (Dwight, sometimes Henry, and I) would all stare at the console LEDs, the logic diagrams, the oscilloscope traces and try to prove that the suspect IC was actually bad. These sessions would always take at least 12 hours and never finished before three or four in the morning. But, they broke the pattern and introduced me to a fairly complicated digital electronic system.

The Network Comes Alive - again!

Meanwhile, Henry and Dwight left. Henry came back the next summer and completed his Ph.D. I don't know if Dwight ever completed his degree – to much MODCOMP maintenance, not enough physics. TPA came back. Joe Nonnast, Betsy Wainwright, and Jack Price moved into my little office adjacent to Room 31 – we couldn't decide whether Olivia Netwon John or Linda Ronstadt was the more attractive singer. Rob Decker and Pat Briggs were busy analyzing IMP results on the MODCOMP. TPA was getting started with Voyager. Robert Bunch and Prof. Unruh were beginning to think about using the satellite Modcomp to control new experiments in optics and Prof. Gilles got another grant. It was time to reassemble the network.

The communication network was custom designed and only documented in the research reports for the Hub. Spare parts were not available and the "home" built printed circuit (PC) boards were in poor shape. No problem. Prof. Gilles and I parted out all unused network hardware, cleaned the pins on the connectors, wrote diagnostic routines to run on both the Hub and the remote machines, and swapped boards as needed.

It is hard to believe, but this was the last time that the Hub had any networking problems. All subsequent interruptions in the network were traced to hardware/software on the remote computers. The Chemistry HP machines continued to use the network almost to the day the Hub was powered down for good. Even the satellite Modcomp II ran until too many spare parts were lost to the Hub.

Voyager Data Processing using the Hub

By now we were receiving Voyager Experimental Data Records (EDR) tapes from Krimigis and friends at APL. TPA was responsible for decompressing the EDR tapes and producing the 5 minute Flux Averaged Tapes (FAT) plus associated graphics. This turned out to be a fairly complicated process. The Hub had only one 9-track tape drive – a WANCO 45 ips 800 bpi unit. The EDR tapes had to be decompressed and dumped to a scratch disk. The FAT tape was then mounted and the stored EDR data averaged and appended to the FAT tape. After the FAT tapes were complete, they became input for the graphics display program which produced the hardcopy output on the Versatec.

TPA wrote all (or rather almost all) of the code to handle the raw Voyager data processing. Poor TPA did not grow up computer literate. It took us years to unravel his programs. Whenever anything went wrong, half of Laurel Md. would call and TPA would cover any available free space with various flow charts. The other graduate students and I provided much of the manual labor in actually getting the work done. We also provided considerable software support – graphics routines, binary number conversion, etc. But, TPA continued to do most of the physics programing and most of the thinking.

I have seldom met people who are as active and capable as TPA. However, there was one area of the data processing in which TPA did not participate. Hardware is usually thought to be maintenance free. But this was not the case for the HUB. Both the WANCO tape drive and the Versatec constantly required maintenance. The Versatec was the worst. It had a liquid toner dispersent system. Hence, there were plumbing as well as electrical problems!

TPA discovers the government surplus list!

We were getting behind with the Voyager data processing. The Hub, with its single tape drive just couldn't keep up with Voyager. Worse, the near-encounter with Jupiter wasn't far away. Soon, Voyager was going to be sending a lot more data. Something had to be done. TPA quit throwing away the surplus equipment notices and found a Modcomp I system complete with a barrel disk drive and a functioning WANCO tape unit. It wasn't long before there was another computer system in the basement of Mallot Hall.

The Modcomp I system was almost as big as the Hub and nearly totally useless. It was pointless to even hope that this system would run again. However, the tape drive was nearly the same model as the Hub's, and the equipment racks were similar. Room 31 was rearranged so that the new tape unit would fit. After some maintenance and magic, the Hub had two tape drives.

Voyager production now proceeded at about twice the rate as before. Multiple EDR tapes were mounted and averaged to the FAT tape – without the intermediate disk operations. TPA's production programs became more complicated. After a while they worked again, and just in time – we were behind in production.

Another property of graduate students (I was one by now), was that in spite of Voyager production, there was always time to play.... It was cold and snowing outside. The Hub was busy digesting Voyager data tapes, we were preparing for finals, and it had been a long time since TPA checked up on the remains of the Modcomp I. This generated the following idea. The old disk drive had a large (3-4 feet diameter) fiberglass shell mounted over the barrel shaped disk. It appeared that if one removed the shell, it would be handy to slide down hills covered with snow. There were an incredible number of screws fastening the shell to the disk housing. But it wasn't long before the physics department had a new snow disk. Unfortunately, it also wasn't long before the department's new (now chilled) snow disk shattered upon impact with an unmovable object. It was time to surplus the surplus Modcomp I. TPA didn't comment about the missing disk drive shell – at least not much!

The HUB becomes a multi-user system

By middle of 1978, Voyager processing was beginning to take exclusive use of the HUB system. This was a problem. The solid state Roberts, (Rob Bunch and Rob Barnett) had already been moved to the satellite Modcomp system. There was no place left for TPA and his cadre of graduate students (Mohammad Ahmadian, Pat Briggs, Rob Decker, Frank Kutchko, Joe Nonnast, Mark Paonessa, Jack Price, Elizabeth Wainright, and me) to develop new codes. We needed another computer – and we didn't have another $250,000!

