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The Power Of Z-System

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In the November, 1985 issue of REMark, I described the features of ZCPR3, an enhanced Z80-based replacement command processor for CP/M 2.2. ZCPR3 replaces CP/M's standard console command processor (CCP) and provides tremendous power and flexibility. We can now take what we know of the benefits and features of ZCPR3 and move ahead to even greater heights. What Richard Conn did in creating ZCPR3, Dennis Wright did in creating ZRDOS. ZRDOS is an enhanced Z80-based replacement disk operating system. ZRDOS replaces CP/M's standard basic disk operating system (BDOS). When you combine ZCPR3 and ZRDOS you get "Z-SYSTEM". This means that by upgrading your CP/M 2.2, you have replaced so much code that there is nothing written by Digital Research left in the system. The CCP was replaced by ZCPR3. The BDOS was replaced by ZRDOS. The only thing left is the basic input/output system (BIOS) which was written specifically for Heath 8-bit computers by Heath.

In this article, I will explain the features of ZRDOS and a few advanced features of ZCPR3, as well as some special considerations which arose while implementing Z-System on Heath computers.

ZRDOS

ZRDOS is fully compatible with the ZCPR3 command processor, ZCPR3 features and utilities. It is also fully compatible with CP/M's BDOS, but it does a few things differently to enhance system performance.

Differences Between BDOS And ZRDOS

The bdos err is DEAD! ZRDOS permits disk swapping without requiring a control-C to warm boot. ZRDOS automatically logs-in a new disk after it was changed. There are, however, two special circumstances which require special discussion. ZRDOS will normally handle a disk swap and perform the warm boot as required. But if a file was open at the time you did the swap and an attempt is made to write to the file on the swapped disk, you will see the error:

```
ZRDOS Error 5 on B:
```

There are a total of six ZRDOS Error messages which are explained later.

The second special situation involves swapping a disk with one of a different density or number of sides. ZRDOS can not cope with this because it is not the responsibility of ZRDOS to adjust itself to disks of different densities or number of sides. This function is performed by the BIOS. On warm boot, the BIOS determines the density and number of sides of the disk. So, in the case of disk swapping, unless the swapped disk is of the same density and number of sides, a control-C will always be required. Under CP/M, a drive may be made read-only using the STAT utility. However, this R/O status is lost after a warm boot. Under ZRDOS, the drives R/O status is remembered after warm boots for improved file security. System calls which reset the disks will reset the log-in vector, but will not change the drive's R/O status.

In ZRDOS, a change was made involving the Read Console Buffer. The Delete key is now always treated the same as the backspace key and the control-R (retype the command line) was not implemented since these were Teletype oriented commands. It is important to note here that Heath's CONFIGUR utility does not know that ZRDOS has replaced the CP/M BDOS. Therefore, do not alter option 'L' on the Terminal/Printer Sub-Menu of CONFIGUR which allows control of the Echo-On-Delete in the old BDOS. ZRDOS will always treat the delete key the same as the backspace key and changing option 'L' in CONFIGUR will poke an undesired byte into ZRDOS which will corrupt it and produce unpredictable results.

CP/M supported two file attributes: R/O or R/W, and DIR or SYS. ZRDOS supports two more file attributes: Archive and Wheel. The archive attribute, when set, is used to indicate that a given file has not been altered since the last time it was copied to a backup disk (the archive disk). You could set or reset the archive bit manually with a ZCPR3 utility, such as PROTECT. You could also use the public domain program NSWEEP or you could use the ZRDOS utility SFA (Set File Attributes). The real beauty of the archive bit shines when using the ZRDOS utility AC (Archive/Copy). When you use AC to archive (backup) a working disk to another disk, AC will copy only those files whose archive bit is not set. If the archive bit is not set, that means that the file has been altered since the last time it was archived. After AC copies

and verifies the file, it will set the archive bit to indicate that it was archived. Now your backup procedures will not needlessly copy all the files from disk to disk. Modern archiving procedures copy only those files which changed since the last time archiving was done.

