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AN IBM 360/370 CHANNEL FOR CDC COMPUTERS

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Introduction

The Lawrence Berkéley Laboratory has developed hardware and software subsystems to allow the use of IBM plug-compatible peripherals on the CDC 6400, 6600 and 7600 systems installed at the LBL Computer Center. This has given the ability to replace unreliable CDC tape drives and controllers and overpriced CDC disk drives and controllers with their IBM plug-compatible versions.

Most important of all, LBL is now able to procure peripherals in an open and competitive marketplace, taking advantage of the best cost and performance benefits available in the computer industry today.

Background

LBL has used large CDC computer systems since 1965. These systems historically used only CDC designed and built peripheral systems. This was not at all uncommon for computer systems of this era as the developments prior to then had hardly yielded any standards in channel, controller and peripheral technology worth standardizing upon. Only the most commonly

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used storage media were standardized (e.g., Hollerith punched cards, 5 and 8 channel punched paper tape, and IBM 7 track NRZI magnetic tape).

Then the IBM System 360 appeared and became the first really upward compatible computer system family offered in the marketplace. It was totally accepted as a standard to compete against. About 1965 efforts began in earnest to carve out a piece of the IBM marketplace, not by offering something different, but the same thing cheaper and sometimes better (occasionally worse, too).

Of course the easiest place to compete then was in the peripheral area as IBM had defined a 360 channel standard to allow movement of peripherals between systems. This led to the explosive plug-compatible manufacturing (PCM) industry that now includes most all peripherals imaginable: tape, disk, unit record, communications, mass storage, etc.

Early in the procurement of the first LBL CDC 6600, we felt that IBM printers and mass storage systems were better than those offered by CDC. In fact, CDC had no equivalent mass storage to the IBM 2321 data cell or the IBM 1360 photodigital storage system. In the case of the IBM 1403 printer and 2321 data cell, CDC obliged by designing controllers (which are in use by LBL today) to allow the connection of these devices to 6000 channels.

LBL was not so lucky with tape and disk peripherals as only the CDC versions were available. CDC dual capstan drives (e.g., 60X and 65X) performed in an unsatisfactory manner for LBL. The CDC disk drives have been very good performers, though the controllers for them are often difficult to use. The big problem with CDC disk drives, for use on CDC systems, is the price. Current IBM plug-compatible 3350 disk systems are only about 45% of

the price of equivalent CDC 844-41 disk systems. Interestingly, CDC also competes in the IBM disk system market at the aforementioned 45% of their own captive disk market prices. Clearly this is an unacceptable situation.

Adapter Project

By 1973 LBL had become discouraged enough about CDC peripherals that Bob Harvey came up with the idea of attaching IBM peripherals to the LBL Computer Center mainframes. Because of our continuing technical and managerial interaction with the Brookhaven National Laboratory Computer Center, discussion, at an informal level, occurred with technical staff at BNL.

BNL was interested in pursuing technical evaluation of the idea. In early 1974 LBL, KAPL and BNL technical staff met at BNL and discussed the impact of IBM peripheral systems on the operating system environment and the hardware required to adapt the CDC channel to an IBM channel standard. The results of this meeting were:

(1) To pursue a search, in the marketplace, for hardware capable of performing this IBM adapter function on CDC mainframes. Though there was discussion about the concept of having minicomputers act as interfacing devices, it was generally agreed that system complexity was reduced by connecting the peripheral controllers as closely to the native CDC 6000 or 7600 channel environment as possible. This means no CDC 6681 3000 channel adapters or minis, but a single hardware device capable of 6000/7600 interfacing on one side and IBM 360/370 peripheral controller interfacing on the other.

(2) A clearer understanding of the operating system problems in supporting IBM style peripherals. BNL systems people felt that their staff could not afford to handle the manpower problems of supporting non-standard I/O drivers while LBL felt it was possible. (Note that LBL develops its own operating systems, as do LLL and LASL, while BNL uses standard CDC operating systems.)

Though it seems desirable to have the hardware interface make the IBM peripheral controller look like its CDC counterpart, as it minimizes or eliminates software effort, it is impractical to do. On the hardware side, it would double the complexity of the device and make it quite unique for each peripheral type interfaced. On the software side, it would not allow PPU access to the many superior features of IBM controllers. More will be said relevant to this software issue at the end of this paper.

(3) That it was basically a good idea to pursue the IBM plug-compatible peripheral systems issue further, with LBL being the initial point of focus as it could commit to the effort.