TPA and I discussed the problem and found a solution. The HUB's memory could be expanded by another 16K words – enough to support another user. The operating system already had the concept of "background" (where everybody was currently working) and "middleground" (for running diagnostics). The only problem was that middle ground could not support any of the system utilities such as the editor and FORTRAN compiler. TPA purchased more Modcomp memory and hired a Modcomp consultant, Kelley Gregory, to fix the software problems.

Kelley was the perfect consultant. He came up with all of the right promises - then waited for me to figure out how to make it all work. By December, we had succeeded. The HUB now had a "B" and a "C" user area. The original user area ("C") was now reserved for Voyager data processing, and new area ("B") was available for interactive programming.

The HUB was now doing nearly twice as much work as before. The new system ran fairly well, that is with one notable exception. Once an additional Hazeltine terminal was located, we discovered a problem with the hardware. The serial port controller could not always tell which terminal had sent the last character. Hence, from time to time, one person's typing would be sent to the other person's program!

Tom's empire expands

It was late 1979 or early 1980, Voyager I had completed a successful encounter with Jupiter. Mark Paonessa, TPA, and I were busy unfolding pitch angle diffusion data from the Voyager information. TPA's graduate students were scattered all over Mallot Hall (Tom's office was still on the 5th floor). Everyone was working on some segment of the Voyager data.

However, some other instrument groups on Voyager began producing color plots. There was no color on the Modcomp. Meanwhile, the last nuclear (really atomic physics) graduate student, Randy Zombolla, had completed his degree in Biophysics. This left a rather large nuclear physics lab, Room 55, which was now unused.

Room 55 was really a complex of rooms, all built to support the department's 5 MeV Van de Graaff accelerator and related computer interface (IBM 1800 series). All of this was just so much junk, but there was a gleam in TPA's eye's. He persuaded Prof. Prosser to sell (give) all of this equipment to, I think, Oaklahoma State University for perhaps $12,000. TPA was then able to use this money, along with about an additional $3,000 to purchase a color Tektronics 4027 terminal and pen plotter. Soon we were producing color plots, too.

But TPA wasn't done. Now the Room 55 complex was really empty – and available. With the exception of a small office kept by Prof. Prosser and Bob Racca, the rest became the territory of "Armstrong and his space physics bandits". I was now alone in my office next to the HUB. It would be another nine months or so before I moved to Rm. 55.

End of an Era

As the Voyager Jupiter encounters came and went, the HUB became very over loaded. EDR tapes started piling up. TPA moved to a 24 hour production schedule. The HUB hardware was getting older and even less dependable.

Luckily, by this time my ability to both trouble shoot the HUB system and scrounge for parts (I had a lab master key) had reached new heights. Eric Shank and/or Rob Bunch would help as well. It was my policy to always, no matter what, replace bad unsocketed IC's with sockets. The circuit cards in the WANCO tape drives and the Versatec 1100 now had a large percentage of their IC's in sockets. This was intended to speed repair if the same thing broke twice. Unfortunately, it was usually a different IC the next time! There were now about three levels of hardware crashes. The easiest type of problem was that of a dead power supply (one of the twelve) or a bus problem somewhere. This level of problem was scarcely worth mentioning – down time was seldom even two hours. Then there were the problems with one of the

hardware controllers or CPU boards. These were challenging. Down times were up to three days (involving lots of midnight oil). And finally there was the Floating Point Accelerator.

Without the floating point accelerator, the Voyager processing proceeded at a crawl. Hence, it was important to repair. However, there was little documentation, and many errors in the schematics. Also the frequencies were higher than that of the CPU. It was very difficult to obtain meaningful diagnostics with the equipment available. Repair of the floating point accelerator proceeded by trial an error - and there were possibly 300 IC's involved. This was not very satisfactory.

We also had a lot of trouble (before we purchased upgraded mother boards) with the Tektronics 4027 color terminal. Finally, late one night, I was just fed up with the poor color convergence on the 4027. Before I was a graduate student, I earned pocket money repairing color TV's. The 4027 could not be harder to converge than those ancient color TV's. Off came the access panels, out came the instructions. It plainly said to use nonconducting tools, however fiber tools just don't turn set screws properly.

I made good progress in clearing up the convergence problems. But, suddenly, the screen went blank. Have you ever smelt the smell of semiconductors frying? Unfortunately, I have many times. The smell of a very expensive (still under warranty) color terminal burning was one of the worse. It took a soldering gun, inspired guesses, extensive searches for spare parts, and the rest of the night, but the Tektronics was working again by 6:00 AM – which coincided with the opening of Joe's Doughnut Shop. The color convergence was not much better that it was before I started. But, after all of this, it didn't bother me as much.

We NEEDED a new computer system. With a little coaching, TPA put out the bids. We expected to choose between a Modcomp IV or a HP minicomputer. Lady Luck was still smiling at us. When the bid closed, there was an unexpected competitor. DEC had just released a cheaper (slower) version of its "superminicomputer" series, the VAX 11/750. The VAX was still quite expensive, but Tom took the chance, and had it installed in the Rm 55 complex. All of our lives would be forever changed with the coming of the VAX. But, that is another story.