The Wheel Byte is a feature of ZCPR3 which allows system security. Turning the wheel byte off will disable certain ZCPR3 features and utilities. Depending on how you implemented your ZCPR3 system, you could place many restrictions on the user when the wheel byte is off. He could be denied access to user areas above a certain number or drives above a certain letter, as well as being denied the privilege of erasing or renaming files.

ZRDOS takes this concept further by placing a wheel-protect attribute on a file. If the W/P file attribute is set, any attempt to change this file will result in the error message:

ZRDOS Error 6 on B:

Changing of the wheel byte is under password control using the ZCPR3 utility WHEEL.COM or the resident command WHL, if implemented in your resident command package (RCP).

ZRDOS Function Calls

ZRDOS supports all of CP/M's BDOS Function Calls. Function Calls are used by assembly language programmers to interface their programs to the operating system. In addition to the standard Function Calls, ZRDOS supports four new calls:

- Function 47: Get Current DMA address
- Function 48: Return ZRDOS Version Number
- Function 50: Set Warm Boot Trap
- Function 52: Reset Warm Boot Trap

Function 47 will return the current DMA address in HL. Function 48 would be used to test for the existence of ZRDOS by programs which require it to be present in order to utilize its features. The last two functions 50 and 52 provide a method of intercepting a warm boot and transfer control to a custom program, such as one which would print user defined error messages.

ZRDOS Error Messages

The following is a comparison of the error messages found in BDOS and ZRDOS:

ZRDOS Error Number	ZRDOS Meaning	BDOS Meaning
1	Read Error on A:	Bdos Err On A:Bad Sector
2	Drive Select Error on A:	Bdos Err on A:Select
3	Disk R/O Error on A:	Bdos Err on A:R/O
4	File R/O Error on A:	Bdos Err on A:File R/O
5	Disk Changed Error on A:	N/A
6	File W/P Error on A:	N/A

The error display of ZRDOS is in the form:

ZRDOS Error n on d:

Where 'n' is the error number between 1 and 6 and 'd' is the drive letter on which the error occurred.

A utility is provided to expand the error message into screens of text data further describing the nature of the error.

Public

Using the "public" feature of ZRDOS, any drive from A through H and any user area from 1 through 8 can be designated public. Any files which are now placed in a public area are accessible

from any other drive or user area on the system. This means that you can place commercial files like WordStar or dBASE-II in a public area, and those programs can be run while you are logged into a different drive and user area. The programs will have no trouble finding their overlays in the public area, and they will run as though they are in the current user area. This allows tremendous flexibility in organizing your files on your working disks.

Re-Entrance

This feature is used to permit assembly language programs to access the ZRDOS system calls in between the times that another program was using them without disturbing the other program's operation. It is as though your assembly language program is temporarily 'stealing' ZRDOS for a minute, but doing so in an orderly fashion so that the other program does not lose its place (pointers and parameters) during its own ZRDOS system call. The main reason why re-entrance is desirable is to allow greater flexibility in ZCPR3 I/O Packages. I/O Packages redirect console and printer activity to and from disk files so it is nice to do this disk accessing smoothly through ZRDOS without interfering with another program doing disk operations at the same time.

ZRDOS Utilities

The following utilities are included with ZRDOS and require ZRDOS to be present on the system in order to run:

- COMP File Compare Utility
Compares two files and reports in Hex and ASCII any differences in a full screen format.
- AC Archive Copy Utility
This powerful utility takes advantage of the file Archive Attribute to copy only those files to your backup disk which have changed since the last time that AC was run. Many options are available at run-time.
- DFA and SFA Display File Attributes
Set File Attributes
These utilities allow display and manipulation of the File Attributes.
- DUMP A HEX/ASCII file dump utility.
- VIEW A file display utility which allows paging backwards and searching for strings.
- PUBLIC Used to designate public drive/user areas.
- VTTYPE A full screen, bi-directional file display utility which uses the ZCPR3 environment (TCAP) to determine the characteristics of your video terminal. It allows for string searches and displays a command menu.
- DOSERR This utility is used when the user receives a ZRDOS error. ZRDOS prints an error number. By invoking DOSERR followed by the error number, you will get a full explanation of the particular ZRDOS error.