LBL circulated a request for information among IBM plug-compatible vendors and several engineering systems houses, and received only one reply. This was from National Computer Systems who offered a device called a UN-100. The UN-100 was a generalized micro-sequencer processor capable of CDC 6000 channel interfacing. The UN-100 was then being installed in several CDC 6000 environments where non-CDC peripherals were being interfaced. Micro-sequencer programs were being written for the UN-100 to allow it to act as a disk or tape controller. In the spring of 1974, LBL, KAPL and BNL technical staff visited the NCS plant in Houston, Texas. Though

the UN-100 has definite capabilities, it was determined, after several months of evaluation and actual work with the UN-100 at LBL, that it was not flexible enough, or fast enough, for the task of being an IBM adapter without substantial additional hardware work. It also represents a larger cost component than the eventual total adapter reproduction cost.

At this point LBL decided to undertake the engineering development of an IBM adapter. Design specification started in early 1975 leading to the start of actual logic design in mid-1975. The prototype 6000 version of the IBM adapter became operational in June 1976.

It was decided that the most productive peripheral system to experiment with first was a 380X/3420 tape system. This was due to the great problems LBL is having with CDC tapes and LBL's interest in the new 6250 BPI tape drives for SLAC tape compatibility and mass storage. After looking carefully at the tape market, it was clear that IBM and STC (Storage Technology Corporation) are the leaders in quality tape systems. LBL feels that tape diagnostics are the most critical of all diagnostics for peripherals, thus it became a strong need that any tape controller chosen should have a significant stand-alone diagnostic capability. (CDC mainframes cannot run IBM diagnostic programs.) STC has such a capability, and in fact is a leader in this area. Also, there is a nearby STC installation (including 6250 BPI drives) at UC Berkeley, with an on-site spare parts depot. LBL is thus leasing, on an experimental basis, an STC tape controller system with two tape drives (one 6250/1600 9 TRK, the other an 800 7 TRK). The IBM tape handlers, for the LBL system, are now being debugged. LBL hopes to be operating the STC tape system at an experimental user level (via the LBL IBM adapter) in October 1976.

LBL is now canvassing the IBM plug-compatible disk system marketplace to determine how to proceed in the disk peripheral area.

When necessary, the LBL IBM adapter will be modified to operate on a CDC 7600 front level PPU channel.

The LBL IBM adapter has the following basic features:

(1) IBM 360/370 block multiplexer and selector channels are supported.

(2) Bus extension, I/O error alert, command retry and high speed transfer IBM channel features are supported.

(3) Speed capabilities of the adapter are 400 ns/12 bit wd on the 7600, 1 μs/12 bit wd on the 6000/CYBER 70, 500 ns/12 bit wd on the CYBER 170, and 500 ns/16 bit wd on the IBM channel (with bus extension and high speed transfer).

(4) Internal buffering to allow PPU startup and switching to handle high speed long record transfers.

LBL welcomes participation of those ERDA computer centers now using CDC mainframes. Extreme care has been exercised (by LBL) to see that the hardware is easily and cheaply reproducible away from LBL (or by LBL) and that it is of the high reliability needed for the large CDC computer environment.

Conclusion

LBL has proven the value of the IBM plug-compatibility concept for CDC mainframes. In the next year IBM plug-compatible tape systems will replace the less reliable CDC tape systems and offer 6250 BPI service as well.

The disk controller and disk drive capacity of the LBL Computer Center can now be enhanced at extremely low prices (45% of CDC disk system prices).

The most important issue revolves back to software effort. Many large CDC installations use standard CDC operating systems (e.g., Fermilab and BNL). These sites are quite reasonable in their unwillingness to take on large, to them, system programming tasks to rewrite and maintain tape, disk and other peripheral subsystem handlers. What is unreasonable is the captive marketplace Control Data enjoys as they supply no software handlers and hardware interfaces for IBM plug-compatible peripheral systems on their large computer systems. Instead, they compete in the IBM plug-compatible marketplace at competitive low prices and maintain high prices in their CDC captive audience marketplace.

It also seems absurd for Control Data to maintain duplicate controller design organizations, within their own company, for identical peripherals. Some devices, such as the 819, are unique to CDC large mainframes; however, other even more desirable products (e.g., the 400 MB disk drive, the 38500 mass storage system, and the 6250 BPI tape drives) are offered to the IBM plug-compatible marketplace before their own CDC mainframe marketplace.

Well, all this seems quite ridiculous and unacceptable. The LBL Computer Center management believes that ERDA should seriously consider restricting all future large-scale computer acquisitions to those manufacturers who will provide standard hardware and software support for IBM plug-compatible peripherals.

To conclude, LBL has developed an IBM plug-compatible peripheral capability for its large CDC mainframes that will offer large cost and performance benefits in the future.

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