Installation Of ZRDOS

Installation of ZRDOS is not very difficult. If you purchase the auto-install version of Z-System, everything is taken care of for you. If you purchase the manual install version, installation is still simple. ZRDOS will have to be installed after ZCPR3 has been installed. On the ZRDOS disk is a utility (ZRDINS.COM or some

similar name) which will relocate the ZRDOS binary image to its running address for your system and create a file containing the new ZRDOS. The utility obtains the old BDOS running address and location of the Wheel Byte from the SYS.ENV ZCPR3 environment descriptor. If it can't find SYS.ENV, it will prompt you to manually enter these addresses. The installation utility will then create the ZRDOS binary image (ZRDOS.BIN or some similar name). You will next run SYSGEN to copy the ZCPR3/BDOS from the system tracks into memory. Then you will **SAVE 38 CPM.SYS** to transfer the ZCPR3/BDOS from memory to a new disk file. Now you need DDT to overlay the new ZRDOS over the old BDOS. Here is a sample command dialog:

```
DDT CPM.SYS<cr>      (have DDT load CPM.SYS)
IZRDOS.BIN<cr>      (define the next file to read)
R1080<cr>           (read the new file with an offset)
^C

SAVE 38 Z.SYS        (save the changes to a new file)

SYSGEN Z.SYS         (place the new file on the system
                    tracks)
```

A very important note about that offset 1080 regarding Heath systems: This offset is the standard offset for DDT to find the start of the BDOS. It is actually one page (100H or 256 bytes) less in value than the actual address of the BDOS in the SYSGEN image (CPM.SYS). This means that you will find the start of the BDOS at 1180H in a standard CPM SYSGEN image. On Heath systems, you will find the BDOS there if you booted your system from an H-17 hard sector drive. However, if you booted from an H-37 soft sector drive, the locations of the CCP and BDOS (as well as ZCPR3 and ZRDOS) will be 80H or 128 bytes higher in the SYSGEN image. Therefore, on an H-37 system, you will find ZCPR3 at 0A00H and ZRDOS at 1200H. So, if you are installing ZRDOS on an H-37 drive, you will use 1100 as the offset value instead of 1080.

Other Notes Regarding Z-System Running On Heath Z-80 Computers

The CONFIGUR utility may crash Z-System unless certain precautions are taken. As mentioned before, do not change the option of echo-on-delete on the Terminal/Printer options menu if ZRDOS is installed. ZRDOS always treats the delete key the same as the backspace key and changing this option with CONFIGUR will corrupt ZRDOS.

The other option which will surely crash Z-System (ZCPR3 in particular) is messing with menu screen D which allows set-up of automatic command lines on cold or warm boots. With the standard CP/M CCP, you could run a program automatically on cold or warm boot by placing the file name directly into the CCP at a known address and passing control to the CCP. Under ZCPR3, you could do the same thing, but the method is vastly different. The recommended ZCPR3 configuration calls for a Multiple Command Line Buffer (MCLB) external to ZCPR3. It is 200 bytes in length and stores multiple commands, separated by semi-colons, up to 200 characters in length. If you wanted to automatically run a program on cold boot, you would place the file name in the MCLB. When control is passed to ZCPR3, it will execute that file. When ZCPR3 was installed, the BIOS was modified to insert the filename STARTUP.COM into the MCLB. This means that STARTUP.COM will be run every time the system is booted (if it can be found on the disk). To make matters more complex, STARTUP.COM is usually an ALIAS. It was created with the ALIAS utility and it is merely a list of other files to be executed. It is similar in operation to a submit file, except that an ALIAS looks

just like a .COM file to ZCPR3. STARTUP.COM usually will load all of the ZCPR3 support files, such as the Flow Command Package (FCP), the Resident Command Package (FCP), the Environment Descriptor (ENV), Named Directories (NDR) and any other desired .COM file or terminal/printer initialization sequences.

Getting back to the original problem of crashing ZCPR3 with CONFIGUR, if you perform any changes to the D menu screen which specifies command lines to run on cold or warm boot, CONFIGUR will poke the file name into ZCPR3 instead of the MCLB where it belongs. This will corrupt ZCPR3. The only recovery is to SYSGEN the disk from your backup disk (you do have a backup, don't you?).

All other CONFIGUR screens and options will not cause a problem with Z-System. Other than the two problems mentioned, you can do no more harm to Z-System than you could have done to CP/M. You do realize that reckless use of CONFIGUR can render a disk useless in a matter of seconds regardless of the operating system used.

Looking For Available Memory For Manual Install

The following table outlines the page zero memory assignments for standard Heath CP/M 2.2. They will be the same under Z-System and you may assign unused bytes to Z-System functions. For example, I used address 3BH for the Wheel Byte. Many Z-System implementations use address 40H for the Path information. This area is used by the Heath BIOS so the Path will have to be located elsewhere (mine is at FFC0H).

Heath/Zenith CP/M 2.2 Page Zero Memory Assignments

Address	Contents	(INT)	Description
0000H-0002H	JMP BIOS+3	(0)	;Warm Boot, points to the ;BIOS Jump Table
0003H-0003H	DB IOBYTE		;Intel Standard IOBYTE
0004H-0004H	DB DEFAULT DISK		;Current Default Disk
0005H-0007H	JMP BDOS+6		;BDOS Entry Point
0008H-000AH	JMP CLOCK	(1)	;Clock Interrupt ;Service Vector
000BH-000CH	DW TICCNT		;Two Byte counter ;incremented every 2 ms.
000DH-000DH	DB H88CTL		;Current contents of the ;H89 Control Latch
000EH-000EH	DB H8CTL		;Current contents of the ;H8 Control Latch
000FH-000FH	DB DEVCTL		;Current Contents of the ;H17 Control Latch
0010H-0017H	DB INT2	(2)	;Interrupt 2 (Not Used)
0018H-001AH	JMP CRTINT	(3)	;CRT Interrupt Service ;Vector
001BH-001FH	DB UNUSED		; (Not Used)
0020H-0022H	JMP H37INT	(4)	;H37 Interrupt Service ;Vector
0023H-0023H	DB DLYM03		;H37 Motor turn-off delay
0024H-0024H	DB DLYH37		;H37 Deselect Delay Count
0025H-0025H	DB H37CTL		;Current contents of the ;H37 control latch
0026H-0026H	DB H37IRET		;Where to go after H37 ;interrupt
0027H-0027H	DB UNUSED		; (Not Used)
0028H-002FH	DB INT5	(5)	;Interrupt 5 (Not Used)
0030H-0037H	DB INT6	(6)	;Interrupt 6 (Not Used)
0038H-003AH	JMP DDT/SID	(7)	;Interrupt 7 contains a ;jump to DDT or SID when ;running in debug mode
003BH-003FH	DB UNUSED		; (Not Used, Reserved)
0040H-0047H	DB DRIVEMAP		;Logical/Physical ;drive map
0048H-0048H	DB BOOTFLG		;Boot Device Flag
0049H-0049H	DB BOOTDEV		;Boot Device Address
004AH-004CH	DB BOOTBEGIN		;Boot beginning of ;Partition (H67)

004DH-004DH	DB	BOOTLAST	;Boot last sector of ;partition+1 (H67)
004EH-004FH	DB	ADDRBIOS	;Address of start of BIOS
0050H-005BH	DB	UNUSED	;(Not Used, Reserved)
005CH-007CH	DB	FCB	;Default File Control Block
007DH-007FH	DB	RRP	;Random Record Position
0080H-00FFH	DB	DISKBUF	;Default 128 byte DMA ;Buffer

TPA And Memory Restrictions

Because ZCPR3 relies heavily on memory locations external to itself, the Transient Program Memory (TPA) is normally smaller than a standard Heath CP/M system. The TPA is that part of memory where your applications programs run. You can not take system memory and dedicate it to special functions without sacrificing somewhere else. The TPA is where the sacrifice occurs. In my H89 system running H17 and H37 disks with a full Z-System (not including I/O Package), I have approximately a 48K TPA available. Some users of certain very large applications programs will find that they run out of memory (TPA space) after changing over to Z-System. One case comes to mind regarding the Microsoft Basic Compiler and L80 Linking Loader. Under Z-System, you are limited to about a 20K COM file obtained from the Basic Compiler. Under CP/M you can obtain about 24K in a COM file. This means that if your Basic program causes the compiler to generate a COM file larger than 20K, under Z-System, you probably will run out of memory either compiling or linking the program. However, applications programs which are disk-oriented like WordStar and dBASE-II will run without any problems under Z-System since the disks are used for program data memory and the programs do not fully reside in memory all the time. They use overlays which are constantly manipulated in and out of memory.

Source For Z-System

Z-System, namely ZRDOS, is not in the public domain. The only source is Echelon, Inc. Z-System is offered in two versions. The first is a manual-install version using CP/M, MOVCPM, SYSGEN, MAC, and DDT. The second is an auto-install version called Z-COM. Echelon recommends that you not attempt the manual-install version unless you have at least two years of programming experience, especially in assembly language.

Z-COM is sold in either a single or four-disk set. The single disk is for those who already have the manual-install ZCPR3 running and now want to add auto-install capabilities to their collection. The four-disk set is a complete auto-install Z-COM system and includes over seventy utility files in object form.

The single disk for those who already have ZCPR3 running is priced at \$69.95. It will enable you to use your manual-install ZCPR3 files to create a full auto-install Z-System. The four disk set is priced at \$119.00 and is a complete auto-install Z-System which can be implemented by a novice.

Echelon also offers a complete line of development tools and applications, such as a relocating macro assembler, disassembler, debuggers, disk cataloging program, modem communications program and remote bulletin board program which all utilize the power of Z-System. Echelon also publishes a newsletter called Z-NEWS. This newsletter provides timely information for Z-System users from novice to expert. Since Digital Research all but totally abandoned support of their existing 8 bit products and discontinued development of new 8 bit programs, you would be foolish not to turn to Echelon for high-tech 8 bit products to keep your Z-80 humming. You may think that I own stock in Echelon the way I carry on about them. Actually, I am

only one of their customers. However, Echelon is one of the few companies where you feel that you are important to them. You sense that they are excited about and believe strongly in the quality of their products. They support their customers more like personal friends. You can tell that they like what they are doing. Echelon is 'number one' in my book.

For more information and a current price list, contact:

Echelon, Inc.
101 First Street
Los Altos, CA 94022
(415) 948-3820

Z-NODE Central BBS: (415)-489-9005
300/1200/2400 baud

There are a number of Z-NODE remote access systems from coast-to-coast. They all support and maintain the latest ZCPR3 upgrades as well as provide Z-System question and answer sessions. Write to Echelon for a list of Z-NODE systems.

Z-System And Further Reading

I know that all this Z-System stuff sounds complex and I am sure that writing about it without the reader having hands-on experience does not do it justice. I only hope I have created an interest in Z-System so that you will seek it out and begin to learn about it. The system is vast in many ways. It has raw power itself. ZCPR3 source code is available so it has the power to teach you. It is almost impossible to exhaust its potential. You do need to put forth some effort yourself. Here are a few books and articles about ZCPR3 and ZRDOS.

Conn, Richard. *'ZCPR3 - The Manual'*, New York Zoetrope, 1985, 351 pages. This book was written by the creator of ZCPR3. This is the 'bible' of ZCPR3 and accompanies the many on-line help files which come with ZCPR3. Available for \$19.95 from Echelon, Inc.

Conn, Richard. *'ZCPR3 and I/O's'* Echelon, Inc, 1985, 50 loose-leaf page booklet. It details the implementation of I/O packages and how to modify your BIOS to include I/O redirection. Available for \$9.95 from Echelon, Inc.

Swenton, Rick. *'Upgrade Your CP/M 2.2 With ZCPR3, A Z80-Based Command Processor'*, REMark, November 1985.

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Conn, Richard. *'The Evolution of ZCPR, Part 1'*, Computer Language, October 1984.

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McCord, David. *'Z-System reasserts 8-bit computing in 16-bit world'*, Electronic Products, March 15, 1985.

Ciarcia, Steve. *'Build the SB180 Single-Board Computer, Part 2, The Software'*, Byte, October 1985.

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